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LEAD POISONING IN THE POTTERY TRADES

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TABLE OF CONTENTS.

PART I.

PART II.

PART IV.

PART V.

ILLUSTRATIONS.

INDEX OF TABLES.

INDEX OF CHARTS.

LEAD POISONING IN THE POTTERY TRADES.

PART I.

POTTERY REPORT.

INTRODUCTION.

REQUEST FOR A SURVEY.

In December, 1918, the Brotherhood of Operative Potters, through Mr. William Mushet, health officer of the brotherhood, requested an investigation to determine the prevalence of lead poisoning among dippers in the pottery industry. Dr. Francis D. Patterson, chief of the bureau of hygiene, Pennsylvania department of labor and industry, to whom the request was made, after conference with Mr. John Roach, chief of the bureau of hygiene and sanitation of the New Jersey department of labor (both field directors of the Office of Industrial Hygiene and Sanitation, U. S. P. H. S.), forwarded this request to the United States Public Health Service, with their indorsement that the Service undertake the survey, extending its scope to include all processes in the manufacture of pottery where the workers are exposed to a lead-poisoning hazard. This recommendation met with the approval of the Surgeon General, who acceded to the request and directed the Office of Industrial Hygiene and Sanitation to conduct the research required.

ALLEGED DISCRIMINATION AGAINST POTTERS DUE TO PREVIOUS SURVEYS.

Surveys had previously been made of the lead hazard in the pottery trades.[1] Analyses of vital statistics had also been made, with the result that a well-defined belief prevailed that certain pottery occupations are hazardous, and that dippers in particular are exposed, to a marked degree, to lead poisoning. As a result of these conclusions the Brotherhood of Operative Potters felt that dippers and some other pottery workers were unjustly discriminated against in the matter of obtaining life insurance. That there is a hesitancy among life insurance companies and fraternal societies to accept dippers as a safe risk is undoubtedly true. Frederick L. Hoffman,[2] Ph. D.,

[1] Lead Poisoning in Potteries, Tire Works, and Porcelain Enameled Sanitary Ware Factories, Bulletin of the U. S. Bureau of Labor Statistics No. 104, by Alice Hamilton.

[2] Mortality from Respiratory Diseases in Dusty Trades, Bulletin No. 231, pp. 265–266, Bureau of Labor Statistics.

vice-president of the Prudential Life Insurance Co., states: "As a general rule both life insurance companies and fraternal societies are extremely cautious in accepting risks on the lives of persons employed in at least the more health injurious processes of the pottery industry. Dippers, flint-mill workers, ground layers, mixers, scourers, and sweepers are generally declined unconditionally. Kilnmen, mold makers, placers, pug-mill workers, sagger makers, and slip makers are occasionally accepted, but at somewhat higher premium rates than those charged men in recognized healthy employments." Believing that denial to certain potters of the right to obtain life insurance is due to misunderstanding of the hazards of their trade as prevalent to-day, the Brotherhood of Operative Potters made this request for an impartial survey.

RESULTS OF PREVIOUS SURVEYS.

It will be recalled that the two previous surveys of importance in this field in the United States showed a high rate of plumbism. One of these was made by Dr. Alice Hamilton in 1910 and 1911 and the other by Dr. Emery R. Hayhurst in 1914. Dr. Hamilton's survey included 68 plants in the States of New Jersey, Ohio, West Virginia, Kentucky, Tennessee, Indiana, Illinois, Wisconsin, and Pennsylvania, while Dr. Hayhurst made a survey of 47 plants in the State of Ohio.

Both these investigations covered plants making white ware; yellow, art, and utility ware; tile; and porcelain enameled sanitary ware. The survey by Dr. Hamilton might be called a period survey, the number of cases of lead poisoning over a period of two years being listed; while Dr. Hayhurst's survey might be called a cross-section study, there being listed the number of cases found when the plants were investigated.

Dr. Hamilton covered such points as methods of handling lead glaze; the extent to which workers are exposed; the precautions taken to prevent poisoning; a study of the workers themselves—their living conditions, their nationality, the character of their work, and the extent of industrial lead poisoning among them.

Dr. Hayhurst emphasized plant conditions as found, and made a comparison of the various conditions.

Dr. Hamilton obtained her list of cases of lead poisoning from four sources, namely, from physicians practicing in the towns where the plants were located, from hospital records, from cases discovered by physical examination of certain pottery workers, and from the history obtained from workers, of their own attacks of lead poisoning, with hearsay evidence of cases they had known among their fellow workmen. Dr. Hayhurst gives the number of cases found at the time of making investigations of plants. Unfortunately, there was included in this list a number of cases of absent workers, not seen by examining physicians, but alleged by fellow workers to be complaining of symptoms of plumbism.

Dr. Hamilton found 87 cases of lead poisoning among 1,100 men in a year and 57 cases among 393 women. Of 148 enamelers and mill hands examined, 54, or 36 per cent, were found by Dr. Hamilton to be suffering from chronic lead poisoning. Dr. Hayhurst reports that of 2,585 persons exposed, 109 were found to be suffering from lead poisoning. It is interesting to note that our investigators found 40 out of 50 of the above 109 cases still suffering from lead poisoning. Of the remaining 59 cases, our men procured information for about 24. Five of these had died of some unstated cause, 2 were employed in a pottery where lead is said not to be used, and the remainder were found to be insurance agents, farmers, teamsters, and foundrymen.

These two surveys clearly demonstrate the presence of lead poisoning among pottery workers, and both Drs. Hamilton and Hayhurst pointed out defects found in working conditions and made suggestions and recommendations which, if applied, would reduce the number of cases of lead poisoning.

For obvious reasons, since these two previous studies have been made in the pottery field of the United States, and because of the motive underlying the request for this particular study, the results of this research have not been compared with rate of plumbism found in foreign potteries. The main point here is whether, in a field where previous work has been done and definite recommendations have been made, and where the industry has been developing to supply home trade, and during a period of definite growth in plant hygiene and sanitation, the improvement in industrial hygiene and sanitation has been such as to reduce or eliminate the hazard of plumbism.

SURVEY DECIDED UPON.

In view of the fact that almost a decade has passed since Dr. Hamilton's survey in this field was made, and that during this time industrial hygiene and sanitation have made rapid progress in industrial establishments in general, the United States Public Health Service felt the necessity of making a more comprehensive survey as to the prevalence of lead poisoning among workers in exposed processes in the pottery industry.

SURVEY PERSONNEL.

Three districts of the Office of Industrial Hygiene and Sanitation, working under the close supervision of the research branch, participated in the survey, and the following personnel was employed for varying periods of service:

Philadelphia district:
- Passed Asst. Surg. (R.) Paul M. Holmes, director.
- Scientific Assistant Philip G. Kitchen, M. D.
- Scientific Assistant Eloise Meek, M. D., Dr. P. H.
- Scientific Assistant Myron A. Bantrell.
- Scientific Assistant E. N. Riley.
- Scientific Assistant C. A. Ward.
- Scientific Assistant George E. McElroy.

Pittsburgh district:
- Associate Sanitary Engineer (R.) G. E. P. Wright, director.
- Scientific Assistant Eli A. Miller, M. D.
- Scientific Assistant Harry C. Angermyer.
- Scientific Assistant E. Paul Raiford.

Cleveland district:
- Associate Sanitarian (R.) N. P. Bryan, director.
- Asst. Surg. (R.) Marvin D. Shie, M. D.
- Scientific Assistant Edythe M. Bacon, M. D.
- Scientific Assistant Walter H. Harris.
- Scientific Assistant Howard K. Thompson.

Dust analyses were made by—
- Chemist Edward L. Helwig.
- Scientific Assistant George H. Birch.
- Chemist Harry W. Houghton.

In addition, the research was directed in the Washington office by Passed Asst. Surg. A. J. Lanza and Sanitarian Bernard J. Newman (Reserve), with the assistance—toward the close of the study—of Passed Asst. Surgs. (Reserve) Wm. J. McConnell and O. M. Spencer in checking up the accuracy of the diagnosis; and Frank M. Phillips, statistician, in analysis of the data collected.

COOPERATION.

Throughout the survey the most cordial cooperation was received from the plant managers, from the members of the Brotherhood of Operative Potters, and from the pottery workers themselves. The extent of this cooperation is shown by the relatively high percentage of physical examinations made among the total number of employees engaged in the hazardous processes. With scarcely an exception, both owners and workers, including time and piece workers, seemed eager to promote a comprehensive and fair study of the alleged hazards.

CONFIDENTIAL DATA.

In all contacts made with the plants, as well as with the workers, the point was emphasized that information obtained would be considered strictly confidential in so far as local identity of plant or worker was concerned. Thus the history of a physical examination would not be furnished to any other individual but the one personally and immediately concerned, while statements of plant conditions and recommendations based thereon would be supplied only to the plant management. All material collected about the physical condition of individual workers or of individual plants would, when embodied in this final report, be so employed as to lose the identity of the individual and of the plant. The reason for this attitude is evident. The Office of Industrial Hygiene and Sanitation has no authority in the law to act as factory inspectors. Its sole function is to discover industrial health hazards involved in the causation of specific disease of man, and to determine engineering and other prophylactic measures for the prevention or elimination of such hazards. In this particular survey the object was to determine the presence and extent of the alleged lead hazard in certain processes, and, if such alleged hazard proved to be real, to suggest methods for its control. With this end in view, reports on individual plants were submitted to the plant managements concerned, while each pottery worker whose physical examination disclosed symptoms of lead poisoning or of any other physical ailment or defect was given private consultation. His condition was made known to him, and he was advised to see a physician of his own choice. To each pottery worker examined instructions were given relative to measures of personal hygiene, which if observed would materially reduce the hazard of his occupation.

ACKNOWLEDGMENTS.

Acknowledgments for valuable assistance and counsel are due Dr. Alfred Stengel, consulting hygienist, U. S. P. H. S., and professor of medicine, University of Pennsylvania; R. R. Sayres, passed assistant surgeon, U. S. P. H. S., chief surgeon, Bureau of Mines; Dr. Emory R. Hayhurst, consulting hygienist, U. S. P. H. S., and professor of hygiene, Ohio State University; Dr. Francis D. Patterson, chief of the division of industrial hygiene, Pennsylvania Department of Labor and Industry; Mr. John Roach, chief of the bureau of hygiene and sanitation of the New Jersey Department of Labor; Mr. William Mushet, health officer of the National Brotherhood of Operative Potters; The Bureau of Mines, Pittsburgh, Pa.; the Hygienic Laboratory, U. S. P. H. S.; Mr. R. T. Stull, superintendent of the Ceramic Laboratory, United States Bureau of Mines, Columbus, Ohio; and Mr. N. P. Bryan, associate sanitarian (R.), U. S. P. H. S.

THE POTTERY INDUSTRY AND ITS IMPORTANCE.

POTTERY PRODUCTION IN THE UNITED STATES.

The pottery industry is one of the oldest industries in the United States. On a commercial basis, excluding aboriginal ware, pottery production dates from 1685, when Dr. Daniel Coxe, of London, established a white-ware pottery at Burlington, N. J. In 1744, about 24 years before Cooksworthy discovered a suitable clay for the manufacture of chinaware in England, china clay was imported to England from the United States by Edward Heylan and Thomas Frye.[3] America, therefore, at one time helped to supply England with china clay, a fact the reverse of what is true to-day.

THE INCREASE OF POTTERIES IN THE UNITED STATES AND THEIR DISTRIBUTION.

The United States census of 1850 reported 484 potteries engaged in the manufacture of various types of pottery products. The United States Geographical Survey of 1912 shows 4,628 operating establishments making pottery, brick, or tile products, of which number 434 plants were manufacturing pottery products exclusively. The distribution of these latter plants by States is not available.

The impression seems to prevail among pottery workers that improvements in working conditions and in operations for decreasing production costs are not of material importance because of the alleged fact that the pottery industry in the United States is bound to decline. The difficulties in securing clay without importation may have contributed to this belief.

Nevertheless the fact remains that in a period of little over 60 years there has been almost a thousand per cent increase in the number of potteries in the United States, while those plants manufacturing exclusively the type of ware covered by this survey almost equal in number to-day the total number of plants manufacturing all kinds of ware in 1850.

The 1914 Census of Manufacturers shows the following distribution of potteries by States:

TABLE A.—*Summary for industries: Comparative for the United States, by States for 1914.*

State.	Number of establishments.	Wage earners (average number).	State.	Number of establishments.	Wage earners (average number).
United States	350	26,705	New Jersey	50	5,225
			New York	16	1,691
Alabama	12	26	North Carolina	12	11
California	11	177	Ohio	99	11,096
Colorado	5	53	Pennsylvania	21	1,564
Georgia	14	32	South Carolina	5	10
Illinois	16	1,459	Tennessee	5	48
Indiana	9	770	Texas	11	46
Louisiana	3	24	West Virginia	15	3,339
Massachusetts	8	138	Wisconsin	3	8
Michigan	6	339	All other States	26	641
Missouri	3	8			

Although the potteries engaged in production of sanitary and like ware covered in this survey are widely distributed over 36 States, yet

[3] Edward Atlee Barber: "Pottery and Porcelain in the United States."

the majority of these plants are found in 13 States, while the States of New Jersey, Pennsylvania, Ohio, and West Virginia—those covered in this survey—have 52.7 per cent of the total number of plants of like character in the United States. It will thus be seen that the area of the survey embraces the more prominent centers of pottery producion.

NUMBER OF EMPLOYEES AND NATIONALITIES.

In a comparison of the number of employees engaged in the various manufacturing industries in the United States the pottery industry stands sixty-first.

POTTERY EMPLOYEES.

TABLE B.—*The number of persons employed in the pottery industry, by age periods and sex, not including brick, tile, terra-cotta, clay, or stone industries.*[1]

Age.	Number of employees.			Per cent of total number of employees.	
	Total.	Males.	Females.	Males.	Females.
10 to 13 years	63	47	16	0.16	0.05
14 to 15 years	898	520	378	1.76	1.28
16 to 20 years	5,965	3,783	2,182	12.81	7.39
21 to 44 years	17,687	14,966	2,721	50.69	9.22
45 years and over	4,913	4,562	351	15.45	1.19
Total	29,526	23,878	5,648	80.87	19.13

[1] Miscellaneous Publication, Series 21, Department of Commerce, 1915, p. 269.

The pottery industry is now very largely American manned, as shown by the following table quoted from the department of Commerce report, and by our own table, which will be found under the section on Field Survey. As noted by this table, 73.79 per cent of all pottery employees were born in the United States. The industry may therefore be considered as carried on in the main by workers familiar with American customs and able to understand the English language; and the hazards of their work are not intensified by lack of knowledge of English or lack of Americanization.

TABLE C.—*Persons 10 years of age and over employed in the pottery industry, not including brick, tile, terra-cotta, clay, or stone industries, in the United States in 1910.*[2]

Nativity and parentage.	Total.	Males.	Females.	Per cent of total.
Native white of native parentage	15,344	12,027	3,317	51.97
Native white of foreign or mixed parentage	6,444	4,887	1,557	21.82
Foreign-born white	7,090	6,486	604	24.01
Japanese and Chinese	171	5	166	.58
Negro	477	473	4	1.62
Total	29,526	23,878	5,648	100.00

[2] Miscellaneous series No. 21, Dept. of Commerce, 1915, p. 345.

According to the distribution of employees this survey covers also the States containing the larger plants in the pottery industry. Eighty and five-tenths per cent of all employees are employed in 87 plants. The remainder, or 19.5 per cent of the employees, are employed in 263 plants, while 52.6 per cent of the plants employ less than 20 people each.

TABLE D.—*Number of wage earners and per cent in each class for the 350 plants covered in the 1914 Census of Manufacturers.*[1]

	Number of establishments.	Number of employees.	Per cent of average number employed.
No employees	27	None.	....
1–5 employees	99	232	0.9
6–20 employees	58	753	2.6
21–50 employees	40	1,454	5.4
50–100 employees	39	2,768	10.4
101–250 employees	62	10,377	38.9
251–500 employees	19	6,093	22.8
501–1,000 employees	5	3,800	14.2
Over 1,000 employees	1	1,228	4.6

[1] 1914 Census of Manufacturers, p. 418.

TABLE E.—*Production, capital invested, and value of products.*

[In establishing the importance of the pottery industry it is essential to show not only the number of employees but the value of the products. Such values are quoted from Miscellaneous Series No. 21, *Bureau of Commerce*, 1912, p. 73.]

States.	White ware.[1]	Stoneware, yellow, red, and Rockingham ware.	China-ware.[2]	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
Ohio	$9,969,491	$2,095,351	....	$451,971	$1,827,290	$1,164,632	$15,508,735
New Jersey	1,090,683	84,952	$1,155,766	5,199,278	1,146,467	258,774	8,935,920
West Virginia	2,051,987	(3)	50,002	1,156,478	(3)	36,444	3,365,166
New York	(3)	31,497	691,065	(3)	1,269,108	51,988	2,405,532
Pennsylvania	902,585	443,663	280,472	185,000	307,636	9,184	2,128,540
Indiana	(3)	46,100	....	633,578	(3)	....	1,077,102
Other States	814,685	2,176,485	....	275,950	376,815	268,787	3,083,109
Total	14,829,431	4,878,048	2,177,305	7,902,255	4,927,316	1,789,809	36,504,164

[1] White ware, including semiporcelain, white granite, china-clay ware, and semivitreous ware.
[2] China, bone china, delft, and belleek ware.
[3] Included in "Other States."

From an analysis of the foregoing tables it occurred to the investigators that if, on a survey of the larger plants, it was found that the industry did present to workers in selected occupations a definite exposure to lead compounds, with a resultant percentage of employees affected with plumbism, the hazards might be classed as normal trade hazards and should not be confused with those arising from abnormal working conditions found in small shops with limited facilities and a diversity of occupations carried on alternately by the same employee. The predominance of larger plants in the production of pottery ware is evident from Table D, showing

"Number of wage earners and per cent in each class for the 350 plants covered in the 1914 Census of Manufacturers." Moreover, the practicability of a reasonable control of plumbism among pottery workers in the United States is more certain because of the greater number of large plants with ample resources. Where large plants show a higher rate of plumbism than small plants, there is less excuse for the continuance of working conditions responsible in the main for such higher rates. Such plants, having larger resources and more continuous use for improvements, can better afford to install them. Were the industry one of small plants mainly, as assumed by many pottery manufacturers, there would be but small chance of the installation of devices to control its hazards. The table mentioned above and given on page 18 shows, however, that small plants play but a relatively insignificant part in the total distribution of pottery employees.

The States covered in this survey are among the five leading States in the production of pottery ware, and the total value of their products is approximately five-sixths of that of the entire production in the United States—Ohio producing a little over 42 per cent of the total output.

In 1914 the total capital invested in this industry was $44,704,000, the wages paid to employees were $16,666,000, and the cost of material was $12,032,000.[5]

The value of all domestic pottery marketed in 1918 was $65,222,951. Of this Ohio, the leading State, produced ware valued at $25,779,654, nearly 40 per cent of the value of the production in the United States; and of Ohio's production the white ware was valued at $15,779,620, 61 per cent of the entire State production. The first five States in order of the value of their productions are Ohio, New Jersey, West Virginia, New York, and Pennsylvania, with a total production valued at $56,534,495, nearly 87 per cent of the value of the total production of the United States. (U. S. Geographical Survey on "Pottery in 1918," p. 4.)

CONSUMPTION, EXPORTS, AND IMPORTS OF POTTERY IN THE UNITED STATES IN 1918.

CONSUMPTION.

The value of the pottery imported into the United States in 1918, added to that of the domestic pottery marketed, amounted to a total of $71,616,531. After deducting from this sum the value of the exports of domestic wares, approximately $1,479,552, and of the reexports of foreign ware, $70,099, the value of the apparent net consumption was $70,066,880, of which the domestic production

[5] Census of Manufactures, 1914, p. 202.
[6] U. S. Geographical Report on "Pottery in 1918," p. 12.

was 93 per cent—the highest proportion recorded. In 1917 and 1916 it was 92 per cent. In 1915 this per cent was 86, in 1914 it was 82, in 1913 it was 80, in 1912 it was 81.45, in 1911 it was 78.93, and in 1910 it was 77.08. Here, again, it will be seen that in addition to the steady increase in the number of potteries there is an increase also in the percentage of home ware used in the United States. This is a situation which not only indicates the continued importance of the industry, but nullifies the argument so often met with during the survey—that the industry is declining, and hence would not justify any extended improvements for lessening the lead hazard.

IMPORTS.

The total value of all clay products imported in 1918, at the port of shipment, was $6,684,200. Of this earthenware, crockery, china, and porcelain amounted to $6,370,530, the balance consisting of pipes, clay bowls, sanitary ware, bricks, and tile.

EXPORTS.

The value of the clay products of domestic manufacture exported from the United States in 1918 was $7,932,574, and these products were exported to the following countries in order of the value of exports: Canada, Central America, West Indies, South America, Mexico, Europe, Oceania, Newfoundland, and Africa.

CONCLUSIONS.

As shown by the table compiled from the official statistics of the principal foreign countries manufacturing pottery ware for the period between 1895 and 1913,[7] the United States is of all nations the heaviest importer of pottery products, importing over 100 per cent more pottery products in 1913 than France, our nearest competitor, yet our imports have not increased materially from 1895 to 1913. The total increase in 1913 over 1895 is $689,045, which is 7.6 per cent, as compared with an increase from 8 per cent to 1,141.66 per cent, of 12 other leading countries in the world. This increase in imports does not correspond with the population increase of 36 per cent for the same period, which fact not only shows that our own pottery products are approaching our needs more nearly than in the past, but also indicates a permanency of the industry, which warrants serious consideration of the character of its health hazards and of means to minimize them. This conclusion is further strengthened when it is recalled that our exports are on the increase, a gain of 1,432.34 per cent having been made in 1913 over 1895.

[7] Pottery Industry, Miscellaneous Series No. 21, p. 645, Department of Commerce.

The increase in percentage of exports and the decrease in percentage of imports are purposely omitted here because of the interference in any accurate interpretation of the trend of the industry, due to the abnormal trade relations caused by war.

The problem of the industry is not, as potters frequently express it, one of a declining trade which ultimately will cease to be a factor in the industrial world, but rather of a growing industry, to lessen the production cost of which requires thought in terms of labor-saving devices and working conditions from which unnecessary health hazards have been removed.

ORGANIZATIONS AND PUBLICATIONS.

Social and industrial progress follows the dissemination of ideas among groups held together by common interest. It is gratifying to note that the pottery industry is well organized into groups of like kind, which hold meetings and publish trade journals, and thus afford vehicles for the dissemination of ideas concerning all phases of production of interest to pottery manufacturers or pottery workers.

The American Ceramic Society, the object of which is to promote the arts and sciences connected with ceramics by means of meetings for the reading and discussion of professional papers, for the publication of professional literature, and for social intercourse, is the largest and most cosmopolitan organization among pottery manufacturers. The United States Potters' Association is an organization of potters manufacturing vitreous china, sanitary ware, and earthenware. It has been in existence for 36 years, and its general objects are "to procure regularly the statistics of the trade, both at home and abroad; to provide for the mutual interchange of experience, both scientific and practical; to collect and distribute all information relating to the various branches of our arts, and to take such means as will devise theoretical and practical information to our trade in all its branches."

The publications circulated among manufacturers are the Journal of the American Ceramic Society and the American Potters' Gazette.

Among pottery employees the National Brotherhood of Operative Potters, which is affiliated with the American Federation of Labor, is the chief organization. This society is composed entirely of pottery employees, and is the final perfected organization of various unions in existence among the potters prior to 1890. It has grown from a membership of 200 to its present size of 8,870 members. The National Brotherhood of Operative Potters has a death-benefit system of insurance and a tuberculosis fund.

The principal publication of employees is The Potters' Herald, which is published by the National Brotherhood of Operative Potters. There are several plants that have local health and sick-benefit associations, as well as publications for the mutual advantage of employers and employees.

The National Brotherhood of Operative Potters and the United States Potters' Association settle all questions arising between manufacturers and employees, and because of this arrangement the pottery industry has not for a long period been troubled by any serious strikes or labor disturbances.

The advantages gained in recent years by employers and employees through their organizations have been many—a few of which are the establishment of uniform piecework prices and of a system of collective bargaining, the continuance of work while grievances are being adjusted, the regulation of the working day, and the prevention of unwarranted strikes.

Both manufacturers and workers are provided with means through organization, meetings, periodicals, and joint relations, for cooperation to eliminate any and all occupational health hazards arising within the industry.

SCOPE AND TECHNIQUE OF THE SURVEY.

WHERE MADE—IN WHAT STATES.

Representative potteries of New Jersey, Ohio, Pennsylvania, and West Virginia are included in the survey. The total number studied is 92—24 in New Jersey, 47 in Ohio, 8 in Pennsylvania, and 13 in West Virginia. Two additional plants in New Jersey were superficially studied, but are not included in this report, because the manager of one of them refused permission for a comprehensive survey and the other was undergoing reconstruction, so that a complete survey was impracticable.

For administration purposes the work was divided into districts—the Pittsburgh district, with 30 potteries; the Cleveland, with 38; and the Trenton, with 24. The potteries, however, came largely within two definite trade areas, one known as the East Liverpool district, with 30 plants, and the other as the Trenton, with 24. There were 38 other potteries scattered outside these trade districts.

ATTITUDE OF PLANTS TOWARD THE SURVEY.

In a preliminary survey to determine the attitude of the pottery manufacturers toward the prospective study of a lead hazard in the industry, letters were sent to 54 plants, stating the purpose and plan of the survey and soliciting information as to the use of lead compounds in preparing glaze. Replies were received from 31 plants, of whom 27 expressed a willingness to cooperate. It appeared, therefore, that the attitude of the trade would be favorable to the study. Throughout the period of the survey this favorable attitude was uniformly found among both the plant owners and their employees.

After the selection of districts, service officers were detailed to make personal contacts with the plant managers to arrange for a formal entry into the various plants, for sanitary examination of personal service facilities, workrooms, and practices of employees, as exhibited in the various processes of production. Similar arrangments were made with the plants and the employees, for the physical examination of men and women exposed to a lead hazard.

COORDINATION OF FIELD INVESTIGATIONS.

Field investigations were begun in January, 1919, and were continued until August, 1919, save in a few instances where the necessary data pertaining to specific plants could not be secured until later.

The survey includes 21 plants making sanitary ware; 59, general ware; 4, tile; 4, yellow; and 4, art.

According to number of employees the sizes of the plants vary as follows:

Number of employees.	Number of potteries.
0- 50	5
51-100	14
101-250	55
251-500	14
500 plus	4

SCOPE OF TECHNIQUE.

The above tables show us that this survey includes plants of all sizes and a large number of plants of the most frequent size, as indicated in our tables on page 17, under "The Pottery Industry and its Importance." Therefore our selection is representative of the pottery industry of the United States as far as size is concerned.

Physical examinations were made of 1,809 workers out of a total of 1,902 engaged in the glaze departments of plants employing a total of 17,297 workers. Of these workers 1,436 are men and 373 women. Plant sanitation was investigated at the time of making the physical examinations. Dust samples were taken at various places of employment and in the line of travel in each department. These samples were analyzed for per cent of lead, for per cent of soluble lead, for dust count, and for weight. Samples of glaze mixture were also analyzed for per cent of lead and per cent of soluble lead.

QUALIFICATIONS OF PERSONNEL.

Great care was exercised in selecting the investigators. It was felt that routine investigations would not yield satisfactory results, and that although a comprehensive schedule was adopted, as will be indicated later, yet the investigators should be conversant with industrial processes and especially with the factors involved in the maintenance of health, or, in other words, with the factors that are capable of endangering health. With this end in view the investigators assigned to the physical examination of plants were chosen because of their technical training and were mainly men trained in chemical or sanitary engineering or experienced in public-health research work.

The medical officers assigned to the physical examinations of employees were all acting assistant surgeons of the United States Public Health Service, experienced in industrial hygiene and conversant with the effects of lead compounds upon the body. Women physicians were employed for the physical examination of women workers. In order to coordinate the work of the physicians, conferences were held at which the characteristic symptoms of lead poisoning were discussed and a uniform method of diagnosing plumbism was agreed upon. Throughout the period of the survey there was a close interchange of information among the members of the field force. Wherever deviations from agreed technique were made, records of such deviations were interchanged.

Close supervision of the work of the medical officers in making physical examinations was maintained by Dr. A. J. Lanza, in charge of the Office of Industrial Hygiene and Sanitation at that time, while similar supervision was given by field directors, working under Sanitarian Bernard J. Newman (R.), to the work of the engineers in the physical examinations of the plants and the determination of engineering, sanitary, and hygienic conditions.

SCHEDULES.

In order to assure the collection of pertinent data, a comprehensive schedule was prepared and used by all field workers. This schedule covers in detail all phases of plant conditions and of plant management that might have a bearing in the final analysis of the extent to which plant working conditions contributed to the occurrence of lead poisoning.

It was felt that data pertaining to plant management should picture the provisions made for supervision of workers as to personal practices and personal hygiene, since such matters affect the control or the incitation of the hazards of their employment. Hence personnel problems, medical supervision, health education, welfare work, housing, and like items were noted on the survey forms. To secure a picture of working conditions and of possible sources of health hazards, process analyses were made; and to facilitate the isolation of practices which might explain the greater or lesser prevalence of lead poisoning among potteries, plant physical conditions and the methods used by employees in pursuing their operations were correlated. Predisposing factors were included, such as fatigue, poor light, poor ventilation, uncleanliness, excessive heat or cold, inadequate or imperfect personal-service facilities, or their insanitary use. Each of these topics was subdivided in great detail. In addition, engineering practices to facilitate hygienic working conditions and to eliminate possible sources of infection were carefully noted. The schedule was elastic in that the engineers using it were instructed that it was to serve as a guide to help standardize the type of data from the various plants, as collected by many investigators, and that it was to be suggestive also of the new factors, which, if noted, were to be numbered and explained in full detail on the reverse side of the form.

A similar careful preparation was made of the form for noting the information obtained by the medical officers in their physical examination of employees. A standard schedule was also adopted here, to be supplemented by additional data as required by the physical condition of the workers examined. It was not deemed necessary to make a detailed examination of the workers further than to obtain information in regard to the subjects listed in the following outline:

Name.
Address.
Age.
Sex.
Nationality.
Occupation.
Process.
Location.
Time in present work.
Other occupations—time in each.
Hazards—dust, heat, poisons.
Light, vibrations.
Work:
- Time.
- Piece.

Hours of work.
Lunch:
- Time.
- Place.

Father's chief occupation.
Mother's chief occupation.
Maximum weight.
Weight after 3 months at present work.
Weight now.
Height.
Chief complaint, if any (in patient's words).
History of present illness from first symptom.
Social history (personal habits).
Past history from infancy (include menstrual and maternity).
Temperature. Pulse.
Build. Anasarca.
Emaciation.
Posture. Lordosis.
Gait. Kyphosis.
Glands—enlarged.
Skin:
- Color.
- Jaundice.
- Eruptions.
- Ulcers.

Arteriosclerosis.
Blood pressure.

Objective findings.

Well-nourished condition.
Color. Development.
Age. Apparent age.
Facial expression.
Evidence of paralysis.
Tremors.
Tongue.
Fingers.
Strabismus.
Eye:
- Vision (R) (L).
- Ptosis.
- Pupils.
- Disease.

Condition of teeth.
Lead line.
Tongue—coated.
Hearing.
Neck.
Children.
Chest—tender areas.
Heart.
Lungs.
Abdomen.
Eyes:
- Disease.
- Movements.
- Trachoma.
- Tremor (of lids).
- Exophthalmos.
- Pupil reactions.
- Cataract.
- Blindness.
- Vision (Snellen test, distance 20 feet).
- Right.
- Left.

Sense of smell (asafetida and peppermint):
- Sharp.
- Dull.

Nose diseased.
Lips:
- Color.
- Disease.

Objective findings—Continued.

Teeth:
- Condition.
- Occlusion.
- Absent (number).

Subjective history.

Headache.
Malaise.
Nausea—when.
Appetite—metallic taste.
Tongue—coated.
Abdominal pain (colic).
Constipation. Diarrhea.
Weight now. One year ago.
Neuralgic pains.
In muscles. Joints.
Lumbago.
Muscles—sore.
Prickling, burning, numbness in extremities.
Mental symptoms.
Eyesight.
Menstrual history.
Rigidity.

Subjective history—Continued.

Tenderness:
- Tumors.
- Enlarged liver.
- Other abnormalities.

Extremities:
- Wrist drop.
- Shoulder drop.
- Other paralysis.
- Muscular weakness.
- Grip (by dynamometer).

Neuritis.
Joints (inflammation).
Joints—swollen.
Contractures.
Reflexes:
- Knee.
- Biceps.
- Ankle clonus.

Blood examination.

Haemoglobin.
Microscopic.
Basophilic granulation.

All findings of physical examinations were noted at the time of the examination except such data as were determined by laboratory work. Physical examinations were made in the plant except where it was inconvenient for workers to be examined during the working period, in which event arrangements were made to have them attend temporary clinics. This was especially the case in the Trenton district, where a clinic was opened in the post-office buildings and workers appeared there for examination. After the purpose of the survey was understood and certain employees were advised of physical defects with which they had not been acquainted there was an evident willingness on their part to supply all information called for and to assist in securing accurate data.

MEASURING INSTRUMENTS AND METHODS OF COLLECTING SAMPLES.

The measuring instruments used in the survey were the anemometer, the sling psychrometer, and the Palmer water-spray dust machine to determine the air flow of exhaust systems, the temperature, and the relative humidity, and to collect dust samples for analysis, respectively. The anemometer was of the zero-setting attachment type, with four dials reading to 100,000 feet, the air current being determined by multiplying the velocity by the area of the fan chamber. The sling psychrometer consists of two thermometers whirled upon a handle, the bulb of the longer thermometer being covered with a cloth which was moistened with water before the instrument was put in motion. After whirling the thermometers for a few seconds, the readings of each were taken. This process was duplicated several times, until the values became constant. Relative humidities were computed from psychrometric tables of the Weather Bureau.[8]

Air sampling made with the Palmer water-spray dust machine followed the technique recommended by the committee on standard methods of the examination of air, American Public Health Association.[9] The machine works by the principle of suction, which is furnished by a motor-driven aspirator. A column of air is drawn through a quantity of distilled water, about 40 c. c., at a uniform rate, varying from 1 to 6 cubic feet of air a minute. This process is kept up for definite periods of time, which in the survey averaged about 35 minutes. The air thus filtered through the water represents in volume approximately that breathed by a man during eight hours of moderate labor. While the Palmer machine does not collect an air sample that is comparable with air conditions as they vary during the working day period, yet it approximates, among other devices on the market for air sampling, a standard test of air dustiness at a given place and for a given period during which it is in operation. According to the committee on ventilation of the American Public Health Association, the rate of efficiency of this instrument is about 60 per cent. Thus the dust counts given on the basis of the air samples collected may be interpreted as being less in quantity than the actual dust content of the air of the work places at the time of collecting the samples.

In an attempt to show the amount of lead which a man would take into his nostrils during the entire working day, some experiments were made with the "Dustite respirator." The principle upon which this respirator works is that of filtering air through a collecting gauze, the surface of which is at such an angle as to prevent settling of dust other than that drawn in by breathing. This respirator was adjusted to individual faces, and an allowance of 5 per cent was made for leakage. Workers volunteered to wear the apparatus for continuous periods. By placing the respirator on a number of workers in the same occupation, an average was obtained for the group for the entire working day. Samples thus collected were analyzed in the same manner as were those collected by the Palmer machine.

TECHNIQUE OF DUST ANALYSIS.

DUST WEIGHT.

The dust samples collected by the Palmer machine were transferred in the field to clean 100 c. c. volumetric flasks, the original containers being thoroughly rinsed with distilled water, sufficient in quantity to bring the total sample up to 100 c. c. These samples were then sent to the laboratory for examination. In the laboratory the flasks were thoroughly shaken, and two 1 c. c. portions of the solution were

[8] W. B. No. 235, U. S. Dept. Agriculture.
[9] The American Journal of Public Health. Vol. VII, 1917.

removed for the dust count. The remainder of each sample was filtered through a carefully prepared Gooch asbestos filter previously dried at 100° C. and weighed. The residue of dust was carefully washed with cold distilled water, dried at 110° C. for one hour, and weighed. The total weight of dust obtained was corrected for the amount of sample previously removed for the dust count. In case 2 c. c. were removed, 2.04 per cent of the weight of dust obtained was added to obtain the weight of dust in the original sample.

DUST COUNT.

The 2 c. c. removed from the sample for the dust count were placed in Sedgwick-Rafter cells. Two counts were made of each. Typical squares were selected and counts were made, the average of which was taken as the dust count of the sample. The magnification used was such that with the eyepiece micrometer each square approximated one standard unit. Dust counts were made and distributed, according to methods adopted in the dust analysis work of the United States Public Health Service, into groups 1, 2, 3, 4, and 5. Such groups were expressed according to size and according to standard units as follows:

Group.	Standard units.	Size per square millimeter.
1	100	0.04
2	25	0.01
3	1	0.0004
4	000.25	0.0001
5	Fine dust particles below one-fourth standard unit in size	

DETERMINATION OF LEAD.

Soluble lead.—Soluble lead was determined by the following method: 0.15 gram of the dry sample was weighed in duplicate into a glass-stoppered bottle, and after 150 c. c. of 0.25 per cent hydrochloric acid were added shaken for one hour in a shaking machine at a rate of 200 excursions a minute. The contents of bottle were transferred to a 200 c. c. volumetric flask and diluted to mark with water. After one hour of standing the sample was filtered and 100 c. c. aliquot were transferred to a 300 c. c. Erlenmeyer flask. Two c. c. of N/5 acetic acid were added, saturated with hydrogen sulphide and allowed to stand over night under a bell jar. The entire precipitate was filtered and transferred with the aid of the first filtrate. The precipitate was washed six times with 10 c. c. portions of a solution of H_2S, 100 c. c. of water, and 5 c. c. of N/5 acetic acid. The filter containing the precipitate was then returned to the original Erlenmeyer flask and 2 c. c. of 1–10 HNO_3 were added. A funnel was placed in the mouth of the flask, and the contents were boiled moderately for five minutes.

After being filtered the residue was washed six times with about 10 c. c. each of hot water, and the filtrate was evaporated on a steam bath to about 10 c. c. When cool, 5 c. c. of concentrated sulphuric acid were added and heated until copious SO_3 fumes were given off. When cool, it was diluted with 5 c. c. of water, 150 c. c. of 50 per cent alcohol were added, and the mixture was allowed to stand over night. After being filtered through a tarred Gooch crucible it was washed six times, the crucible being filled each time with 50 per cent alcohol. The final washing was done with 10 c. c. of 95 per cent alcohol. The crucible and the lead sulphate were dried two and one-half hours at 100° C. and weighed. The increased weight of the crucible was the lead sulphate. Using the factor 0.6832, the per cent of soluble lead in the sample was calculated.

Total lead.—One gram of the dried sample was weighed into a 100 c. c. casserole, 30 c. c. of 1–1 nitric acid was added and evaporated to dryness on a steam bath. The residue was then taken up with hot water and filtered and the resulting residue was washed on filter paper with hot water. Filtrate was reserved for combination with filtrate from fusion of residue. Residue and filter paper were transferred to a platinum crucible, dried, and ignited until paper was nearly ashed. Four grams of fusion mixture (5 parts Na_2Co_3 and 7 parts K_2CO_3) were added to residue in crucible and fused until fusion was complete. The crucible was removed to casserole, and the fused sample was dissolved in a weak aqueous solution of HCl until crucible was clean. The resulting solution was filtered and residue washed on filter paper until free of solids. The filtrate was combined with the above filtrate and the combined filtrate was evaporated and transferred to a 200 c. c. volumetric flask. It was diluted to mark and mixed thoroughly. Two 40 c. c. aliquots were evaporated to dryness in 200 c. c. casserole. Thirty c. c. of 1–1 HNO_3 were added and evaporated to dryness again, then taken up with hot water and transferred to 300 c. c. Erlenmeyer flask and diluted to 100 c. c. mark. Five c. c. of N/5 acetic acid were added, saturated with H_2S, and allowed to stand over night under bell jar. The lead sulphide was filtered, and the same process as that for the determination of soluble lead was followed, weighing the lead sulphate and calculating the per cent of total in the sample.

GLAZE SAMPLES.

One hundred and seven glaze samples were collected in all from 92 plants. Our investigators failed to get glaze from five of the plants. One of the number was destroyed by fire before the glaze could be secured, one became bankrupt, and those who took over the plant used a new glaze. Another, while not refusing the glaze, delayed furnishing it until too late to be used in this survey, and two plants refused to furnish samples of glaze for analysis.

Some of the plants used more than one kind of glaze, so that 87 plants furnished the total of 107 samples. These samples were analyzed, some by our own chemists and the remainder by chemists in the Bureau of Mines. The per cent of total lead and the per cent of soluble lead in the dry glaze are those used in this study.

RESEARCHES OUTSIDE THE PLANT.

Attempt was made to obtain supplementary evidence by consulting the records of the hospitals and those of the Brotherhood of Operative Potters. From the former very little information could be obtained. Apparently local physicians either did not recognize plumbism among their patients or were not consulted by them after symptoms of lead poisoning had developed. Table No. 1 gives the result of the study of the records of the Brotherhood of Operative Potters. It will be seen that the causes of death there given are in general terms only. A presumption as to the real cause of death would be the only means of approximating the fatalities from lead poisoning. Literature was also consulted, such as that published by the Division of Vital Statistics of the United States Census Bureau. Records thus obtained were for one year only. Other sources of information are the life-insurance companies and fraternal societies. Records from these sources were found to have a limited value on account of the shortness of the time for which they were kept. From a study of available mortality statistics the only conclusion that can be drawn is that in giving the cause of death the attending physician too seldom makes a diagnosis of plumbism. Tables II *a* and *b* give deaths of pottery workers by age groups.

Visits were made to the homes of the workers, but the information obtained there being decidedly of a secondary character, while interesting, could not be incorporated in a scientific analysis of the occurrence of lead poisoning.

TABLE I.—*Cause of death among potters as shown by reports of National Brotherhood of Potters, 1911–1919.*

Cause and percentage of deaths among potters, 1911–Apr. 30, 1920, inclusive.	Tuberculosis.	Other respiratory diseases.	Heart disease.	Nervous circulatory diseases.	Paralysis.	Paresis.	Complication.	Bright's disease.	Liver-kidney.	Digestive.	Accident.	Miscellaneous.	Contagious infections.	Total.
1911	5	4	......	......	1	......	......	1	5	2	1	1	......	20
1912	16	6	3	......	1	......	6	7	......	......	1	3	2	45
1913	13	5	5	1	3	......	2	1	4	4	3	1	2	44
1914	9	4	2	1	4	......	1	1	5	......	1	4	1	33
1915	26	12	9	......	3	1	3	2	5	2	2	8	......	73
1916	20	8	10	5	1	1	4	3	4	3	2	20	......	81
1917	25	14	5	3	2	......	7	......	3	4	1	12	......	76
1918	30	20	8	4	1	1	4	1	8	1	7	17	......	102
1919	16	80	4	3	......	......	9	3	3	1	15	8	......	142
1920	21	28	3	7	1	......	5	5	2	3	8	8	1	92
Total....	181	181	49	24	17	3	41	24	39	20	41	83	6	708
Yearly average.	18.1	18.1	4.9	2.4	1.7	0.3	4.1	2.4	3.9	2.0	4.1	8.2	0.6	70.8
Per cent of total	25.6	25.6	6.9	3.4	2.4	4.2	5.8	3.4	5.5	2.8	5.8	11.6	.85	100

TABLE IIa.—*Age of death among potters, 1911–1919.*[1]

Age (years).	Tuberculosis.	Other respiratory diseases.	Heart disease.	Nervous circulatory diseases.	Paralysis.	Paresis.	Complication.	Bright's disease.	Liver-kidney.	Digestive.	Accident.	Miscellaneous.	Contagious infections.	Total.
15-24	6	12	1						3	1	6	8		37
25-34	38	40	7	1				2	4	4	9	18	1	124
35-44	36	31	11	3	1	2	9	4	6	2	9	15	3	132
45-54	56	31	9	3	6		12	6	15	5	9	15		167
55-64	15	28	10	7	7	1	11	4	7	3		11		104
65 and over	4	6	5	3	1		4	2	2			2		29
Not stated	5	5	3		1			1		2		5	1	23

[1] Age of 1920 not given.

TABLE IIb.—*Per cent of age groups shown in Table IIa.*

Age (years).	Tuberculosis.	Oth r respira- ory diseases.	Heart disease.	Nervous circulatory diseases.	Paralysis.	Paresis.	Complication.	Bright's disease.	Liver-kidney.	Digestive.	Accident.	Miscellaneous.	Contagious infections.	Total.
15-24	16.2	32.4	2.7						8.1	2.7	16.2	21.6		100
25-34	30.6	32.3	5.6	0.8				1.6	3.2	3.2	7.3	14.5	0.8	100
35-44	27.3	23.5	8.3	2.3	0.8	1.5	6.8	3	4.5	1.3	6.8	11.3	2.3	100
45-54	33.5	18.6	5.3	1.8	3.6		7.2	3.6	9	3	5.3	9		00
55-64	14.4	26.9	9.6	6.7	6.7	.96	10.6	3.8	6.7	2.9		10.6		100
65 and over	13.8	20.7	17.2	10.3	3.5		13.8	6.9	6.9			6.9		100
Not stated	21.7	21.7	13		4.3			4.3		8.7		21.7	4.3	100

PART II.

FIELD SURVEY.

POTTERY EMPLOYEES.

NUMBER AND PER CENT OF TOTAL POTTERY WORKERS REPRESENTING EXPOSED GROUPS.

In the 92 plants surveyed the total number of workers employed is 17,297, 12,558 being males and 4,739 females. However, only 1,504 males, or 11.9 per cent, and 398 females, or 8.4 per cent, were found to be exposed to the lead hazard. Of the number exposed only 68 males and 25 females were absent or unwilling to take the time to submit to a physical examination.

AGE.

The grouping of the pottery employees into age groups according to occupations and sexes and percentage distribution of each group is shown in Table III.

Of the total number of men exposed to the lead hazard, which is 1,436, it is seen that 108 are under 20 years of age, and 110 women of the total number of 373 are under 20. The largest number of males in this group are employed as dippers' helpers and ware carriers, while the females of the group are chiefly dippers' helpers, ware gatherers, and cleaners. In the age group of 60 plus there are 80 men, 21 of whom, representing the largest group, are employed as glost-kiln placers. The four women in this group are employed as ware cleaners. The largest number of males are found between the ages of 30 and 49, comprising 761 of the total. Of this group those between 35 and 39 number 220, or 15.4 per cent of the entire number. This is not true of the female group. It is seen that the largest number of females is found in the group under 20 years. In this group there are 110, or 29.4 per cent, of the total number of 373. The number in the successive age groups diminishes until the age group of 45 to 49 is reached, where there is a slight rise, and after the age of 50 there is a marked diminution.

The men are largely employed as glost-kiln placers and dippers. Thus, of the 1,436 men exposed 974 are employed in these two occupations. The women are largely employed as dippers' helpers and ware cleaners. There are 149 in the former and 95 in the latter group.

TABLE III.—*Age groups, by occupations and sexes, and percentage distribution of each group of pottery workers.*

MEN.

Occupation.	Age frequencies.											Per cent of age group.									
	Under 20.	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60 plus.	Total.	Under 20.	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60 plus.
Foreman		1	2	2	5	8	7	7	6	1	39		2.6	5.1	5.1	12.8	20.5	17.9	17.9	15.4	2.6
Glaze mixer	8	7	4	10	13	14	18	14	13	11	112	7.1	6.2	3.6	8.9	11.6	12.5	16.1	12.5	11.6	9.2
Dipper	8	29	35	39	49	32	25	21	17	12	267	3.0	10.9	13.1	14.6	18.3	11.0	9.0	8.0	6.3	4.5
Dipper's helper	35	10	5	5	6	4	2	2	1	1	71	49.3	11.1	7.1	7.1	8.4	5.6	2.8	2.8	1.4	1.4
Ware carrier	32	3	4	4	3	2	1	2	2	5	58	55.2	5.2	6.9	6.9	5.2	3.4	1.7	3.4	3.4	8.6
Ware cleaner	5	2	1			1					9	55.5	22.2	11.1			11.1				
Glost-kiln placer	14	44	93	109	121	126	76	65	38	21	707	1.9	6.2	13.1	15.4	17.1	17.8	10.7	9.2	5.4	3.0
Kiln fireman						4	1	5	1	1	12						33.3	8.3	41.6	8.3	8.3
Kiln drawer		2	1	2				1			6		33.3	16.7	33.3				15.7		
Oddman	2	2	6	8	11	9	7	5	8	11	69	3.0	3.0	8.7	11.6	15.9	13.0	10.1	7.2	11.6	15.9
Sagger washer	3	6	5	6	9	11	4	7	5	17	73	4.1	8.2	6.9	8.2	12.3	15.1	5.5	9.6	6.9	23.3
Decorator	1	1	2	2	3	2		2			13	7.7	7.7	14.6	14.6	23.1	14.6		14.6		
Total	108	107	158	187	220	213	141	131	91	80	1,436	7.5	7.4	11.0	13.0	15.4	14.9	9.8	9.1	6.3	5.6

WOMEN.

Occupation.	Under 20.	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60 plus.	Total.	Under 20.	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60 plus.
Forewoman		1		3	2		3	1			10		10.0		30.0	20.0		30.0	10.0		
Dipper	1	7	4	4	1	2	2	2	2		25	4.0	28.0	16.0	16.0	4.0	8.0	8.0	8.0	8.0	
Dipper's helper	47	39	21	15	10	4	11	2			149	31.6	26.3	14.1	10.1	6.7	2.6	6.8	1.4		
Ware carrier	25	11	9	3	2	3	6	2	1		62	40.3	17.7	14.5	4.8	3.2	4.8	9.7	3.2	1.6	
Ware cleaner	30	9	13	7	5	7	8	7	5	4	95	31.6	9.5	13.7	7.4	5.3	7.4	8.4	7.4	5.3	4.2
Kiln drawer		1	2	2	3	4	1				13		7.7	15.4	15.4	21.0	30.7	7.7			
Decorator	7	1	3	3	2	2	1				19	36.8	5.3	15.8	15.8	10.5	10.5	5.3			
Total	110	69	52	37	25	22	32	14	8	4	373	29.4	18.5	13.9	9.9	6.7	5.9	8.5	3.8	2.2	1.1

SEX.

There are 7,819 more men than women employed in the plants surveyed; that is, 72 plus per cent of the workers are males, and 1,106 more men than women are exposed—that is, 79 plus per cent of workers exposed are males.

RACE AND NATIONALITY.

Only two colored employees were observed at work in the potteries, so that with very few exceptions the potteries are worked by the Caucasian race. Table IV gives the distribution by nationality for the various occupations.

TABLE IV.—*Nationality by occupation of pottery workers.*

Occupation.	Native born, native parents.		Native-born, foreign or mixed.		Foreign born.		Austrian.		Belgian.		Bohemian.		Bulgarian.		Canadian.		English.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Foreman, assistant	6	2	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1	....
Glaze mixer, sifter	59	4	18	....	51	....	3	....	....	....	....	....	....	....	1	....	9	....
Dipper, enameler	173	1	42	1	62	....	2	....	....	....	1	....	1	....	....	....	29	....
Dipper's helper, taker off	34	134	14	12	16	12	5	3	....	1	....	....	....	....	1	....	....	1
Ware carrier, gatherer	32	56	10	6	9	9	1	1	....	1	....	....	....	....	....	....	3	2
Ware cleaner, stamper, brusher	4	57	3	8	....	23	....	1	....	1	....	1	....	....	....	....	....	2
Glost-kiln placer	472	....	135	....	98	2	4	....	....	....	....	....	....	....	1	....	48	2
Kiln fireman	7	....	3	....	7	1	....	....	....	....	....	....	....	....	....	....	1	....
Kiln drawer	6	4	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
Oddman, utility	37	2	2	....	23	....	1	....	....	....	....	....	....	....	....	....	5	....
Sagger washer, mender	39	4	2	....	27	....	5	....	....	....	....	....	....	....	....	....	3	....
Decorator, tinter	4	11	1	8	5	1	....	....	....	....	....	....	....	....	....	....	1	1
Total	873	275	230	35	299	49	21	5	0	3	1	1	1	0	3	0	91	8

Occupation.	French.		German.		Greek.		Hungarian.		Irish.		Italian.		Polish.		Scotch.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Foreman, assistant	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Glaze mixer, sifter	....	....	4	....	....	....	11	....	3	....	8	....	8	....	1	....
Dipper, enameler	1	....	4	....	....	....	19	....	5	....	5	....	2	....	2	....
Dipper's helper, taker off	....	....	3	....	....	....	....	....	....	3	4	....	3	1	....	....
Ware carrier, gatherer	....	1	....	....	....	....	1	1	1	....	2	1	1	2	....	....
Ware cleaner, stamper, brusher	....	....	....	....	....	....	....	3	....	5	....	....	....	4	....	1
Glost-kiln placer	2	....	7	....	....	....	1	....	22	....	3	....	1	....	5	....
Kiln fireman	....	....	....	....	....	....	3	....	2	1	....	....	....	....	....	....
Kiln drawer	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....
Oddman, utility	....	....	1	....	....	....	2	....	1	....	11	....	2	....	....	....
Sagger washer, mender	2	....	3	....	1	....	....	....	4	....	7	....	2	....	....	....
Decorator, tinter	....	....	2	....	....	....	1	....	....	....	....	....	1	....	....	....
Total	5	1	24	0	1	0	38	4	38	10	40	1	20	7	8	1

TABLE IV.—*Nationality by occupation of pottery workers*—Continued.

Occupation.	Welsh.		Roumanian.		Swiss.		Russian.		Slav.		Spanish.		Lithuanian.		Total.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Foreman, assistant															7	2
Glaze mixer, sifter					1		2								128	4
Dipper, enameler															277	2
Dipper's helper, taker off								1		1				1	64	158
Ware carrier, gatherer															51	71
Ware cleaner, stamper, brusher		1						3				1			7	88
Glost-kiln placer	2				2										705	2
Kiln fireman			1												17	1
Kiln drawer															6	5
Oddman, utility															62	2
Sagger washer, mender															68	4
Decorator, tinter															10	20
Total	2	1	1	0	3	0	2	4	0	1	0	1	0	1	1,402	359

It is seen from the table that by far the majority of pottery workers are native born, and that of the 21 foreign nationalities represented—17 of them by men—the English are most numerous. The nationalities of 1,402 males and 359 females were ascertained, and of the 1,402 males 873 are native born with native-born parents, 230 are native born with foreign and mixed parentage, while only 299* are foreign born. Thus, 1,103 are Americans, while the remaining 299 are divided into 21 nationalities. Of these the English are represented by the highest number, 91, followed by the Italians, with 40. Of the 359 women 310 are native born, 35 of these having foreign and mixed parents. Only 49 are foreign born. Therefore, we are justified in saying that the pottery industry in America is carried on mainly by native workers.

MARITAL STATE.

The marital conditions and fertility of the potters by sexes are shown in the following tables. Table V shows the marital state of male and female pottery employees by occupation:

TABLE V.—*Marital state by occupations.*

MEN.

Marital state.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Glost-kiln placer.	Ware cleaner.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
Single	13	26	40	47	35	79	4	3	3	10	7	7	264
Married	30	73	217	18	20	545	3	9	2	57	58	4	1,036
Widowers	3	6	7	5		30				2	7		60
Divorced		2	3			8					1		14

WOMEN.

Marital state.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Glost-kiln placer.	Ware cleaner.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
Single	3		1	76	30		40		1			11	162
Married	1		2	60	21		45		5			4	138
Widows	1			10	7		7					1	26
Divorced	1		1	3	1		2						8
Menstrual disorder	4			44	12		21		1			8	99

It will be observed that the majority of male workers are married. Of the 1,374 males of whom we have a record 1,110 are or have been married, 60 of them being widowers and 14 divorced; the remaining 264 are single. Of the 334 women concerning whom we have a record 162 are single, 172 are or have been married. Of the latter class 26 are widows and 8 divorced.

There is a higher per cent of single men among the dippers' helpers, ware carriers, cleaners, decorators, etc., while among the glaze mixers, dippers, kiln placers, and sagger washers the greater number are married.

TABLE VI.—*Fertility of pottery workers by occupation (men).*

Occupation.	Absolute.			Relative.		
	Marriages.	Children born.	Children living.	Marriages.	Children born.	Children living.
Foreman	33	98	85	100	298	257
Glaze mixer	81	255	190	100	315	234
Dipper	227	594	525	100	262	231
Dipper helper	23	48	37	100	209	161
Ware carrier	20	60	53	100	300	265
Glost-kiln placer	583	1,733	1,409	100	295	242
Ware cleaner	3	1	1	100	333	333
Kiln fireman	9	39	33	100	433	367
Kiln drawer	2	15	13	100	750	650
Oddmen	59	207	167	100	351	283
Sagger washer	66	236	192	100	358	291
Decorator	4	12	10	100	300	250
Total	1,110	3,298	2,715	100	297	245

In the above table the first column includes all those who have been married, as shown in Table V. The second column shows the number of children born, and the third column the number of children living; for example, among the foremen there have been 33 marriages of which marriages 98 children have been born and 85 of these were living when this survey was made. In Table VI there is shown also the relative number of children that would be expected to be born and living on the basis of 100 marriages. This relation was computed upon the ratio furnished by the absolute figures shown in the first three columns of the table; for example, if there had been 100 marriages among the foremen we might expect 298 children to be born and 257 to be living, provided the same rate prevailed as in the 33 marriages of which we have a record. Among the 1,110 females there have been born 3,298 children, and of these 2,715 are still living. This is at the rate of almost three children born for each marriage and two and one-half still living, or 297 born per 100 marriages and 245 still living. Without analyzing these figures further for age variation, it appears that the male potters particularly have an average birth rate, and that a reasonably large proportion of their children are still living.

Table VII shows these same facts for the female workers, and includes additional information in regard to stillbirths, miscarriages, and abortions, as far as it was possible to obtain this latter information from the women themselves. It is of course understood that specific information concerning these matters is usually difficult to procure.

TABLE VII.—*Fertility of pottery workers by occupations (women).*

Occupation.	Absolute.						Relative.					
	Marriages.	Children born.	Children living.	Stillborn.	Miscarriages.	Abortions.	Marriages.	Children born.	Children living.	Stillborn.	Miscarriages.	Abortions.
Foreman	3	10	10	......	......	......	100	333	333	0	0	0
Dipper	3	12	8	......	......	......	100	400	267	0	0	0
Dipper's helper	73	157	106	5	2	12	100	215	145	7	3	17
Ware gatherer	29	88	72	4	......	4	100	304	248	14	0	14
Ware cleaner	54	141	109	4	1	......	100	261	202	7	2	0
Kiln drawer	5	11	10	1	......	......	100	220	200	20	0	0
Decorator	5	4	3	......	......	......	100	80	60	0	0	0
Total	172	423	318	14	3	16	100	246	185	8	2	9

It will be observed that this table is made up by a plan similar to that of Table VI. Among dippers' helpers there were 73 marriages, from which 157 children were born, with 106 still living. Among these same 73 women there occurred 5 stillbirths, 2 miscarriages, and 12 abortions. Reducing these figures to the rate of 100 marriages, 215 births might be expected, 145 still living, 7 stillbirths, 3 miscarriages, and 17 abortions, providing that the same rate prevailed among the 100 marriages as among the 73. Of the 172 marriages among the pottery women, 423 children had been born, and 318 were still living, at the time of this survey. This is at the rate of about two and one-half children per marriage of women workers, with approximately two children of each marriage still living; or 246 children born per 100 marriages, with 185 children living at the time of the survey. While this rate is not so high as that noted in Table VI for the male workers, it is to be remembered that these women are much younger than the male workers and have not been rearing families for so long a period as they. The rates, however, are about as high as might be expected for both the number of children born and the number of children living. The rate of stillbirths per 100 marriages is 8, of miscarriages 2, and of abortions 9. These rates do not seem exceptionally high, if all such cases have been reported to us. It does not appear that the high rates for these three marital conditions which are reported by Oliver in his study of the incidence of lead poisoning, as given in Diseases of Occupation,[1] prevail among the women workers in the lead department of the pottery industry.

[1] Diseases of Occupation, Thomas Oliver, p. 199.

Table VIII gives by sexes and occupations the number of workers under 20 years of age, and the average age of those over 20; the average number of children born per marriage; and the average number and the per cent of children living.

TABLE VIII.—*Fertility, by occupations and sexes.*

MEN.

Occupation.	Number under 20.	Average over 20.	Average per family.		Per cent of children living.
			Children born.	Children living.	
Foreman	0	45.9	2.98	2.47	86
Glaze mixer	8	45.6	3.15	2.34	74
Dipper	8	38.5	2.62	2.31	88
Dipper's helper	35	33.8	2.09	1.61	77
Ware carrier	32	43.5	3.00	2.65	88
Ware cleaner	5	28.8	3.33	3.33	100
Glost-kiln placer	14	40.0	2.95	2.42	82
Kiln fireman	....	50.4	4.33	3.67	85
Kiln drawer	....	35.0	7.50	6.50	87
Oddman	2	45.3	3.51	2.83	81
Sagger washer	3	49.3	3.58	2.91	81
Decorator	1	34.6	3.00	2.50	83
Total	108	40.9	2.97	2.45	83

WOMEN.

Occupation.	Number under 20.	Average over 20.	Children born.	Children living.	Per cent of children living.
Forewoman	....	38.8	3.33	3.33	100
Dipper	1	35.0	4.00	2.67	67
Dipper's helper	47	30.0	2.15	1.45	68
Ware gatherer	25	31.7	3.04	2.48	82
Brusher	30	39.0	2.61	2.02	77
Kiln drawer	....	38.2	2.20	2.00	91
Decorator	7	31.2	.80	.60	75
Total	110	34.2	2.46	1.85	75.2

The number of children born per family ranges in this study from 1 to 8. The average number born and living per worker of either sex seems to be within the normal. Of the 3,298 children born whose fathers as pottery workers were exposed to lead 83 per cent were living at the time of this survey. Of the 423 children born whose mothers were working in the glaze department 75.2 per cent were living. It would seem, therefore, that we did not find anything of special significance in the marriage rates, in the birth rates, in the death rates of the children born, nor in the rates of stillbirth, miscarriage, and abortion among the potters examined in this survey. The lack of significant data relative to stillbirths, miscarriages, and abortions may probably be due to the difficulty met with in ascertaining all the facts.

OCCUPATION.

Length of employment in the pottery trades.—We gathered information concerning the length of time each individual examined had worked in the plant in which he was found at the time of the survey and concerning the length of the exposure of each to lead poisoning. Since no plant records were kept, the only possible source of information of this nature is the worker himself. Table IX gives by occupations and sexes the facts ascertained.

TABLE IX.—*Length of exposure and time in present plant of pottery workers, by sexes.*

Length of exposure.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Ware cleaner.	Glost-kiln placer.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
MEN.													
0-2.9 months		7	13	16	7		13			10	9	3	78
3-5.9 months	1	5	8	10	10	1	12			3	4		54
6 months-0.9 year		13	9	12	10	3	11			5	3	1	67
1-1.9 years		11	4	11	8		17		2	4	11	1	69
2-4.9 years	6	18	19	9	13	3	92	4	1	15	15		195
5-9.9 years	3	31	52	6	3	2	112	2	1	16	7	5	240
10 years plus	29	27	160	7	3		450	6		16	21	2	724
Total	39	112	265	71	54	9	707	12	4	69	73	12	1,427
WOMEN.													
0-2.9 months				15	4	25							44
3-5.9 months			2	10	2	15						3	32
6 months-0.9 year	2			13	9	13			2			3	42
1-1.9 years	1		3	20	2	14						1	41
2-4.9 years	1		11	40	17	12			2			5	88
5-9.9 years	4		6	31	11	10			3			2	67
10 years plus	2		2	20	16	5			4			5	54
Total	10		24	149	61	94			11			19	368

Time in present plant.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Ware cleaner.	Glost-kiln placer.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
MEN.													
0-2.9 months		5	13	7	9	1	27			4	2	3	91
3-5.9 months	1	1	6	12	5		17	1		1	2		46
6 months-0.9 year	1	8	6	11	6	1	23			1	1	1	59
1-1.9 years		10	7	6	4	1	23			4	7	1	63
2-4.9 years	3	11	19	12	13	2	70	2		7	18	3	160
5-9.9 years	3	15	32	6	2		92	2	3	8	10	3	176
10 years plus	5	26	57	7	4	2	147	2		5	9		264
Total	13	76	140	61	43	7	399	7	3	30	49	11	839
WOMEN.													
0-2.9 months				8	3	6			1			2	20
3-5.9 months				13	6	3			1			2	25
6 months-0.9 year				11	6	6			2			1	26
1-1.9 years				28	9	3			1				41
2-4.9 years				19	9	4			1			3	36
5-9.9 years				4	1	8			2				15
10 years plus				4	3	3			2				12
Total				87	37	33			10			8	175

Table IX shows that one-fifth of the men had been employed in the present plant for less than one year, a little over one-fourth had been employed more than one yeariand less than five years. The table also shows that about 14 per cent had been employed in the glaze department for less than one year, 18½ per cent more than one year but less than five years, and 67.5 per cent for five years and more. Slightly more than one-half of the men had been exposed to lead hazards for 10 years and more. These figures would indicate that the male potter remains in the same plant for a considerable period of years, and that he remains in the galze department at one occupation, or at various occupations, for a still longer time. Among the glost-kiln placers about 65 per cent of the men had been employed in the glaze department for 10 years and over. Among the dippers 70 per cent of the men had been working in lead for more than 10 years.

About 40 per cent of the men had been employed in the potteries in which they were found at the time of examination for less than one year, 44 per cent for more than one year and less than five years, and the remaining 16 per cent for five years and over.

But the mistake must not be made of interpreting these figures to indicate a large turnover, because it is a known fact that the turnover rate is highest during the first three months of employment. The data covering the rate of turnover in the potteries surveyed are not available. Approximately one-third of the workers had been exposed to the lead hazard for one year or less, another one-third more than one year or less than five years, and another one-third for five years and more.

Concerning the women it appears, as might be expected, that the occupation is not very stable and that they do not remain long in any one plant.

Previous occupations.—In order to justify the allegation that a certain industry exposes workers to a hazard, it is necessary, if the number of workers suffering from the effects of the hazard attributed to that industry is based upon physical examinations, to eliminate from the cases enumerated those of workers who may have developed their present physical findings in previous occupations.

The following tables give not only the number of workers who may have developed symptoms of plumbism before entering the potteries, but also the main sources of supply from which the workers are obtained.

TABLE X.—*Previous occupation of male pottery workers.*

Present occupation.	Previous occupation.																
	Foremen, assistant manager.	Glaze mixer, sifter.	Dipper, enameler.	Dipper's helper.	Ware carrier.	Ware cleaner, brusher, stamper.	Kiln placer.	Kiln fireman.	Kiln drawer.	Oddman, utility.	Sagger washer.	Decorator.	Other pottery.	Army.	Athlete.	Baker.	Barber.
Foreman, assistant manager	3	3	2	1	1		7			1			3	2			
Glaze mixer, sifter	1		1	1	1	2	5		3	10	1	2	12	3		1	
Dipper, enameler	1	1	3	19	16	9	20		1	7	4	3	22	6	1	1	
Dipper's helper, taker off			1	2	1		1				1		11	2			
Ware carrier, ware gatherer		1	2			7	3		4	3		1	2				
Ware cleaner, brusher, stamper							1						1	1			
Glost-kiln placer	4	12	10	1	21	14	34	2	65	20	6	5	95	9	1	2	2
Glost-kiln fireman			1				3		1	2							
Glost-kiln drawer										1			1				
Oddman, utility	1		1	1	4		1		1	2	3		4	1			
Sagger washer	1	1		1	1		4		11				8	1			
Decorator, tinter												1					
Total	11	18	21	26	45	43	79	2	86	46	15	12	159	25	2	4	2

Present occupation.	Previous occupation.															
	Bartender.	Blacksmith.	Bricklayer.	Carpenter.	Clerk.	Cigarmaker.	Electrician.	Engineer fireman.	Factory.	Farmer.	Iron and steel.	Laborer.	Livery.	Lumberman.	Machinist.	Mechanic.
Foreman, assistant manager					2						2	3				
Glaze mixer, sifter				1	2		2	1	4	4	3	10			1	
Dipper, enameler			3	2	2	1	1		10	10	2	19			3	
Dipper's helper, taker off			1								2	5				
Ware carrier, ware gatherer			1		1				3	3		1	1			
Ware cleaner, brusher, stamper												1				1
Glost-kiln placer	1	2	1	4	3	1		2	44	43	14	38	1	2	4	2
Glost-kiln fireman									1		2					
Glost-kiln drawer										1						
Oddman, utility	1		1	1					2	8	3	10			1	
Sagger washer			1	1	1					3	3	6				
Decorator, tinter										2						
Total	2	2	8	9	11	2	3	3	64	74	31	93	2	2	9	3

Present occupation.	Previous occupation.															
	Merchant.	Messenger.	Molder.	Painter, paper hanger.	Packer.	Plumber.	Printer.	Railroad.	Student.	Stonemason.	Tailor.	Teamster.	No other occupation.	Miner.	Other occupation.	Total.
Foreman, assistant manager	2							1				1		1		35
Glaze mixer, sifter	1		1		1	1	1	2		1	1	4	21	4	2	111
Dipper, enameler	5	1	1	3	1			5	8	1		3	50	9	1	265
Dipper's helper, taker off	1						1	7	15			1		2	9	63
Ware carrier, ware gatherer	1			1				1	2			2	17	1		58
Ware cleaner, brusher, stamper													2			7
Glost-kiln placer	10		7		2	2	2	11	7		1	10	109	27	5	658
Glost-kiln fireman	1												1			12
Glost-kiln drawer												1				4
Oddman, utility			1					2				2		9	2	62
Sagger, washer			1					3				3		7	2	60
Decorator, tinter				2								1			2	8
Total	21	1	11	6	4	3	4	32	33	2	2	28	200	60	23	1,433

TABLE XI.—*Previous occupation of female pottery workers.*

Present occupation.	Previous occupations.																					
	Forewoman.	Glaze mixer.	Dipper, enameler.	Dipper's helper.	Ware carrier.	Ware cleaner.	Kiln drawer.	Kiln placer.	Decorator.	Other pottery.	Clerk.	Cigar maker.	Factory.	Housekeeper.	Laundry worker.	Saleswoman.	Seamstress.	Student.	Teacher.	Textile worker.	Waitress.	No other occupation.	Total.
Forewoman	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3
Dipper	...	...	...	...	...	1	...	...	2	...	...	...	...	1	...	...	...	...	...	...	1	2	7
Dipper's helper	...	...	5	3	10	41	5	2	12	8	4	...	9	14	2	...	...	2	...	...	1	30	148
Ware carrier, gatherer	...	...	3	4	1	19	3	...	3	12	1	...	...	3	...	...	...	...	...	...	1	9	59
Ware cleaner, brusher, stamper	1	1	2	5	6	12	4	...	5	8	2	5	6	13	...	1	2	2	...	3	1	10	89
Kiln drawer	...	...	1	...	...	1	...	1	1	1	1	...	...	2	...	...	...	...	...	...	1	3	12
Decorator	...	...	...	...	...	...	...	...	...	1	2	...	1	1	...	...	1	3	1	...	2	1	13
Total	1	1	11	12	17	75	12	3	23	30	10	5	16	34	2	1	3	7	1	3	7	57	331

It is seen that among the men 5 were previously occupied as painters, 3 as plumbers, and 4 as printers, making a total of 12 who may have been exposed to lead before working in the potteries; but the number is so small that it is practically negligible. It is likewise seen that the largest number of men were previously occupied as laborers, factory hands, and farmers, although many had no former occupation. The women, as noted in Table XI, are generally recruited either from the nonemployed list or from housekeepers. A large number of men and women had held previous positions in the pottery, and some of these had not been exposed to lead in those positions. Among the men 167 had worked in occupations where lead was absent, and among the women 31 had been so employed.

Tables X and XII give the last previous occupation held by the workers according to present occupations.

TABLE XII.—*Next previous occupation of male pottery workers.*

Present occupation.	Next previous occupation.																	
	Foreman, assistant manager.	Glaze mixer, sifter.	Dipper, enameler.	Dipper's helper.	Ware carrier.	Ware cleaner, brusher, stamper.	Kiln placer.	Kiln fireman.	Kiln drawer.	Oddman, utility.	Sagger washer.	Decorator.	Other pottery.	Army.	Bartender.	Bricklayer.	Carpenter.	Car shops.
Foreman, assistant manager	...	1	1	...	1	1	...	...	...	...	...	...	2	...	...	...	...	...
Glaze mixer, sifter	...	...	1	...	...	...	1	...	5	2	1	1	3	1	...	...	1	1
Dipper, enameler	...	1	3	3	5	2	...	...	1	1	...	1	9	5	1	...	...	...
Dipper's helper	...	...	...	1	1	...	...	...	1	...	...	1	1	...	...	...	...	...
Ware carrier, gatherer	1	...	...	...	2	1	1	...	...	2	...	...	1	1	...	...	...	...
Ware cleaner, brusher, stamper	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...
Glost-kiln placer	...	2	6	2	5	2	9	1	5	7	4	4	29	11	1	2	4	5
Glost-kiln fireman	...	...	1	...	...	...	...	...	...	...	1	...	...	1	...	1	...	...
Glost-kiln drawer	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
Oddman, utility	3	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
Sagger washer	...	1	...	...	...	...	...	1	3	3	1	...	3	1	...	...	...	...
Decorator, tinter	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	4	5	12	6	14	7	11	2	16	15	8	7	49	20	2	3	5	6

TABLE XII.—*Next previous occupation of male pottery workers*—Continued.

Present occupation.	Next previous occupation.																
	Clerk.	Electrician.	Engineer-fireman.	Factory.	Farmer.	Iron and steel.	Laborer.	Machinist.	Merchant.	Messenger.	Miner.	Packer.	Plumber.	Railroad.	Salesman.	Student.	Teamster.	Other occupations.
Foreman, assistant manager					2	1							1					
Clay maker, sifter			2	4	4	3	7	1			1			2		1	1	
Dipper, glazemaker	1		2	4	8	1	7		1	1	2	1		2	2	3	1	3
Dipper's helper	2			4	3	5	1				3		1		1	2		
Ware carrier, gatherer				1	1	1	1								1	1	1	
Ware cleaner, brusher, stamper								1										
Kiln placer	1	1	1	22	34	10	23	5	1	1	18	2	1	9	4	4	5	9
Kiln fireman					1		1											
Kiln drawer					1		2											
General utility	1		1	2	3		3							3			1	
Sagger maker		1	1	2	4	1	4							4				
Decorator, liner						1											2	
Total	5	2	7	39	61	23	49	7	2	2	24	3	3	20	8	11	11	12

TABLE XIII.—*Next previous occupation of female pottery workers.*

Present occupation.	Next previous occupation.														
	Dipper.	Dipper's helper.	Ware carrier.	Ware cleaner.	Kiln drawer.	Kiln placer.	Decorator.	Other pottery.	Clerk.	Factory.	Housekeeper.	Laundry.	Saleswoman.	Seamstress.	Student.
Glaze mixer									1		1				
Dipper				4											
Dipper's helper	2		3	7	4	1	3	2	3	1	6	1			
Ware carrier		1		12			1	1			1				
Ware cleaner, brusher		1		5			1	2			7		1	1	1
Kiln placer									1						
Decorator				1		1					1				
Total	2	2	3	29	4	2	5	5	5	1	16	1	1	1	1

There is very little to be learned from these tables, except that quite a number had held different positions in the potteries. It is also noted that only three had been plumbers. The conclusions to be drawn from these tables of previous occupations are that the physical findings of plumbism among the workers can not be attributed to former occupations.

Height and weight.—Table XIV shows a correlation of height and weight for 903 pottery men. Table XV shows the same data for 120 pottery women.

TABLE XIV.—*Height and weight of male pottery workers.*

[Average height=67.76 inches. Average weight=151 pounds.]

Weight (pounds).	Height (inches).																
	Under 60	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74+	Total.
200+						1		3	2	2	4	1	2	3	1		19
190-199					1				3	3	4	2	2	2	3	1	21
180-189						1		4	4	8	4	8	7	3	2	1	42
175-179		1					4	3	3	5	3	1	1	1			25
170-174						1	5	2	3	5	[illegible]	7	6	5			39
165-169				1		2	1	6	9	4	8	12	14	4	2	3	66
160-164	1			1		2	2	7	10	9	17	13	11	19	1		91
155-159						6	7	13	10	18	11	16	17	2			98
150-154		1		2		4	8	13	9	25	12	11	6	6			100
145-149		4	1	1	4	5	7	16	16	17	17	17	8	2			115
140-144		2		1	2	7	7	14	11	16	15	1	1	5			82
135-139				2	3	14	9	10	18	16	9	2		1			94
130-134		2		1	2	5	5	5	6	5	4	2	2				39
120-129		5		2	1	12	5	9	3	2	2	3					41
110-119	1	1	1	2	2	5	1	3									16
Under 110	12	5	3	3	3	3											23
Total	14	21	5	16	18	68	61	108	107	133	115	102	77	44	9	5	903

TABLE XV.—*Height and weight of female pottery workers.*

[Average height=62.35 inches. Average weight=126.1 pounds.]

Weight (pounds).	Height (inches).																
	Under 60	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74+	Total.
170+								1	1	1							3
160-169						1	1	2	1	1	1	1					8
155-159				1			2		1								4
150-154																	0
145-149		1					2	1	1								5
140-144				1		1	2	2									6
135-139		1		5	1	2	2	1		1	2	1	1				17
130-134				2	1	3		1	1								8
125-129		2	1		4	4		2	3	1							17
120-124		2		1		1	1	1									6
115-119		1	1		4	6	2										11
110-114	3	3	3	3	2	3											17
105-109	1	1		2	1	1											6
100-104			1	2	1												4
90-99	1	3	1														5
Under 90																	0
Total	5	14	7	17	14	22	12	11	8	4	3	2	1	0	0	0	120

It is to be noted that the average height of the men is 67.5 inches and the average weight 151 pounds. The average height of the women is 62.35 inches and the average weight 126.1 pounds. In order that we may give a better picture of the group, the figures in Table XIV are analyzed a little more closely. Chart 1 shows the distribution of weights for the 903 male potters in a frequency curve upon which is superimposed for comparison a probability curve. Barring a few irregularities in the actual frequency curve, the weights do not seem to be abnormally distributed. By use of a frequency curve, upon which is superimposed for comparison a probability curve for this same number of workers, figure 2 shows the frequency distribution for the heights of these 903 pottery workers. A Pearson coefficient of correlation computed between these two parts of meas-

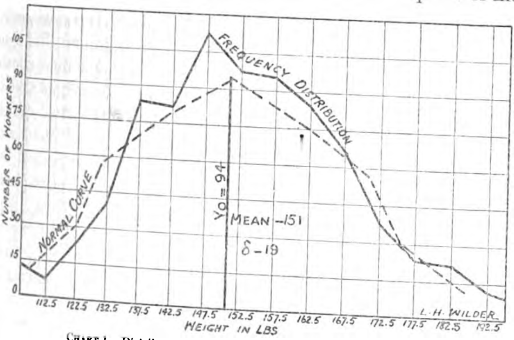

CHART 1.—Distribution of weight of 903 male pottery workers.

ures for the 903 individuals is 0.547, which is considered a reasonably good correlation, although it indicates considerable irregularity in these two measurements. That is, there are quite a number of individuals of overweight and quite a number of underweight, for their heights. Table XVI shows an attempt to find the deviation of these

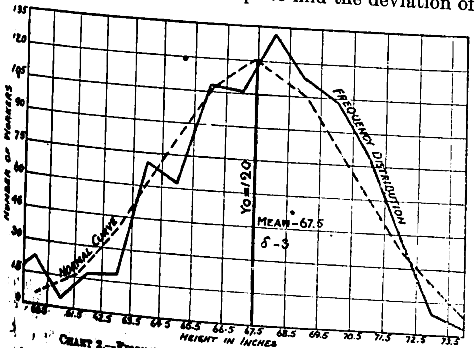

CHART 2.—Frequency of heights of male pottery workers.

various height groups from what is considered a normal weight for each group. The standards taken are those of Butler, and vary about 5 pounds for each inch in height. An individual 67 inches in height is expected to weigh 150 pounds; one 68 inches in height, 155 pounds; one 66 inches in height, 145 pounds, etc.

TABLE XVI.—*Frequency of overweight and underweight among 903 pottery men.*

Height (inches).	Pounds underweight (average).					Pounds overweight (average).					
	25 plus.	15–24.9	10–14.9	5–9.9	0–4.9	4.9	5–9.9	10–14.9	15–24.5	15–34.9	35
Under 60...	0	0	4	4	4	1	0	0	0	0	1
60..........	0	0	2	2	1	1	2	2	2	6	2
61..........	0	1	1	1	1	0	0	0	0	1	0
62..........	0	3	1	1	1	1	1	2	2	2	2
63..........	0	5	1	1	1	2	3	2	4	0	1
64..........	0	8	5	7	5	14	7	5	10	4	3
65..........	0	3	3	5	8	7	7	8	9	6	4
66..........	0	12	5	10	14	16	13	13	13	5	7
67..........	....	9	18	11	16	9	10	10	12	7	5
68..........	2	21	16	17	25	16	9	4	10	8	5
69..........	6	24	17	12	11	17	8	5	5	4	6
70..........	7	18	14	16	13	12	7	4	8	2	1
71..........	3	14	17	11	14	6	1	4	4	3	0
72..........	8	8	10	4	5	1	2	1	2	3	0
73..........	0	1	2	0	0	1	1	2	1	1	0
74..........	0	3	0	0	0	1	1	0	0	0	0
Total.....	26	130	116	102	119	105	72	62	82	52	37
	156		337			239			171		

FAMILIARITY WITH TRADE HAZARDS.

Pottery workers, as a whole, are familiar with the lead hazard to which they are exposed. Their knowledge, however, is frequently very vague and is acquired through conversation with associates. Some, indeed, question the existence of such a hazard; and judging from the results of this survey many apparently do not appreciate the dangers thereof. The plants have taken no concerted action to teach the hazards in a logical way. One plant teaches them to some workers, four use placards, one gives instructions once a month and another every three months.

POTTERY BUILDINGS.

In general, the buildings in use for the manufacture of pottery are typical of an old industry, in which processes have remained so uniform as seemingly to demand no radical change of housing for a long series of years. The buildings are mostly makeshift structures, ill-adapted to the processes, although a few were found of modern type, arranged for the most efficient handling of the ware, from raw materials to finished product.

In the older buildings little attention was given to the convenience, comfort, or health of the worker. Glaze mixing was usually confined to an odd corner or to a room unusable for other purposes. Dipping rooms and kiln rooms, which, with the mixing rooms, primarily interest us, were apparently constructed with the idea of capacity mainly, without thought of illumination, ventilation, or any other sanitary consideration. Our investigators noted both dipping and mixing rooms where but one small window placed high in the wall was apparently expected to give ample ventilation, and, with the aid of an open-flame gas jet, sufficient illumination for safe conduct of the work. Though these instances are few in number, they typify the age to which such housing belongs, and in reality stamp such plants as outlawed in the field of modern construction.

Often, however, remodeled plants or plants having recent additions, though still retaining sections that have low walls and ceilings and inadequate illumination and ventilation, show in their newer sections acknowledgment of a need of those very features which the older buildings lack. This same effort toward improvement was found in plants built during the last decade, although these efforts often failed because of lack of full appreciation of the problems offered by the processes involved. The improvements in structures of this period is evident, however, several of the more recent being entirely of modern type and containing the best sanitary equipment and conveniences.

The change from old pottery processes, such as hand dipping and intermittent kilns, to automatic dipping and continuous tunnel kilns, for certain lines of ware, is effecting a substantial change in structure and involves a closer consideration of the sanitary problems relating to the handling of glaze. At the time of this survey continuous dipping and the use of tunnel kilns were confined to a very few plants, but a number had seriously planned to establish the use of continuous kilns; and doubtless by this time some have carried their plans into effect. The newly adopted processes will necessitate new housing, and they are mentioned here not for the purpose of discussing this change of process but as indicating a new epoch in the construction of pottery buildings. While the full significance of machine operation and continuous processes has perhaps not fully penetrated the entire industry, yet practical men of the industry have voiced the opinion that, when fully demonstrated, these new methods will result in a demand for the disuse of old buildings, to the advantage of both employee and employer.

PLANT PROCESSES AND MATERIALS USED.

LIMITATION OF SURVEY TO CERTAIN PROCESSES.

It is not our purpose in this study to give a description of those processes in pottery-making which do not involve the use of lead and its compounds. Each process in which a lead hazard is present is described in a general way, without attempt to include minor variations observed in a few plants. Wherever a process differs materially from the usual processes of other plants, full statements and descriptions are given.

The processes of mixing the clays and other basic materials for making the slip, or of reducing the clay to its proper plasticity for jiggering, pressing, and other methods of shaping the ware, are not ordinarily carried on in the same buildings, or at least in the same rooms, with the processes that involve the use of lead. The processes of burning and cleaning the ware, which is now called "bisque" or "biscuit" ware, are not ordinarily conducted so that the workers are involved in any lead hazard. The first introduction of the ware to the lead department occurs usually when the ware is carried from the ware room into the dipping room to be coated with a lead glaze. There are, though, some underglaze methods of decorating, which will be mentioned later. However, at times brushing of the biscuit ware may be carried on so that the workers come in contact with lead, or at least with glaze dust. It sometimes happens, also, that the bisque-kiln setting and the setting of glazed ware in the kilns are conducted in such a way that the same kiln, or the same kiln setters, are employed for both processes. In this survey when we found kiln placers working in both types of ware they are included among those exposed to a lead hazard. After stating one or two facts in regard to sagger making, our detailed description of processes takes up the mixing of the glaze, its application to the ware, the cleaning, burning, decorating of the ware, and all processes leading to the formation of the finished product.

SAGGER MAKING.

Sagger making of itself does not expose the worker to lead—a fact contrary to statements found in some books—but in the usual process of washing or painting the saggers with a lead glaze the worker is exposed. The process of sagger washing will be taken up later.

GLAZE MIXING.

On account of the secrecy of the formulæ used in glaze mixing the constituents are usually added under the direction of a chemist or some one else who is trusted by the management. The actual work is performed by a laborer, who is often kept in ignorance of the identity and proportions of the ingredients. The process is usually dusty, and the mixer neglects, as a general rule, to wear a respirator. The materials for glazes are kept in bins or barrels and when needed are shoveled into barrels or galvanized buckets and wheeled or carried to the scales to be weighed. Little uniformity of method was noticed in the several plants. In some the ingredients are poured into a glaze pan which has previously been charged with the proper amount of water, while in others they are mixed dry. Some use what is known as a "raw glaze," in contradistinction to a "fritted glaze." The latter, again, may or may not contain lead. When lead is

FIG. 1.—GLOST KILN ROOM. NOTE OLD CONSTRUCTION.

FIG. 2.—DIFFERENT TYPES OF SAGGERS.

present in the fritted form, it is usually called "fritted lead glaze," although this descriptive term is not always employed.

In the process of frit making the materials are emptied into a mixing box or hopper, whence by means of a chute they drop down into a mixer, where they are mixed either mechanically or by hand with a shovel, as concrete is mixed. Sometimes the batch is dampened by sprinkling it with water. The frit body usually consists of boracic acid, flint, whiting, spar, zinc oxide, and clay, and may or may not contain a lead salt. This mixture may amount to 40 per cent of the entire batch and often includes four-fifths of the lead.

The frit mixture is shoveled into glazed saggers or saggers lined with pulverized flint and is fused in one of the glost kilns. After removal from the kiln the fused glassy "frit" is taken from the saggers and broken up into small pieces or pulverized by means of a chaser or grinding mill. In some plants this pulverized frit is further sieved over a barrel. The managers of a few plants purchase the frit from other plants; some send the fused frit away to be pulverized.

The next step in the process of glaze mixing is to convey the frit, together with the weighed additional ingredients which enter into it, to a grinding mill or "wet-ball" mill, where the entire batch is mixed. The mixing requires frequently from two to six days. The additional ingredients consist usually of cobalt sulphate, white lead, and feldspar. Zinc may also be added. The mill is emptied either by means of buckets or by running its contents by gravity over a vibrating fine silk or lawn screen, through which the frit is filtered to remove any lumps or course materials. In a few plants the charge is "lawned" by hand, a process which consists in sifting the entire charge through a 150-mesh copper cloth screen. The finished glaze, which has a varying consistency depending upon its use, is then transferred by means of buckets or is pumped to a storage tank. Some of the storage tanks are equipped with agitators. From this point the glaze is carried or pumped, as needed, to the glaze-dipping tubs in the dipping room.

GLAZE DIPPING.

The process of covering the ware with a coat of glaze is known as "dipping" and requires skill and dexterity on the part of the operator. The glaze must be so applied that an equal covering of every part of the ware is attained, of a thickness determined by the porosity and shape of the pieces. The ware varies in size and weight from that of a small floor tile to ordinary household goods and sanitary ware, according to the product manufactured in each particular plant.

There are three different processes in use for covering the ware with glaze. In one process the ware, which includes dinner sets and pieces easily handled, is dipped into the glaze mixture; another process consists in dusting or spraying the pieces; and a third in painting the glaze on the ware. The method used depends upon the size, weight, and shape of the ware.

The hand immersion method is used in the majority of plants surveyed. In this method the glaze is contained in tubs, wooden or porcelain, about 4 feet in diameter and 3 feet in depth, set with the top at waist height. In an attempt to keep the glaze mixture of an equal consistency the dipper stirs it at times with a wooden paddle or simply with his hand. The dipper faces the tub, takes the pieces of baked ware, known as "biscuit" or "bisque" ware, previously placed beside the tub by his helper, dips the ware into the glaze, and on taking it out gives each piece a peculiar whirling or rotary motion of two or three half-turns in order to distribute the glaze evenly. With the larger pieces, such as sanitary toilet ware, this whirling is done on a bouncing board which spans the tub. While the piece is held by the dipper on the bouncing board, either he or his helper usually sponges the glaze off the foot of the piece while it is still wet. The dipper or his helper places the piece on the drying rack. After the glaze has dried on a sufficient number of pieces, the dipper and his helper "fettle" the ware, using a wet sponge. "Fettling" is the process of removing excess glaze.

Because of the heavy body of the glaze used in some potteries on sanitary toilets, washbowls, etc., it has never been possible to clean satisfactorily the feet and pipe inlets of the toilets with a wet sponge; and consequently after the ware is dipped it is allowed to dry and is then placed on a rotating wheel of plaster of Paris, on which the greater portion of the superfluous glaze is taken off dry with a steel tool, similar to that used in lathe work in making semivitreous cups of a certain type.

In some plants the dipping is done mechanically. The bisque ware is placed in piles on a table, on which is operated an automatic feeding device. Each piece as it drops is run through a pair of rolls onto a traveling belt. A large wheel which rotates in the glaze solution feeds the glaze to one of the rolls through which the ware must pass. The roll which spreads the glaze on the ware is constructed of some kind of spongy material covered with fine copper gauze. The pressure on this roll can be adjusted so as to give a thin or thick coating of glaze, as desired. As the dipped ware goes through the rolls it runs on a traveling belt and is taken off at the other end by a helper, who places it on boards or in saggers.

The glazing or art tile is usually done with a small brush. The tile is grasped in one hand, the brush wielded with the other. When a sufficient coat of glaze has been applied, the glazer removes the sur-

FIG. 3.—FRIT MIXING ROOM, SHOWING MACHINERY AND COMPOUND IN BIN AT RIGHT. NOTE NO COVERING.

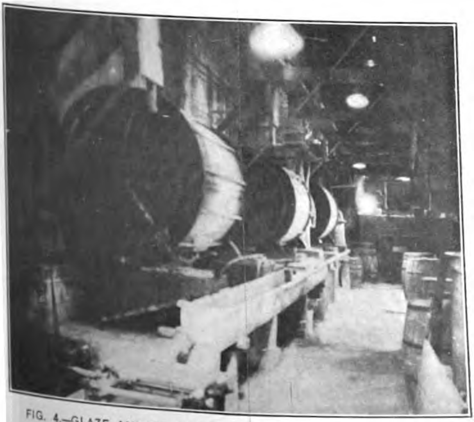

FIG. 4.—GLAZE MIXING ROOM, SHOWING MACHINERY FOR MIXING GLAZE.

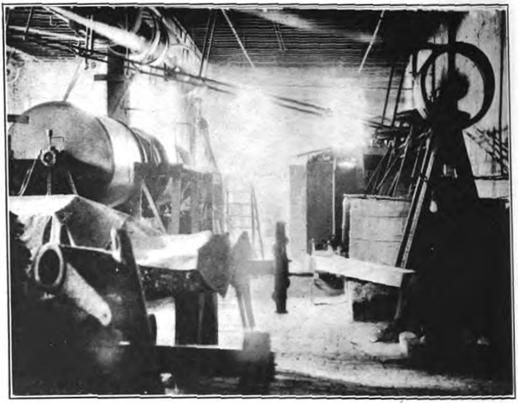

FIG. 5.—GLAZE MIXING ROOM, SHOWING MACHINERY FOR MIXING GLAZE.

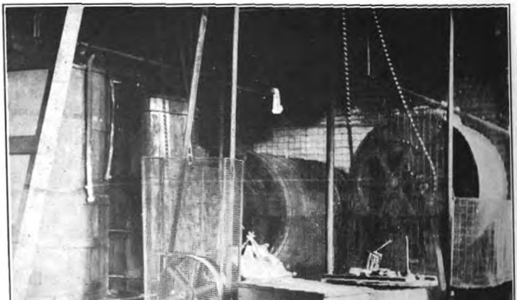

FIG. 6.—GLAZE MIXING ROOM, SHOWING MACHINERY FOR MIXING GLAZE AND SAFETY GUARDS ON MACHINERY.

FIG. 7.—ENAMELING ROOM. NOTE GOOD NATURAL ILLUMINATION AND POSITION OF LOCAL LAMPS.

FIG. 8.—APPLYING THE ENAMEL, ENAMELING ROOM.

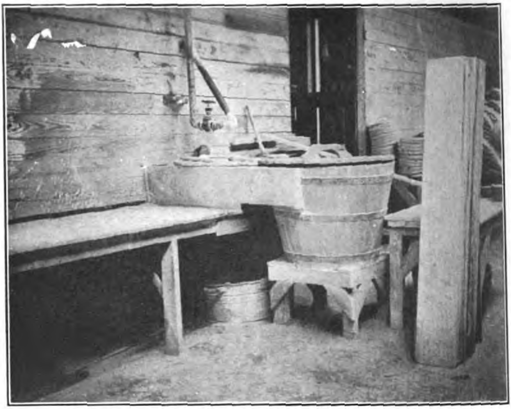

FIG. 9.—DIPPING TUB, WARE BOARD, ETC., ONE UNIT. NOTE PIPE FOR FILLING TUB INSTEAD OF BUCKET-CARRYING METHOD.

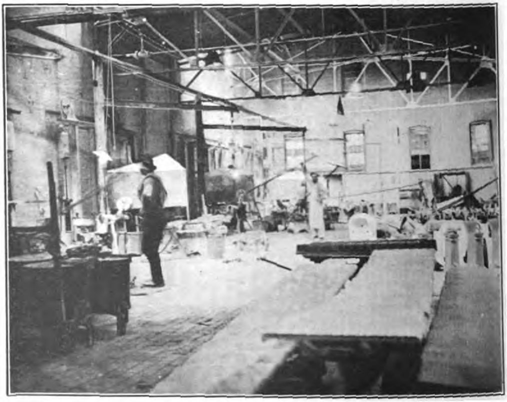

FIG. 10.—ENAMELING ROOM.

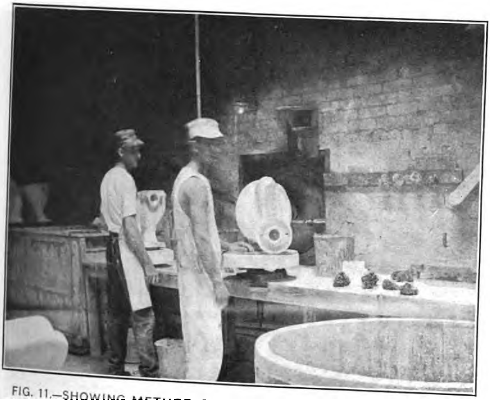

FIG. 11.—SHOWING METHOD OF REMOVING HEAVY GLAZE FROM WARE. SPONGES ARE OFTEN USED AND AFTER GLAZE BECOMES HARD A STEEL TOOL IS USED. NOTE PEDESTAL FOR REVOLVING THE WARE AND EXHAUST FAN IN WALL FOR REMOVING DUST.

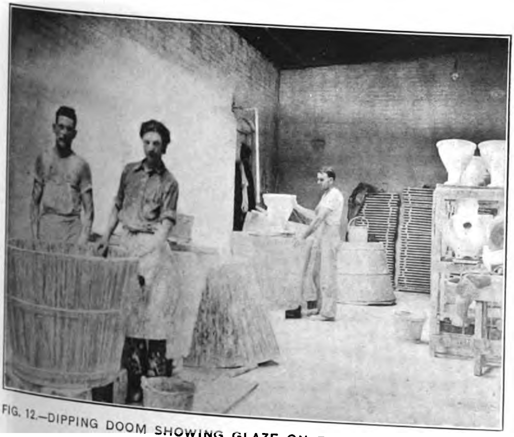

FIG. 12.—DIPPING DOOM SHOWING GLAZE ON FLOOR, WORKMEN, AND OUTSIDE OF TUBS.

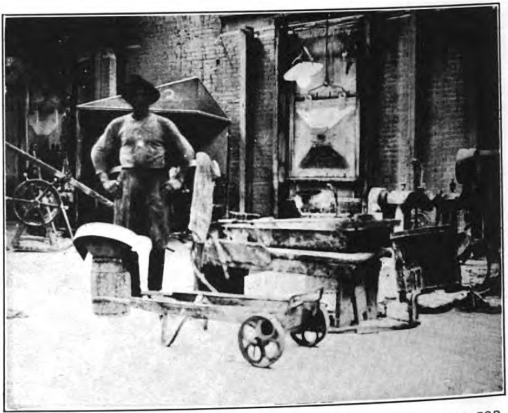

FIG. 13.—SHOWING WORK BENCH, OVEN, AND EQUIPMENT FOR APPLYING ENAMEL TO SANITARY WARE.

FIG. 14.—SAGGER WASHING. NOTE GLAZE ON HANDS OF WORKER AND DRY GLAZE ON EQUIPMENT.

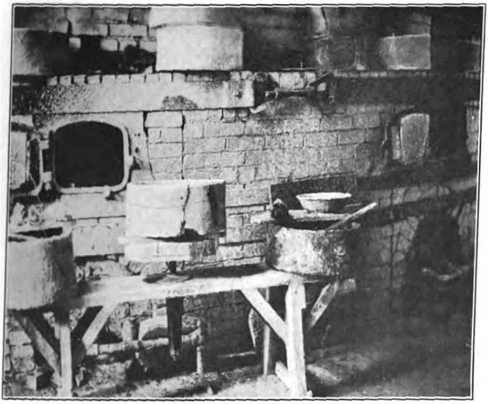

FIG. 15.—WORK BENCH FOR SAGGER WASHING. NOTE GLAZE ON SPONGES, PAN CONTAINERS, BENCH, FLOOR, AND WALL OF KILN. SAGGER TO BE WASHED ON REVOLVING PEDESTAL IN CENTER.

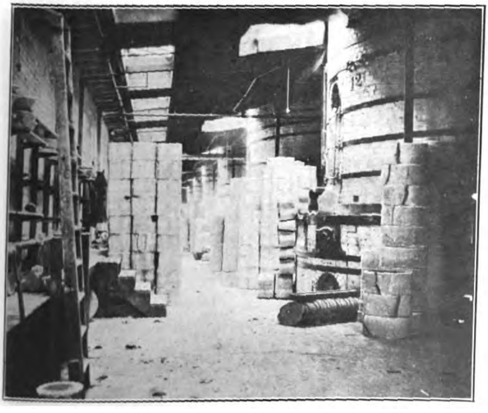

FIG. 16.—GENERAL VIEW OF A GLOST-KILN ROOM, SHOWING SAGGERS WARE WORK BENCHES, KILNS, AND ROOF ILLUMINATION.

plus from the tile edge by scraping it with his finger before placing the tile upon the flat board upon which it is carried away.

In one plant where art pottery is made the glaze is applied by means of compressed-air spraying. The ware is placed upon a revolving pedestal in an inclosed compartment. The glaze is sprayed upon it as the pedestal revolves, exposing all sides of the ware to the spray.

Another method of applying glaze consists in "dusting" the pieces with a dry powder of the glazing material. This is the usual method employed in enameling large pieces of cast-iron ware, such as bath tubs. To make the enameling adhere to the iron, such pieces are first covered with a base coat, applied by means of spraying machines, by which a fine spray is thrown upon the ware. After the base coat has dried, the ware is placed in one of the furnaces and heated to a bright red heat. While it is still glowing, the enameler reaches in with a pair of tongs suspended from a swinging crane, withdraws the ware from the furnace, and places it on the workbench. This workbench is operated by the foot and can be turned to any desired position. Holding in both hands a long-handled sieve, which is pneumatically shaken, the enameler sifts the powdered glaze carefully and evenly over the hot ware. He returns the piece to the furnace and heats it again until the glaze has been well fused; then it is taken out and a second coat is applied in the same manner as was the first, and the ware is again placed in the furnace. When the final coat is properly fused, the piece is withdrawn and placed under the "hood," where, shielded from rapid circulation of air, it may cool slowly and evenly.

SAGGER WASHING.

A glaze, which may be the same as that used in the dipping process or a cheaper grade of glaze—sometimes red lead, or the dregs of the dipping tubs—is applied by means of a paint brush to the inside bottom, sides, and tops of the saggers. This prevents the saggers from absorbing the glaze from the ware with which they come in contact. Again, the bottoms of the saggers are frequently washed with ground bone suspended in water. The object of this is to prevent the ware and the "setters" upon which the ware rests from sticking to the sagger. This washing is usually done by a laborer or kiln drawer, in a corner of the kiln room or wherever the saggers happen to be.

GLOST-KILN WORK.

The kiln placing—proficiency in which process requires considerable experience—is done by men most of whom have served an apprenticeship. The kiln placer carries the dipped ware from the drying shelves in the dipping room to the workbenches in the kiln room. Here the ware is placed in saggers, in such a way as not to touch each other nor the sides of the sagger and at the same time to utilize space to the best advantage. A proper selection of supports for the pieces, so that they stand on each other without touching, is important. This process is an art, and if loss is to be avoided each piece must be carefully placed.

The saggers are separated by clay "wads" to prevent then from sticking together, to keep them level, and also to seal them from the entrance of smoke. As the saggers are filled they are carried on the head, which is protected by a thick pad, to the kiln. They are placed in position, one above the other in a position corresponding to the amount of heat needed to finish the ware, until the kiln is filled to the top. As the pile rises, a ladder must be used by the kiln placer in order to reach the top of the pile. Where tunnel kilns are used, the ware is placed on trucks which run through the tunnel kiln. Saggers may or may not be used in the continuous kiln. The truck when loaded is only about 7 feet high; hence the arduous and somewhat dangerous work of climbing up stepladders is eliminated.

Firing the kilns demands considerable skill and requires accurate knowledge of each particular glaze used and familiarity with any alteration in its fusibility. The tunnel kiln is fired continuously. Trucks of ware are put in at the rate of one every hour and a half, and are carried through in from 48 to 54 hours. As a truck of ware is pushed in at one end, a truck of glazed ware comes out at the other. A small motor, geared to a worm wheel, operates a pushing arm, which keeps the cars of ware always moving at uniform speed.

Kiln drawing is the reverse of kiln placing, and consists in removing from the kilns the baked ware, which is taken off by laborers and carried to the storage or packing rooms. This process requires care—but no great degree of skill—for the saggers must be so carried that pieces do not fall against each other.

DECORATING.

Mechanical processes of decorating earthenware are frequently used, but hand painting will perhaps continue in use as long as the demand for skilful hand art prevails. The absolute correctness of decorations printed by mechanical processes becomes monotonous and militates against the general use of such decorations. The two methods of hand painting in vogue are underglaze and overglaze painting. The highly artistic work is done over the glaze. The underglaze work is much cheaper, but presents a rich, glossy appearance.

The art of painting bands of various widths around the periphery of the ware is called "lining." This work is done entirely by hand.

The width of the lining is determined by the size of the brush used and by the pressure applied. The ware is usually centered on a small horizontal wheel, which is revolved by hand.

Decalcomania is a process of decoration the use of which is becoming more frequent. The design is first printed on a specially prepared sheet of tissue paper and is then transferred to the ware. The original design is engraved on a copper plate and colored, the excess color being scraped off with a knife, so that the coloring matter remains only in the lines engraved on the plate. A specially prepared sheet of tissue paper is then spread evenly over the plate and the whole is put through a press, which transfers the color design to the paper. The designs are then cut out and stuck on the ware, the surface of which has been prepared with a coat of special varnish sizing. By means of rubbing the surface of the paper smooth with a stiff brush, the color is transferred from the paper to the ware. When a sufficient quantity of color has adhered, the paper is washed off with water, and the decoration remains on the ware.

This latter process has largely replaced hand decorating, which was formerly responsible for the lead poisoning in decorating.

LEAD IN GLAZE USED.

Tables.—In studying these tables it must be remembered that the amount of total lead present in any sample of glaze is not proportionate to the amount of soluble glaze in the sample, and vice versa. The lead becomes a hazard to the worker only when it is soluble. It will be noted that the average per cent of soluble lead is high in the glaze used for yellow, art, and general ware, namely, 24.93, 16.65, and 13.71, respectively. In the glaze in use we found samples containing as much as 45.70 per cent of soluble lead. Analysis of the lead content was made from samples taken from the tub while the process of dipping was going on, and it was not infrequent to find the percentage of lead higher or lower than the amount originally alleged to be used in mixing the glaze. In some plants the tubs are emptied periodically. In others, however, the glaze is added to the tubs from time to time. The difference between the laboratory analysis and the lead content originally put into the glaze may indicate a laxity on the part of the dipper in properly agitating the glaze. In this way the lead content may vary slightly from the original mixture.

PER CENT OF LEAD USED IN GLAZE.

We collected and analyzed 107 samples of glaze used in 87 plants. The following tables show, by States and wares, the per cent of lead in the glaze.

TABLE XVII.—*Per cent soluble lead in glaze.*

	New Jersey.		Ohio.					Pennsylvania.		West Virginia.		Total.
	Sanitary.	General.	Sanitary.	General.	Yellow.	Art.	Tile.	Sanitary.	General.	Sanitary.	General.	
No lead	1						2					3
Under 5 per cent		1					1				1	3
5-9.9 per cent	4	1		2	1	1	1		1	1		12
10-14.9 per cent	11	8	1	28	1	1		1	4	1	9	65
15-19.9 per cent	2	3		4	1	1		1		1		13
20-24.9 per cent	3											3
25-29.9 per cent		2				1						3
30-39.9 per cent		1			1							2
40-49.9 per cent		1			1		1					3
Average	12.63	17.40	9.83	13.27	24.93	16.65	10.76	15.19	10.47	15.27	11.92	13.95

Average per cent for each ware as follows: Sanitary, 12.11; general, 13.71; yellow, 24.93; art, 16.65; tile, 10.76.

TABLE XVIII.—*Per cent of total lead in glaze.*

	New Jersey.		Ohio.					Pennsylvania.		West Virginia.		Total.
	Sanitary.	General.	Sanitary.	General.	Yellow.	Art.	Tile.	Sanitary.	General.	Sanitary.	General.	
5-9.9 per cent		2				1						3
10-14.9 per cent	1	3		19		1	1		5	1	8	39
15-19.9 per cent	15	7	1	9	3		1	2		1	2	41
20-24.9 per cent	5	1		5		1	1			1		14
25-29.9 per cent		2		1								3
30-39.9 per cent		1			1	1	1					4
40-49.9 per cent		1			1		1					3
Average	18.81	19.60	17.96	15.73	26.72	20.03	26.78	16.98	11.94	16.35	13.94	16.89

Average per cent for each ware as follows: Sanitary, 18.48; general, 16; yellow, 29.35; art, 20.03; tile, 26.76.

It will be observed from the table that the average amount of lead in these 107 samples taken from the tubs is 16.9 per cent and that 78 of the samples, or 73 per cent of them, contain between 10 and 20 per cent of soluble lead. While this table does not show the average amount according to the type of ware manufactured, yet it does show that the highest per cent of lead, which is 26.72 per cent, is used in glazing the yellow ware. In the tile ware the amount of lead is 26.7 per cent. In the art ware it is 20.03 per cent of the glaze, while in the sanitary ware it is 18.4 per cent of the dry glaze. A glance at these rates is sufficient evidence that American potters are not aware of the number of leadless glazes available. A discussion of leadless and fritted glazes will appear later.

PLANT EQUIPMENT AND PROCESSES.

A description of the plant equipment for processes as found by our investigators is here duplicated in part, so that a picture may be presented which will convey to the reader some impression of the antiquated style of equipment still in use in an industry which, though old, is nevertheless increasing in size, production, wealth, and recognition in the local markets.

TYPES OF TUBS.

In our description of the process of dipping we mentioned the ordinary type of tub used in the potteries. In some plants a still smaller tub is used, in which a more uniform agitation of glaze is possible. The tubs were made of either wood or porcelain, the former material predominating in the plants surveyed by our field men. These are located in a convenient place, usually near a window, and may be adjusted to the height of the dipper.

DRYING RACKS.

The racks used for the purpose of temporarily storing the dipped ware when the glaze is drying are usually located in or near the dipping room and in a place quite accessible to the glost-kiln room, because the ware must be carried from the dipping tubs to these racks, from the racks to benches where the ware is placed in saggers, and thence to the kilns. The racks are usually of wood, and are frequently arranged along the walls or sides of the room, although often they are placed in tiers or rows in the central part. They are usually made so that the ware boards can be stacked upon them, the racks and boards together presenting the appearance of shelves. Ample space is left between the boards for circulation of air and between the racks for the movement of cars or workers.

HOW GLAZE IS CONVEYED FROM MIXING ROOM TO TUBS.

In a few plants the glaze is conveyed from the mixing room to the tubs by means of pipes, but in the majority of plants such labor-saving and health-protecting means are not employed. The glaze is very often carried in buckets, and in a great many plants the glaze room is on the first floor, while the dipping is done on the second, so that it is necessary to carry the glaze up a flight or two of stairs, occasionally through one or two other rooms, to reach the dipping tub.

The conveying of glaze in this manner occasions many chances of spilling; it necessitates, also, frequent stirring of the ingredients of the mixing tub, the continual annoyance of the dipper and his helpers, and additional splashing of the dipping tub. Thus it needlessly exposes a large number of workers to glaze dust and by increasing the spilling, increases the dust hazard.

KILNS.

Almost without exception use is made of the ordinary intermittent kiln in the plants surveyed. The process of placing the saggers in both kinds of kilns has been explained under "Plant processes." The advantages of continuous kilns will be discussed later.

Intermittent kilns are large circular ovens varying in height, but their loading height is usually from 12 to 13 feet; above this level they taper to form a chimney point. Ordinarily there is a false roof with openings which assist in regulating the heat. The kilns are heated by fire boxes, fired by gas or coal, and distributed at regular intervals around the base of the kilns. The temperature is determined by the use of cones and disks, by the melting of which certain temperatures are indicated. The construction of the kiln is such that the high temperature within it does not cause an abnormally high temperature in the workroom. Practically all kilns are above the level of the floor, so that entrance to them is attained by means of a series of steps.

WORKBENCHES, WARE BOARDS, SAGGER BOXES, AND OVERHEAD CARRIERS.

In most plants the workbenches are of wood. They are usually placed along the wall in the vicinity of the kiln doors. They are of convenient height for the kiln placers, who place on them the saggers to be filled with the glazed ware. Very frequently the benches are not kept well cleaned, and a great deal of dust containing lead is likely to accumulate and to add to the hazards already noted in the glaze department. In general pottery-ware plants, racks, designed to hold temporarily the ware boards unloaded for sagger filling, are built above the workbenches. In lowering the boards *to* the racks a considerable amount of visible dust is created.

The ware boards are made of wood and are designed to be of sufficient size and strength to enable them to hold the ware while it is drying, or while it is being transferred from one room to another. The ware boards are cleaned by washing and scraping them, usually in a tank. The loosened glaze is allowed to settle at the bottom of the tank and is later recovered.

The saggers are of such size, shape, and weight as to suit the ware for which they are to be used when loaded. Saggers, according to their contents, vary in weight from 50 to 100 pounds. As we stated above, these saggers are placed upon the workbenches, to be washed and filled with the dipped ware; and they are then carried—usually upon the heads of the kiln placers—into the kilns, where they are set in place for firing. The individual saggers are not covered, but saggers of like size are placed in tiers, one above the other, in such manner that each sagger forms a perfect seal for the one beneath it. Only the top saggers are provided with independent covers.

LABOR-SAVING MACHINERY.

While carts, wheelbarrows, and other transportation facilities are provided for handling the rougher material, as in emptying saggers or transporting the glaze tubs, the majority of workers, including those engaged in the more skilled occupations, are not relieved from the arduous tasks of lifting and carrying the saggers and ware boards.

FIG. 17.—GLOST KILN PLACING. NOTE MEN WITH SAGGERS ON THEIR HEADS, STEPS LEADING INTO KILN, WORK-BENCHES, POTTERY WARE, WORK APRONS, AND ILLUMINATION OF ROOM. THIS ROOM IS WELL LIGHTED.

FIG. 18.—DRYING RACKS FOR DIPPED WARE.

FIG. 19.—SHOWING DRYING RACKS, AND WARE AND DIPPING TUB IN A LARGE ROOM.

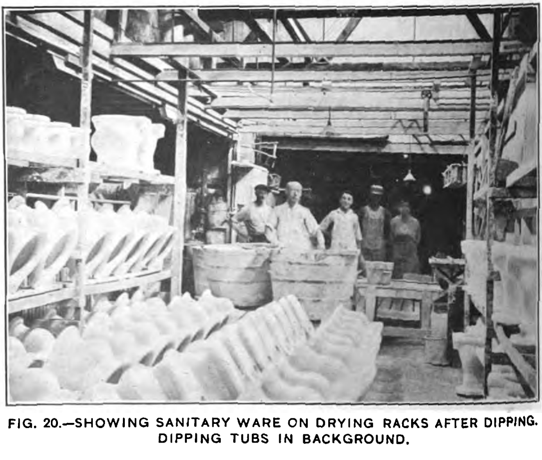

FIG. 20.—SHOWING SANITARY WARE ON DRYING RACKS AFTER DIPPING. DIPPING TUBS IN BACKGROUND.

FIG. 21.—KILN ROOM SHOWING WORK BENCHES (ON RIGHT) WITH WARE BOARDS AND WARE ON SUPPORTS, KILNS ON LEFT, COAL ON FLOOR IN FOREGROUND, AND GENERAL UNTIDY CONDITION OF KILN ROOM.

FIG. 22.—DIPPING ROOM, SHOWING WARE BOARDS, STANDING ON END, TUB FOR WASHING WARE BOARDS, GLOST-WARE, DIPPING TUB, PIPE FOR GLAZE, DIPPED WARE ON WARE BOARDS, CONDITION OF FLOORS AND WALLS.

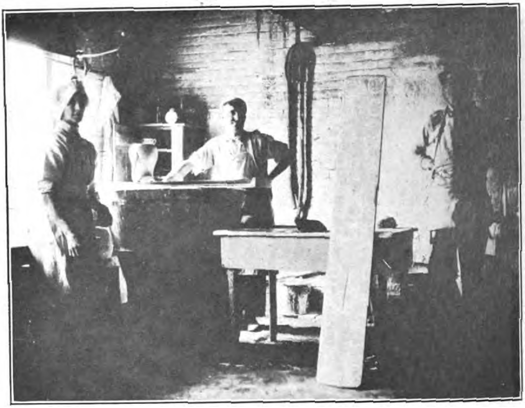

FIG. 23.—DIPPING ROOM. WARE BOARD IN CENTER SHOWS DRY GLAZE, ONE OF THE PRINCIPAL SOURCES OF DUST.

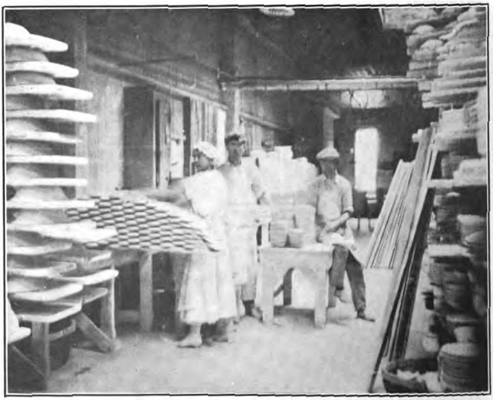

FIG. 24.—DIPPING ROOM, SHOWING MANNER OF DIPPING THE WARE AND USE OF THE WARE BOARDS. WARE BOARDS STANDING ON END ON RIGHT SIDE OF PICTURE.

FIG. 25.—[illegible]

FIG. 26.—GLOST KILN PLACERS AT WORK BENCHES [illegible] SAGGERS. EMPTY SAGGERS ON LEFT. NOTE BROKEN [illegible] ON FLOOR.

FIG. 27.—KILN PLACING. NOTE KILN PLACER WITH LOADED SAGGER ON HEAD CLIMBING STEPS OF KILN, WARE BOARDS LEANING AGAINST KILN, WARE CARRIER OR KILN PLACER IN BACKGROUND WITH WARE BOARD COVERED WITH DIPPED WARE, KILN PLACERS OR SAGGER LOADERS AT WORK BENCHES, WARE BOARDS WITH WARE ON BRACKETS ABOVE WORK BENCHES, APRONS ON WORKMEN, CLOTHING OF WORKMEN AND CONDITION OF FLOOR.

FIG. 28.—TOILET ROOM. TWO MINUTES' EXPOSURE, THIS ROOM BEING VERY DARK AND POORLY LOCATED.

FIG. 29.—WORK BENCH IN GLOST KILN ROOM. NOTE CONGESTION AND POOR ILLUMINATION.

FIG. 30.—KILN PLACING ROOM AND WORK BENCH. NOTE GOOD NATURAL ILLUMINATION AND ABSENCE OF CONGESTION.

PLANT HYGIENE.

NATURAL AND ARTIFICIAL ILLUMINATION.

In this survey both natural and artificial illumination were studied at the place and area according to conditions found in the dipping room, the glaze room, and the kiln room of each pottery. In classifying the rooms as having good, fair, or bad natural illumination, the investigators considered the number of windows, skylights, and doors—whether partly of glass or merely kept open for the purpose of illumination—and carefully noted the number, size, and type of glass in each; whether they were clean, dusty, or dirty; their distribution in various walls; the ratio of light area to floor area; the process; the location of workers; the color of the walls; the amount and nature of obstructions, external or internal; the degree and type of glare, and the position of the workers with regard to light and to the nature of the work.

Of the 75 dipping rooms 30 were classed as good, 20 as fair, and 23 as bad—the respective percentages being 42.6, 26.6, and 30.7.

Of 58 glaze-mixing rooms concerning the illumination of which we have information, 17 are classed as good, 16 as fair, and 25 as bad. Reducing these figures to percentages, we have 29, 28, and 43, respectively.

Of the 65 kiln rooms, 11 were classed as good, 14 as fair, and 40 as bad, the percentage of each being 16.9, 21.5, and 61.5, respectively.

Artificial illumination at best, because of the shortness of the workday and the nature of the work, was not considered of major importance in the analysis of the relationship between such illumination and the possible incidence of lead poisoning. In very few of the rooms did the investigators report the artificial illumination as inadequate.

Differentiation must be made here in the classification of the adequacy of the light, so as to apply the gradation given above only to the plane and area of work and not to the rest of the workroom or to the paths of the workmen, which, according to observation, were not lighted sufficiently to insure the maintenance of a proper degree of cleanliness and other hygienic conditions.

NATURAL VENTILATION.

Seventy-eight plants were classed as having adequate natural ventilation. This classification was made after due consideration had been given to the number of workers in each room, the nature of the work, the size and location of the room, the number of openings (doors, windows, etc.), and to thermometer readings as well as sense perception, at the time of inspection.

Ventilation was provided and controlled by ordinary doors and windows, and by skylights, pivot windows, ventilator windows, air shafts, and air wells, additional fresh air being supplied in many poorly constructed buildings by cracks and openings.

In general, on account of the nature of the buildings, many of them being very old and very poorly constructed, natural ventilation did not seem to be a problem in the pottery industry. In fact, at the time of the survey, the winter temperature in many of the plants inspected was often very near to that out of doors, notwithstanding the various heating systems and devices employed; while in early spring and summer, because of the many windows and other openings in most of the potteries, the interiors were found in most cases entirely satisfactory as far as natural ventilation was concerned, with the exception of dipping rooms and a few small rooms used for special processes. where proper window space and openings were not provided.

In pottery work a very large amount of space per worker is necessary, because of the space needed for the various drying racks, molds, saggers, and other equipment; hence it is only in the kiln rooms, on account of the heat from the kilns, the dust from unloading the kilns and saggers, and the poor location or the lack of windows and doors, and in the rooms where the fettling processes and the bisque-ware brushing are carried on, that the need of ventilation from either dust or heat is especially noticed.

It was found in some potteries that the bins in which the clay mixing and glaze mixing were done are located in the basements or cellars of the plants; and that in many of these basements or cellars, on account of the scarcity of windows and doors—most of the windows, too, being only one-half size—and on account of the dampness caused by the processes, the ventilation is often inadequate.

ARTIFICIAL VENTILATION.

The investigators failed to find a single plant which had adequate artificial vertilation for the entire plant or for any particular part or process of the plant. In 12 plants they found either electric fans or machinery that created a certain amount of air motion, but this could not be considered adequate artificial ventilation. In one or two plants exhausts for fettling and bisque brushing were found. In several others revolving machinery caused a certain amount of air motion, and a few kiln-placing crews used electric fans in and around the kiln when they were loading the saggers or were removing and unloading them. These fans in most instances merely stir up the air and dust, without causing any exchange of air. In one plant was found a 3-foot fan and pipe system which originally pumped air into the glaze-mixing room; but this system had not been in use for a long time, and the investigators were informed by the foreman that it was to be taken out, because when in use it shook the floor above too much. It was thus found that little attention had been paid to the installation of adequate artificial ventilation, in those processes and workrooms in the potteries where its installation was essential.

HEAT, COLD, AND WET HAZARDS.

Heat, cold, and dampness were found by the field investigators to be negligible factors in the production of lead poisoning, except in a very small number of sanitary-ware plants, where enamelers and helpers are exposed to heat from the furnaces and the glowing metal, in the constant handling of heated ware when removing it from the furnaces, placing it upon the workbenches, and applying the enamel. The heat is quite intense, and little ventilation is provided in these plants. The men perspire freely, and when possible rush to the doors and other openings for fresh air. Such exposure to heat is naturally greater in warm weather, but the extremes of heat and cold are more of a risk in cold weather.

The faces of many of the men appear as if sunburned. Little clothing is worm by those engaged in this work, so that their bodies are subjected to many sudden changes of temperature. Practically all the men wear asbestos gloves on the hands nearest the heated ware, for the protection from the radiant heat.

The conditions found in the kiln rooms, in firing, drawing, or loading the kilns, do not present serious heat hazards. The temperature is high, but not dangerous. A heat hazard arises in drawing the kilns, when the employees, for the sake of increasing their compensation, insist on drawing the kilns before they have had time to cool. This, however, is not in the regular course of their occupations and can not be classed as a heat hazard existing in the normal production of pottery.

In certain old and poorly constructed buildings cold is a hazard only in so far as it is made one by the weather conditions. This statement applies also to plants where the toilet facilities are located in outhouses and where no protection from the weather is provided by covered passageway or in other ways for the workers as they go to and from the toilets.

Because of the bodily activities required by most processes in the pottery trade—and increased by the plan of compensation by piecework—likelihood on the part of the worker to take cold while in the plant is very slight; and it is for this reason that cold can not be classed as a hazard in the industry.

In sanitary-ware plants, dippers and dippers' helpers in dipping constantly cover their hands and forearms with glaze. This is the only essentially wet hazard in the pottery industry.

In some plants leakage from the mixing machines, together with the natural dampness of basements with earthen floors, keeps the footing damp and often wet.

These hazards are found frequently to exist in the lead processes, but are not inherent to them.

EXHAUSTS AND HOODS.

The installation and maintenance of exhausts and hoods, which are greatly needed, are sadly neglected, only 11 plants out of 92 having systems of this nature.

The few exhausts and hoods in use, while fairly satisfactory for their particular purpose, are for special processes only; but there are operations where exhausts and hoods could and should be employed. Typical instances of such use are cited from several plants.

GLAZE CLEANING.

After the glaze has dried on the dipped ware it is removed from the foot of every piece. This work is done on uncolored bone china and Belleek ware by placing the piece of ware bottom side upward on a revolving wheel situated over a down-shaft bench exhaust system, which carries away particles of glaze removed from the foot of the ware by the use of the scraping tool. A 4-inch galvanized-iron shield for down-draft exhaust 20 inches in diameter is placed about the wheel. This exhaust system is produced by a three-fourths horsepower motor. The draft is sufficient to carry away all the particles which are thrown off centrifugally by the ware as it is cleaned on the revolving wheel.

WARE CLEANING.

Ware cleaning is done on a bench near the dipping tubs, and consists in removing the excess glaze by scraping or sponging.

Two revolving tables about 2 feet in diameter are located on the bench, and on each table is a thick soft pad. Here the ware cleaner places his ware and revolves it as he cleans it on each side. At a distance of 1 or 2 feet in front of the ware cleaner's bench is the opening of the exhaust from a 22-inch fan, which effectively removes the greater part of the dust generated.

WARE CLEANING OR FETTLING.

Fettling—a process used only for small dishes and cups—is done after the glaze has thoroughly dried, and the dust from this source is very effectively removed by local exhaust systems. A revolving disk, on which there is a piece of rough carpet, removes the excess glaze as each piece of ware is brought into contact with it, and a small exhaust fan draws the dust downward through a 6-inch line into a collecting box in another room.

AUTOMATIC DIPPING AND CONTINUOUS KILNS.

Where automatic dipping and the continuous kilns are found the exhaust fans are connected with the furnaces to carry off the smoke, fumes, and gases, so that the incoming air is not vitiated in any way.

FATIGUE.

There are certain processes in the pottery industry where, because of speed, cramped posture, heavy lifting, and climbing, a fatigue hazard may be present. This is especially true in the case of cup finishers, biscuit brushers, and dressers. The element of posture enters in the case of these workers, in that cup workers stand or sit in a bent-over position all day long, while biscuit brushers and dressers sit on low stools and continually bend over to take pieces from one side and place them on the floor on the opposite side.

In the kiln room and among kiln workers the fatigue hazards are heavy lifting and carrying, constant standing and climbing ladders with heavy loads on the head. The effect of all these fatigue-producing conditions is influenced by the length of the period of uninterrupted activity. Sagger loaders do not work for long hours nor for unbroken periods on the heavy part of their work; dippers and ware gatherers adjust their own rest periods; but those working in cramped positions are so employed for longer periods of time, and therefore come more within the field of fatigue-producing conditions.

AIR DUSTINESS.

Hazards from dust are the bane of many industries. In all potteries dust is present in greater or less quantities. This is shown by the following table of the number of dust particles per cubic foot of air in the glaze mixing, dipping, and kiln rooms, as found by our field men.

TABLE XIX.—*Distribution of dust samples by room according to number of particles, weight, and lead content.*

Rooms.	Number of particles per cubic foot.														
	Class 1.		Class 2.		Class 3.			Class 4.			Total.			
	0–5,000	5,000 plus.	0–10,000	10,000 plus.	0–500,000	500,000–1,000,000	1,000,000 plus.	0–500,000	500,000–1,000,000	1,000,000 plus.	0–200,000	200,000–500,000	500,000–1,000,000	1,000,000 plus.
Glaze mixing	....	....	....	....	40	0	1	20	8	14	12	6	8	15
Dipping	....	....	2	....	128	4	4	83	13	43	36	46	15	41
Kiln	1	....	3	3	102	2	5	53	28	30	25	25	27	32
Others	....	....	....	....	5	0	0	3	0	2	2	1	0	2
Total	1	....	5	3	275	6	10	159	47	89	75	78	50	90

TABLE XIX.—*Distribution of dust samples by room according to number of particles, weight, and lead content*—Continued.

Rooms.	Weight per cubic foot of air.															Breathes per day 135 feet.						
	Total, in milligrams.			Lead, in milligrams.			Soluble lead, in milligrams.			Per cent lead.			Per cent soluble lead.			Number of particles.				Amount soluble lead.		
	0–0.09	0.1–0.49	0.5 plus.	0–0.09	0.1–0.49	0.5 plus.	0–0.09	0.1–0.49	0.5 plus.	0–9.9	10–49.9	50 plus.	0–9.9	10–49.9	50 plus.	Less than 10,000,000.	10,000,000	500,000,000	1,000,000,000	Less than 1 milligram.	1–4.9	5 plus.
Glaze mixing	12	21	11	32	2	1	36	2	2	15	16	2	21	18	2	3	34	2	2	13	15	13
Dipping	86	67	7	135	1	0	140	3	2	83	48	3	90	50	5	17	92	3	12	69	63	10
Kiln	60	57	13	114	1	0	119	1	0	83	26	2	97	21	2	11	87	4	7	74	44	4
Others	5	0	0	5	0	0	5	0	0	5	0	0	5	0	0	1	4	0	0	3	2	0
Total	163	145	31	286	4	1	300	6	4	186	90	7	213	89	9	32	227	9	21	159	124	27

When using the Palmer spray machine and the corresponding method for classification, the number of class 4 dust particles per cubic foot of air should not average over 200,000 dust particles and must not exceed 300,000 dust particles.

It is not our intention to point out the relation of dust to tubercular and other respiratory diseases, since our interest is concentrated on air dustiness in the pottery industry in its relation to the causation of lead poisoning.

Class 4, dust particles are about 0.0001 square millimeter, those of class 3 are four times as large, those of class 2 are 0.01 square millimeter, and those of class 1, 0.04 square millimeter.

In considering the dust here, we will discuss the total number of particles found, because it is on the total sample that the analysis of the second section of the above table is computed, and it is from the solid particles of dust that the amount of lead is computed. It will be noticed that 75, or 25.6 per cent of a total of 293 samples reported, contained less than 200,000 dust particles—the desired maximum; and that 78, or 26.6 per cent of the number of samples, contained 200,000 to 500,000 dust particles, which is a very wide range for permissible air dustiness. Therefore, 47.8 per cent of the air samples contained a number of dust particles beyond the widest ranges permissible, proving that almost one-half of the potteries are suffering from excessive dust.

Of the total number of samples collected in each division of the pottery workrooms it will be noticed that the glaze-mixing room has the largest per cent in the 1,000,000 plus column under "total"—15 samples out of a total of 41; and that the glaze-mixing room also has the highest per cent of samples having a total weight of 0.5+ milligrams.

Throughout the table the glaze-mixing room ranks first; but on account of the shorter time of their exposure, the rate of plumbism of the glaze mixers is second, that of the dippers being first.

The following paragraphs briefly describe the exposure to dust of principal classes of workmen.

...ne plants the processes are well separated, so that workers ...rocess need not be affected by the dust produced by adjacent ...es; but such plants are in the minority.

DIPPING.

...ers and dipper's helpers are exposed to the glaze dust generated ... dipping room. The dipping rooms often have rough floors ... either wood or brick, though occasionally cement dipping ... the tubs are found. Glaze is splashed upon the workers, ... floors, the tubs, and walls. It accumulates on the ware boards, ...ough handling of these boards—especially dropping them down ...d—probably produces more dust in the dipping room than any ...r operation. This, and the constant movement of the workers, passing in and out of the glost placers and ware gatherers as they ...ve the ware from the racks, and sweeping are the chief sources ...ust. It was observed that in most of the dipping rooms sweeping ...d more dust than it raised in any other department of the pottery.

KILN PLACING.

...lost-kiln placers not only handle the ware covered with dry glaze, ... also remove by the rubbing process excess glaze from the feet ...e ware which they place. In many plants we found the workers ...bing the ware on their aprons and thus creating a dust highly charged with lead. This work is done at their temporary workbenches alongside the kiln. The kiln men are also exposed to the poisonous dust in various other ways. Dust is stirred up by handling the ware boards and filled saggers, it is raised from the floors by walking and by sweeping, and the men are continually carrying it on their clothing, and often brush the dusty clothing against their heads and faces. In the kiln rooms glaze dust is constantly in the air, and the workbenches and floor are usually covered with dust.

The air dustiness is increased by certain careless practices of the workers; for example, in many plants field men saw pottery workers brush to the floor the dust that had fallen on their benches, thus causing clouds of dust to float in the air. Apparently the practice is a common one, for the wiping of the workbenches with a damp cloth, or by any other hygienic method, was seldom observed in the plants.

The glaze dust found in the kilns after burning the ware does not contain soluble lead—a fact proved by experiments in the laboratory with samples taken from the kilns and by putting samples of glaze through the glost kiln and later analyzing them for soluble lead.

SAGGER WASHING.

The sagger washer paints part of the new saggers with thick glaze, but the spillage is only slight and occurs only on the workbenches. In carrying glazed saggers the worker wipes some of the glaze off on his apron, but the amount of glaze dust in the air from his operations is probably very slight. However, the sagger washer is usually subject to increased hazard from lead, because his working place is usually quite close to the dipping or kiln room or connected with it and ventilated through it. He is usually located in or near a passageway traversed a great deal by the placers, with either empty or loaded ware boards. As the sagger washer is usually close to the dipping or glost-kiln room and works during longer hours than dippers and kiln men, he is therefore exposed to the dust raised in sweeping the dipping or glost-kiln room.

GLAZE MIXING.

In addition to these constant and regular processes where dust is a continuous hazard, the process of mixing glaze produces more or less poisonous dust by the assembling, handling, loading, and dumping of the lead components into the mixing vat and by continual walking on the dirty floors.

SWEEPING AND DUST CONTROL.

The following methods of sweeping were employed in the various plants: (1) The floors in 19 plants were swept dry. (2) In 73 they were usually sprinkled with water before sweeping. (3) In some they were washed down with water. (4) In 9 plants the floors were strewed with dry sawdust and then were sprinkled or swept dry, and in 24 plants oiled sawdust was sprinkled on the floors and removed at will.

A few plants had special rules concerning the sweeping of the floors and the methods to be employed, and some plant managers and dippers were very careful and had the floors washed with water or sprinkled with oiled sawdust as often as necessary, and did not permit sweeping while the workers were about; while in others there seemed to be no regard for the hazard, and the employees were allowed to sweep the floors at will and in any manner they desired, without regard to the amount of dust raised and the dangers of the dust. In some plants the floors were swept three times a day, and in others only once a week.

In a few plants the men were found to use respirators while sweeping, but in the majority the sweepers used no means of protection whatever.

In 47 plants it was found that sweeping was done during working hours; and in 25 of these the floors were swept dry or only slightly sprinkled, clouds of dust arising during the process.

In the glost-kiln rooms sweeping and cleaning were done after each kiln was loaded, and in the mixing rooms after each batch of glaze had been mixed.

Tables of dust counts according to workrooms is found in Appendix E.

PERSONAL SERVICE FACILITIES.

WASHING FACILITIES.

In the entire survey, covering 92 plants, there was not found a single plant that provided a separate and modern wash room for the use of the employees. In 5 plants shower baths were found, and 20 plants provide hot and cold water for the use of the employees; 4 plants furnish soap and towels; 29 plants provide troughs of some type for washing; and 37 plants have pails that are available for washing purposes; 9 plants have some other form of washing facilities, including tubs, etc.

In many of the plants the workers wash either in basins or bowls removed from the racks, or in troughs used for washing the ware and the ware boards; and in quite a number of plants the dippers and dippers' helpers are known to wash their faces and arms with the sponges which are used in cleaning the sides and edges of the dipping tub.

In general, the washing facilities are scanty and inadequate, and because of this condition the employees wear their work clothes from the plants to their homes and vice versa. The ratio of washing facilities to the number of employees is from 1:4 to 1:45. Many workers were observed to eat with unwashed hands.

In many plants the glaze washed from the ware boards is collected in troughs and tubs for reuse; washing with soap is not permitted at faucets over these troughs and tubs, because the soap would ruin the glaze. Consequently, in some such plants, in which no other faucets are provided for washing, soap could not be used, unless the worker himself make other arrangements for washing.

LOCKERS.

Twenty plants have lockers of some sort, made of either wood or steel; while only one plant has a regular locker room, and 13 other plants have change rooms. The lockers in five plants are in the work rooms. The ratio of employees to lockers, in plants where lockers were found, ranges from 1 :1 to 3 : 1.

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The kind of clothing that should be worn and the care of it are questions left entirely to the employees. The plant owners, apparently uninterested in protective measures in regard to this matter, permit the clothing to be changed in any section of the plant, and consequently to become contaminated with dust.

CUSPIDORS.

Only one plant out of 92 provides cuspidors; positive evidences of expectoration on the floor were found in 68 plants. There seems to be no regard to instructions given concerning this insanitary and dangerous habit.

PLANT MANAGEMENT IN RELATION TO WELFARE OF WORKERS.

Our field investigators gathered as much information as possible concerning the management and welfare of workers, but on account of the almost universal absence of any plant records concerning these matters this information is very meager.

EMPLOYMENT.

No employment bureau existed in any of the plants at the time of the investigation. Each foreman hired his own men. In many of the plants the employee is engaged by the piece, and is interested in turning out as large an amount of the finished product as possible. The foreman has no supervision over those who do not come directly within his department, and practically no interest in them. With the power to hire there comes also the power to "fire," so that each foreman may discharge an employee in his particular department without consulting the general plant management. Frequently the foreman of the dipping room, for example, is paid by the company for the weekly product which passes through his hands for the purpose of receiving a coat of glaze. Out of this amount he in turn pays the other dippers and helpers, and no regular records are kept of the personnel nor of the amount of the individual wages paid. Thus there are no records by which a turnover might be computed. Frequently there is no record of the exact number of people employed. The nearest estimate is obtained by going over the pay roll of each foreman. A few employees who do not come directly under the supervision of the foreman of a given department are employed by the superintendent. Matters of dispute between union members and the management are referred to a standing committee of manufacturers and union men.

TRAINING.

About two-thirds of the plants included in this survey have a system of apprentice training, which is regulated by the unions rather than by the management of the plants. The usual time required for an apprentice is three years, although in some departments four years is required; yet the necessary skill can be obtained in most cases

FIG. 31.—DIPPING. NOTE GLAZE ON FOREARMS OF THE DIPPER. HANDS OF DIPPERS' HELPERS ARE ALSO COVERED FROM HANDLING THE WET DIPPED WARE.

FIG. 32.—DIPPING ROOM. NOTE NARROW AISLE AND GLAZE-COVERED FLOOR.

FIG. 33.—TROUGH FOR WASHING WARE BOARDS. THE ONLY AVAILABLE WASHING FACILITIES IN THIS PLANT FOR GLOST KILN PLACERS AND DIPPERS.

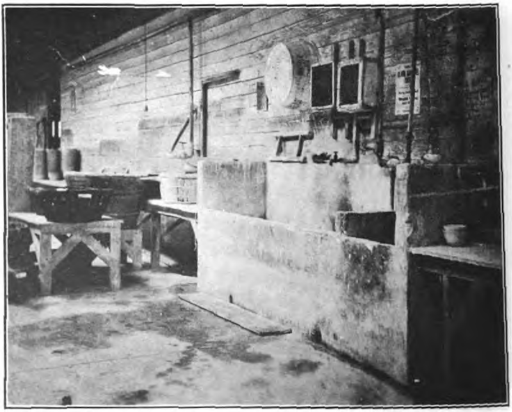

FIG. 34.—TROUGH FOR WASHING WARE AND DRAIN BOARDS. ONLY WASHING FACILITIES AVAILABLE IN THIS PLANT FOR KILN MEN AND DIPPERS.

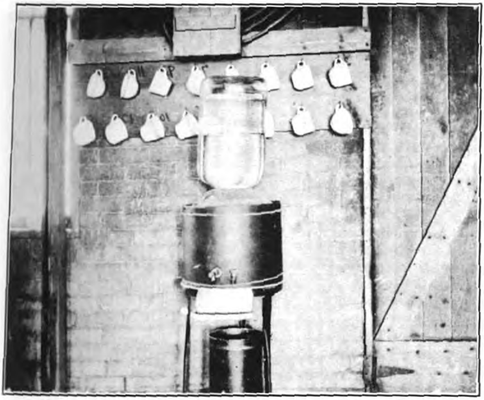

FIG. 35.—DRINKING FACILITIES IN A PLANT SHOWING INDIVIDUAL CUPS, SO ARRANGED AS TO CATCH ALL DUST AND OTHER MATERIAL IN THE AIR.

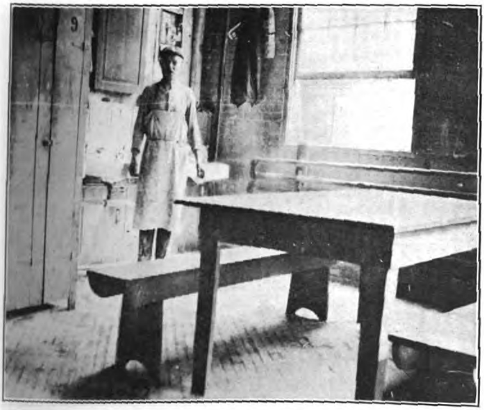

FIG. 36.—SHOWING ONE ROOM USED AS CHANGE, LOCKER, AND LUNCH ROOM FOR USE OF GLAZE MIXERS.

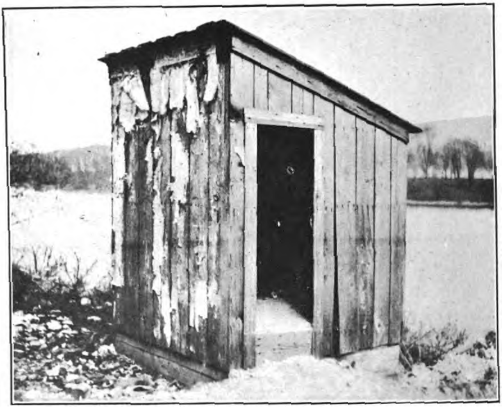

FIG. 37.—OUTDOOR PRIVY FOR MEN, CONTAMINATING STREAM OF WATER.

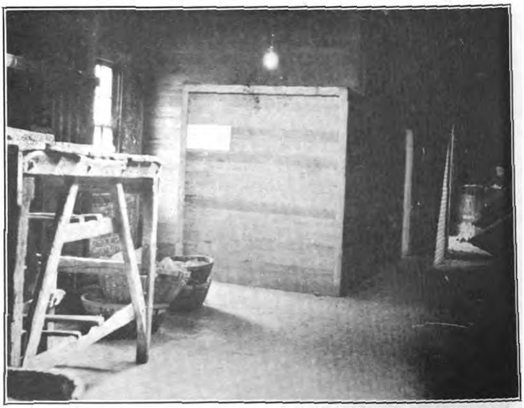

FIG. 38.—SCREENING OF THE DOORS OF THE TOILETS IN A PLANT HAVING EXCELLENT TOILET FACILITIES.

FIG. 39.—TWO-STORY TOILET.

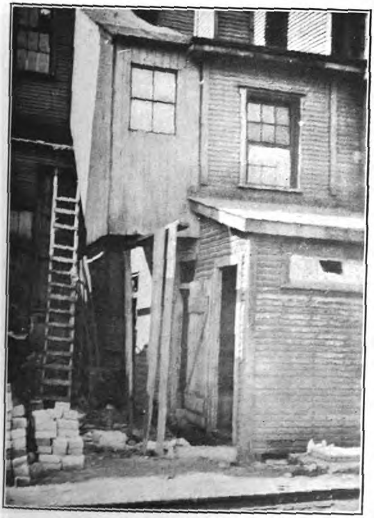

FIG. 40.—CLOSE-UP OF TWO-STORY TOILET. UPPER SECTION FOR WOMEN, LOWER FOR MEN. THIS TOILET IS A NUISANCE AND A HEALTH HAZARD.

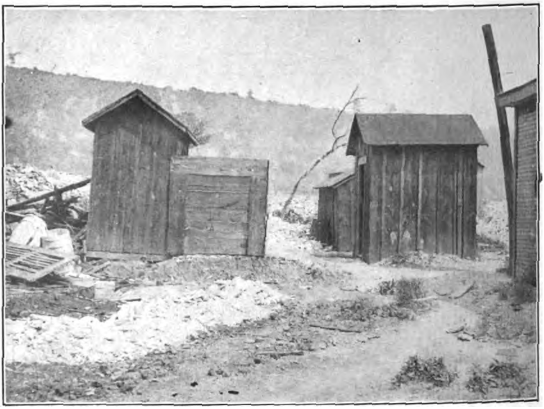

FIG. 41.—COMMON OUTDOOR TOILET. NOTE CONSTRUCTION AND UNTIDY SURROUNDINGS.

FIG. 42.—MODERN TOILET, SHOWING LACK OF CARE, EITHER DUE TO WORKMEN OR LACK OF INTEREST ON THE PART OF PLANT MANAGEMENT.

within six months. One plant was found which had had a training school before the war, and another was found where training is given by the foreman. In a great many instances learning the trade seems to be left to the desire of the employee, and he acquires his knowledge from information and voluntary instruction given by his coworkers.

MEDICAL ATTENTION.

In only one plant out of the 92 was there found any attempt at medical supervision. In 42 plants some form of first-aid cabinets was found, and in eight plants certain individuals are assigned to render first-aid work. In spite of the hazardous processes carried on, it seems that there is an almost complete lack of medical attention. American potteries appear to be very much behind foreign establishments, where through medical attention cases of lead poisoning are discovered in the early stage, and by proper care loss of time and of efficiency on the part of the worker is prevented.

Our investigators found that there are no examinations of workers on the part of the management; no opportunities for the examination and care of teeth, no company hospitals, and in the whole survey only two dispensaries were found.

The plants in West Virginia and Pennsylvania and the few in Ohio are required by the States to keep accident records; one plant keeps a record of severe accidents; two plants were found which keep sickness records for some workers, and one which keeps sickness records for benefits only; one plant was found which keep records for first aid only. The teaching of hazards is not practiced in a regular way. One plant was found which teaches the hazards to some workers; four were found using placards; one giving instruction once a month; one every three months. As a general rule there is an almost utter lack of records of all kinds, and of training and instruction as to lead hazards.

The Brotherhood of Operative Potters have a practical potter as health officer, whose duty is to cooperate with the plant managements toward the welfare of the workers and to arrange for medical care of the workers when they become ill. He has taken many employees from the potteries to the clinics of neighboring hospitals.

The Brotherhood of Operative Potters has installed in hospitals in two cities the Clague Oliver electrolytic apparatus, but comparatively little use has been made of the device. Opinions on the efficiency of this treatment are found in Appendix A.

HOUSING.

The locations of the potteries covered in this investigation are such that the workers may occupy homes in the city or the country, since both are easily accessible. Only one plant was found which furnishes employees with homes for which a reasonable rent is charged.

OTHER WELFARE WORK.

Rest rooms are found in seven plants; plant restaurants in eight. The typical plant in this survey, however, has no welfare facilities and no welfare work. The attitude of the plant managements is usually favorable toward these things, and there seems a willingness for cooperation; but the lack of definite placement of responsibility, owing to the system of employment in practice, seems to prevent not only satisfactory welfare work, but, as will be shown later, satisfactory observance of the rules of plant hygiene.

DISCIPLINE.

No conscientious effort was noticed in any plant to enforce rules which would diminish the number of cases of plumbism. Promiscuous spitting is practiced in most places. Discipline, together with instructions pertaining to the health hazards, is absent.

SICKNESS AND ACCIDENT INSURANCE.

A great many of the plants studied are subject to the workmen's compensation laws of the various States. Local unions also give hospital care and pay death benefits to their members. Only six plants were found which carry any kind of insurance for the employees besides the protection furnished by these organizations.

REST PERIODS.

In most plants a rest period of from 15 to 30 minutes is allowed in the middle of the forenoon. Taking advantage of this is optional, however, with the workmen, and is not favored by those who are on piecework. Few avail themselves of this rest period, even to the extent of using it as a lunch period. Pieceworkers, as a rule, either eat while working or wait until they have finished the day's work.

REST ROOMS.

According to previous statement, only seven of the 92 plants surveyed maintain rest rooms, and even these few are, for the most part, poorly adapted for their purpose. The rooms available for rest were in most cases very small, usually of unclean and uninviting appearance, and poorly kept. The furnishings are meager and uncomfortable. They are not truly rest rooms in any sense of the word.

EATING REGULATIONS.

The managers of most potteries apparently feel that the lunch period belongs to the worker and that they have no concern in it. In only five plants do we find any regulations against eating in workrooms, and in three of these the regulations are not observed. Our investigators noticed that the workmen not only make a practice of eating in workrooms where glaze and lead dust are present, but that they wash their hands either carelessly or not at all. Even workmen who come in contact with the glaze are negligent in this respect. In 80 plants some workers eat in the workrooms, and in 65 of these a majority of the workers do so, involving 969 workers, or over one-half of those examined in this survey.

In one plant a woman worker whose hands were covered with glaze was observed eating a piece of pie. Between bites she placed the pie on a ware board covered with glaze. A foreman, noticing this, reprimanded her, but on account of the system of employment and discharge which prevails in the potteries he could not enforce his reprimand. This is not an isolated instance, for similar carelessness was observed in many plants; eating in workrooms was reported in 80 out of the total of 92 plants surveyed.

Regulations as to washing are urgently needed in most of the plants and should be strictly enforced. Reference to the tables on the dust counts made in these rooms is convincing enough that lead is present in the dust in sufficient quantities to warrant absolute restrictions against eating in the workrooms where such dust is present. Our investigators find that the plant restaurants in existence are well patronized.

MILK SUPPLY.

Some workmen drink milk as a prophylaxis against plumbism. While a study of the effect of milk drinking is reserved for a later part of this report, the statement may be made here that the use of milk has generally been recommended by physicians. Great care should be taken, however, that the milk is not exposed to lead dust or placed in vessels in which lead may be present. Our investigators did not find a single plant, however, in which the management was in any way responsible for furnishing the milk supply.

PRACTICES INVOLVING PERSONAL HABITS.

It was found that smoking and chewing tobacco are practiced to an unusual extent among the workers in the pottery industry. Chewing furnishes an especially fruitful means of introducing lead-laden dust into the stomach. The plug of tobacco is frequently carried in an unprotected pocket and is handled with unwashed hands, so that there is plenty of opportunity to get portions of glaze and of lead dust with each chew. A peculiar idea seems to exist among potters to the effect that chewing, smoking, and liquor drinking are prophylactic aids to prevent lead poisoning. In some potteries the idea prevails that if the worker gets dead drunk on Saturday night he will vomit most of the lead ingested during the week. On the contrary, alcohol lowers resistance and increases personal carelessness, and therefore predisposes to lead poisoning. The effect of these habits was ascertained by investigation, and the rates of plumbism among users of tobacco and liquors will be given in Part IV of this report, where a careful analysis of each is made.

PART III.

LEAD AS A POISONOUS SUBSTANCE.

FORMS OF LEAD COMPOUNDS KNOWN TO BE POISONOUS AND THEIR RELATIVE SOLUBILITY.

The amount of lead which ultimately takes part in damaging the vital organs and tissues is measured by the solubility of the lead in the body fluids, the chemical constituents of these fluids, the facility with which the tissues absorb the particular compound, the amount and the nature of the food in the stomach when the portal of entry is by way of the gastrointestinal tract, the mode of entrance into the body, and the susceptibility of the individual. The larger the ingested particle the better its chance of passing through the intestinal tract before solution and absorption take place.

Lead is more readily absorbed from its fumes than from any of its solid compounds. Some of its compounds are more soluble and more toxic than others. In the comparative tables which follow it will be seen that while all these compounds are regarded as poisonous, lead carbonate, which is generally used in the pottery industry, is one of the most toxic, and therefore one of the most dangerous.

Hamilton (*1*).	*Oliver* (*2*).	*Rambousek* (*3*).	*Legge* (*4*).
Lead carbonate.	Lead carbonate.	Lead acetate.	Lead carbonate.
Lead acetate.	Lead oxide.	Lead chloride.	Lead oxide.
Lead oxide.	Lead chromate.	Lead carbonate.	
Lead suboxide.		Minium.	
Red lead.			
Litharge.			
Chrome yellow.			
Chrome green.			
Metallic lead.			

The first table is in order of toxicity, commencing with the most serious. Oliver names only the compounds most important in respect to their poisoning power. He adds that "metallic lead per se has less poisoning power than its salts."

The third table shows the order in which lead compounds were found by Rambousek to be soluble in water or in weak acids (hydrochloric acid of the gastric juice). He comments further that lead sulphate and lead iodide are to be regarded as relatively less poisonous. "Lead sulphide is," he says, "in spite of various assertions to the contrary, practically nonpoisonous—a fact attributable to its

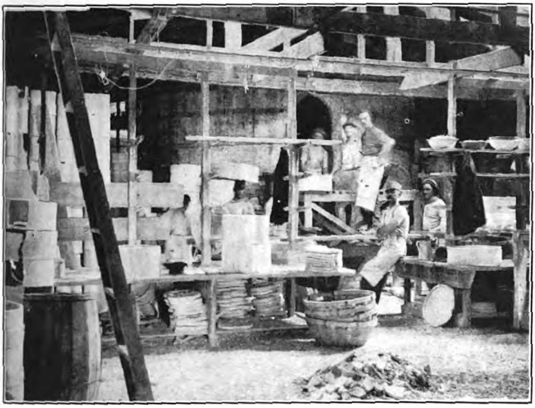

FIG. 43.—SHOWING TYPE OF CLOTHING USUALLY WORN BY THE POTTERY WORKERS.

FIG. 44.—SHOWING TYPE OF CLOTHING USUALLY WORN BY THE POTTERY WORKERS. THE WORKERS ARE EATING LUNCH IN THE BISQUE BRUSHING AND DIPPING ROOM. NOTE FOOD IN THE HANDS OF THE WORKERS.

FIG. 45.—SHOWING TYPE OF CLOTHING USUALLY WORN BY THE POTTERY WORKERS.

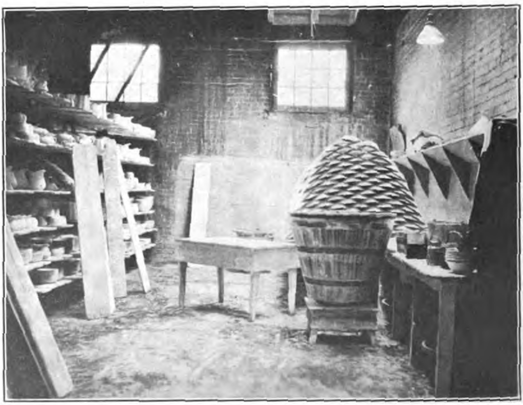

FIG. 46.—DIPPING ROOM. DIRTY WARE BOARDS, GLAZE ON FLOOR, AND DIRTY WALLS. NOTE LUNCH BASKETS ON WORK BENCH AND WRAPS HANGING ON WALLS.

insolubility in water and weak acids. As lead sulphide is the only nonpoisonous lead compound, it is a duty to take advantage of this fact for purposes of lead prophylaxis."

According to Dr. Alice Hamilton (5), the question of the solubility of the sulphide ores was definitely settled by A. J. Carlson and A. Woelfel, of the physiological department of the University of Chicago, who reported the results of their experiments in 1913 on the human gastric juice and the sulphide ores, as showing the average percentage of lead dissolved to be for the pure sulphide, 4.6 per cent; and for the ores from three districts, 1.38 per cent, 2.94 per cent, and 3.32 per cent. (For experiments, see Labor Bulletin No. 120, pp. 22–32.)

Legge (6) lays much stress on air contaminated with lead dust as the important factor in lead poisoning. He states: "The investigations of one of us (K. W. G.) on the experimental production of lead poisoning in animals has shown conclusively that the dust inhaled was far more dangerous and produced symptoms far earlier than did the direct ingestion of a very much larger quantity of the same compound by way of the mouth and gastrointestinal canal. There is no doubt whatever that the chief agent in causing lead poisoning is dust or fume suspended in the air." This is substantiated by the following table of physical examinations among lead workers:

Cases of lead poisoning in dusty and other processes.

Year.	Total number of examinations.	Total cases of poisoning.	Cases in dusty processes.	Cases in other processes.
1905	5,464	9	8	1
1906	5,096	18	16	2
1907	4,303	4	3	1
1908	3,965	4	3	1

TOXIC AND LETHAL DOSES OF LEAD.

Legge (7) estimates the minimum quantity of lead required to produce poisoning as 0.005 gram per kilogram of body weight. "On the other hand," he adds, "persons who have swallowed much larger doses than this have exhibited no symptoms of poisoning." An approximate lethal dose for healthy adults, he states, is probably as large as 50 grams (8) for lead acetate; for lead carbonate, 25 grams. Goadby's (9) results from exposing animals to lead dust were as follows: "Animals subjected to inhalations of lead dust invariably succumbed to the effects of the poison when the dose given represented from 0.0001 to 0.0003 gram per litre of air inhaled, the period of inhalation being half an hour three times a week. On the other hand, when the lead content of the air was as low as 0.00001 gram per litre the symptoms of poisoning were long delayed; and in more than one instance, after an early diminution in weight, recovery of the lost weight took place, and the animals, while showing apparent symptoms of absorption, had no definite symptoms of paresis." Legge and Goadby (10) believe that "if the amount of lead present in the air breathed contains less than 5 milligrams per 10 cubic meters of air cases of encephalopathy and paralysis would never, and cases of colic very rarely occur. About 2 milligrams, or 0.002 gram, of lead we regard as the lowest daily dose which inhaled as fume or dust in the air may in the course of years set up chronic plumbism."

THE LEAD HAZARD IN POTTERIES COMPARED WITH THE LEAD HAZARD IN OTHER INDUSTRIES.

Among industries which give rise to unhealthful occupations potteries occupy a prominent place. With the elimination of the lead hazard the pottery industry will have lost one of its most dangerous features. Rambousek (11) gives the proportion of cases of lead poisoning to those of other forms of industrial poisoning as 20 to 1.

The following table given by Kober and Hanson (12) of Dr. Legge's 6,762 cases of lead poisoning places the pottery industry second in importance among industries where lead is a hazard.

Number of cases of plumbism in the following English industries.

Industry.	Cases.	Industry.	Cases.
White lead	1,295	File cutting	211
Pottery	1,065	Printing	200
Coach building	697	Tinning and enameling	138
Manufacture of paints and colors	422	Manufacture of sheet lead and piping	109
Paints, other industries	452	Red-lead works	103
Smelting of metals	412	Brass works	75
Electric accumulator	285	Enameling iron plates	52
Shipbuilding	269	Glass cutting and polishing	48
Plumbing and soldering in factory premises	217	Lithotransfers	48
		Other industries	659

Dr. Legge says these figures do not include cases among house painters and house plumbers.

PORTALS OF ENTRY AND RELATIVE SIGNIFICANCE OF EACH.

INGESTION.

While it is true that probably most of the lead absorbed gains entrance to the gastrointestinal tract, this does not mean that it is conveyed there only through such habits of the individual as chewing tobacco and eating food contaminated with lead dust, or through carelessness in personal cleanliness. These habits are contributory sources, but the most important source is the fumes and dust which are inhaled and retained in the nasal and pharyngeal cavities and afterwards swallowed with mucus, saliva, and food. The experiments performed on animals by the Japanese pupil of Prof. Lehmann (13) demonstrate that approximately 75 per cent of dust inspired enters the stomach rather than the lungs.

RESPIRATORY SYSTEMS.

PLUMBIFEROUS EMANATIONS.

The question of emanations from the compounds of lead and various glazes is a much disputed one.

J. L. Breton (14), in his book Le Plomb, describes many experiments which he had conducted together with M. Trillat, Dr. Heim, and A. Hérbert, and which, he states, "prove the emanations and tension of fumes of the carbonate and oxides of lead."

In our laboratory tests made to confirm the above experiment Chemist Harry W. Houghton, of the Division of Industrial Hygiene and Sanitation, failed to detect lead emanations from lead glazes and compounds used in the pottery industry.

The experiments of Breton and our own experiments are described in Appendix C of the report.

INHALATIONS.

However, the amount of lead absorbed from the lungs is not to be disregarded, and the respiratory tract is an important portal for the entrance of lead fumes as well as dust.

From certain pathological and histological investigations made by Legge and Goadby (15), and from the fact that particles of lead are, as they state, very readily taken up by white blood corpuscles, they conclude that—

> Absorption of the finer lead particles gaining access to the lungs takes place through the medium of these phagocyte cells, as such cells are well known to exist under the alveoli of the lung. * * * Once having gained access to the interior of the cells, the particles subjected to the action of the serum of the blood in the ordinary process of bathing the tissues by the exuding lymph—nay, more, actual particles of lead—may thus be actually transferred bodily into the finer blood spaces and so be carried forward in the general circulation. Such particles as remain fixed in the lungs will undergo gradual absorption, and the constant presence of carbonic acid in the circulating blood brought to the lung undoubtedly largely contributes to the necessity of some recondite interaction of organic acid for the solution of the inhaled lead in the lungs.

Legge (16) quotes Meillere as one of the few authorities who do not consider the lungs an important channel of absorption. He says that absorption of lead dust by the lungs is hypothetical; that it may take place, but that it is not a channel of absorption of practical importance.

THE SKIN AS A PORTAL.

While the absorption of lead through the skin, though a long-disputed question, is now alleged as possible, yet authorities agree that the amount so absorbed is negligible as far as industrial poisoning is concerned. Skin abrasions, however, afford channels presumably favorable to the absorption of lead, yet the amount absorbed in this way is probably too small to be regarded as a factor in lead poisoning. The absorption of lead through cuts and skin wounds is too commonly suggested as the cause of poisoning which has taken place otherwise.

INDIVIDUAL SUSCEPTIBILITY.

All forms of life—both animal and vegetable, with few exceptions—are susceptible to the destructive action of lead. The notable exception among the lower forms of animal life, found in the studies of Mr. T. W. Hogg (17), is the earth worm. The toxic dose for man varies greatly with the individual. It is cumulative in its action, and the amount which, taken at one time, would produce poisoning, would also, if distributed in minute doses and taken daily, be sufficient to cause serious poisoning. In some workers a very short exposure to lead and its compounds is sufficient to cause serious symptoms of poisoning, while others under the same conditions show no evidence of intoxication. It is said that young adults are more susceptible than old, that women are more susceptible than men, and that alcoholism predisposes to lead poisoning.

The statement that females are more susceptible than males is supported by the report of the British Government Pottery Committee (18) appointed in 1908. The report covers a period of 11 years (1899–1909) and shows that among dippers' assistants the attack rate of females is more than three times as great as that of the males. "The number of miscarriages," according to the report, "among females who had worked in lead before marriage was found to be nearly three times as great as among artisan mothers, and four times as great as in lead workers after marriage."

The apparently greater susceptibility of young adults, as observed by some writers, is perhaps largely the effect of their naturally greater personal carelessness and ignorance.

CONTRIBUTORY CAUSES OF LEAD POISONING.

PERSONAL HABITS.

The habits of the individual worker play a by no means minor rôle in plumbism. Working under the best sanitary conditions it is possible for a slovenly man to ingest more lead than another who, although working under poor sanitary conditions, avails himself of the ordinary preventive measures. The fault is sometimes with the management, because of poor discipline and meager instruction regarding the lead hazard, and again it is with the individual, who either ignores the simple precautions or prides himself on his bravado. It is not infrequent to hear men openly boast of their fearlessness in exposing themselves to danger. They apparently delight to talk of the number of years they have worked in lead and of "what conditions used to be," and to offer themselves as examples of good health and as proofs that lead poisoning does not exist, at least in their plant. These statements are not substantiated by physical examinations, which on the contrary disclose many physical defects and even plumbism in some of these men. Such boasting intimidates the men who are inclined to protect themselves. Habits contributory to plumbism, as they were observed by our investigators, have been discussed under the previous headings and will be analyzed further in Section IV.

PHYSICAL CONDITION OF THE WORKER.

Anything that lowers resistance in the worker increases his chance of lead poisoning. Alcoholism, pulmonary tuberculosis, and syphilis, together with individual susceptibility, are conditions recognized as favorable to lead absorption and subsequent lead poisoning. Mouth breathing, wide atrophic nasal passageways, absence of nasal hairs, removed turbinates, and other defects encountered in individuals, are important physical factors. Near-sighted workers, for instance, may have to get closer to the source of dust, and so may be exposed to more dust than a fellow worker with normal vision.

LEAD POISONING AND IMPORTANCE OF DIAGNOSIS ON ACCEPTED SYMPTOMS.

LACK OF UNIFORMITY AMONG AUTHORITIES.

The reported prevalence of chronic lead poisoning among pottery workers has been for some time the subject of discussion in leading periodicals and medical journals, and has led to surveys of the potteries in a number of States. These surveys were conducted by different investigators, and a great dissimilarity of results is noted, due, in part, to the wide difference of opinions as to what constitutes a case of chronic lead poisoning.

NEED FOR EARLY DIAGNOSIS.

If industrial medicine is to progress at an equal rate with other branches of medicine, industrial physicians must diagnose cases of industrial poisoning promptly, that preventive measures may be adopted on the part of the employees in time to preclude inefficiency with resulting sickness and loss of time from work. The surgeon no longer waits for fecal vomiting before diagnosing intestinal obstruction, nor the internist for the tubercle bacillus to recognize the presence of tubercular processes. Neither must the industrial physician wait for basophilic degeneration, the lead line, or the presence of lead in the urine—symptoms which are frequently absent—before diagnosing lead poisoning. The failure to find basophilia is in many instances due to faulty technique or to the fact that the counterstain used obscures fine stippling. There is no great advantage in diagnosing lead poisoning after the development of arterio sclerosis and chronic nephritis. Frequently the more advanced signs of lead poisoning only tend to complicate the diagnosis and even lead to serious mistakes. Hayhurst (19) says, "Many times the abdominal symptoms are mistaken for constipation, ileus, hepatic colic, renal colic, vesical colic, tabetic crises, and appendicitis." It is not unusual to learn that operations have been performed in such cases.

As the mass of information accumulates there arises the necessity of standardizing the collection of data, in order to make a fair comparison, by conditions and occupations, of the existence of chronic lead poisoning. It is important that investigators in the field who are collecting these statistics should decide upon some group of symptoms and signs which will justify the diagnosis of incipient lead poisoning.

PRESENT-DAY STANDARDS.

A review of the literature of the subject indicates that so far no common basis for determining cases of chronic lead poisoning has been arrived at, and that the individual investigator uses his own standard. Dr. Alice Hamilton (20) very forcibly illustrates this fact in giving the views of two physicians, one of whom considers "anemia and lead line" as a mild case, while with the other nothing less than "a severe attack of colic, constipation, nausea, and vomiting, requiring medical care for two weeks," would be termed a mild case. Dr. Hamilton also emphasizes the fact that "the majority (21) of physicians hesitate to speak of lead poisoning, if there is no colic."

Linenthal (22) enumerates seven cases of undoubted plumbism, but diagnosed otherwise, taken from the records of the Massachusetts General Hospital—a fact which "illustrates the reluctance, even among good clinicians, to make a diagnosis of plumbism in the absence of the lead line, or stippling." He gives the following history of another case:

> For nearly five years this man had been presenting himself at various times at the hospital, complaining of a train of symptons which, taken together with his work, should have made a diagnosis possible, and yet he was permitted, during all this time, to continue to work without any precautions, until the lead line appeared, when the diagnosis of lead poisoning was made.

REASONS WHY EARLY DIAGNOSIS IS NOT MADE.

Such diversity of practice is not strange when leading clinical authorities do not agree among themselves. Some textbooks either do not treat the subject at all or treat it in such a manner as to lead the student to look for the so-called pathognomonic signs rather than to impress upon him the necessity of recognizing the early symptons.

Simon (23) considers the following the "essential factors": "Secondary chlorotic anemia, basophilic granular degeneration, variable hyperleukocytosis with normal differential count; general tendency to interstitial nephritis, with corresponding urinary changes." He further states:

My own investigations, besides those of Grawitz, Block, White, and Pepper, and others, prove that even a comparatively trifling exposure to lead almost invariably leads to the appearance of stippled cells in the blood. Generally speaking, their number is proportionate to the degree of intoxication * * *. In rare instances they may be absent.

According to Stevens (24), the "chief manifestations" are—

anemia with granular degeneration (basophilic) of the red cells; severe colicky pains centering around the umbilicus, with retraction and rigidity of the abdominal walls; constipation; a blue line on the gums near the insertion of the teeth, due to the deposition of a sulphuret of lead; paralysis; tremors; intense headache; pains in the joints (arthralgia); arteriosclerosis; chronic interstitial nephritis; and grave cerebral symptoms (encephalopathies).

Cabot (25) says:

Lead poisoning from occupation is usually preceded by signs of lead colic. The patients are seized with paroxysms of severe cutting pains in the abdomen. An attack in its greatest intensity rarely lasts longer than a quarter of an hour, and after a shorter or longer interval, severe paroxysms of pain set in anew. The abdomen is retracted; there is constipation, and the pulse is slow.

After giving treatment for this condition, he adds:

The first attack is succeeded by a second, a third, etc., and the serious tragedy of lead poisoning begins.

Post Graduate Medicine, by Augustus Caille (26), treats of lead colic, but not of lead poisoning. On the other hand, Osler (27), Anders and Boston (28), Wood and Fitz (29), give descriptions of chronic lead poisoning in its various stages. As a proof of the absence of basophilia, Oliver (30) states that in 70 per cent of his cases he failed to find basophilia. Nor does he consider the blue line in itself a proof of lead poisoning. "In many cases of undoubted plumbism it is absent altogether" (31).

DIFFERENCE IN TERMINOLOGY.

The confusion is increased by the difference in terminology used by various investigators to express different degrees of intoxication. Legge (32) gives as "classical symptons," lead colic, paresis, lead anemia or cachexia; as "earliest symptons," changes in the vascular system, wasting of the subcutaneous fat, pallor and drawn expression of the face; as "definite evidence that absorption is leading on to poisoning," anemia, presence of basophile granules in a previously healthy person, and diminution in hemoglobin to 75 per cent; as "further proof," wasting of the muscles, mental lethargy, and loss of power over individual muscles or groups; and as "prominent," high blood pressure, colic, blue line, and paralysis. Again (33) in classifying cases he divides them into slight, moderate, and severe. In general the groups are as follows:

SLIGHT.

1. Colic without complications—of comparatively short duration.
2. Anemia, in adolescence aggravated by employment.
3. Either of the above, with tendency to weakness of extensors.

MODERATE.

1. A combination of colic with anemia.
2. Profound anemia.
3. Partial paralysis.
4. Cases in which there is constitutional debility.

SEVERE.

1. Marked paralysis.
2. Encephalopathic conditions, such as convulsions, optic neuritis, mental affections.
3. Grave undermining of the constitution, associated with paralysis, renal disease, and arterio-sclerosis.

The phrase "lead absorption," together with the attempt to show a symptomatology for it, has become confusing. Manufacturers' physicians use this term as much as possible instead of the term "lead poisoning," because lead poisoning must be reported. All toxic symptoms and signs due to lead come under the head of "lead poisoning;" and not, even when some of them only appear, under the head of "lead absorption."

Rambousek (34) regards the blue line, accompanied by an unpleasant sweetish taste, malaise, and weakness, and occasionally by tremor of the muscles, disinclination for food, and pains in the stomach, as a "premonitory indication"; colic as the "most important feature"; and peripheral motor paralysis of the extensors of the forearms, as the "predominant" feature of a case running a typical course.

Thompson (35) gives abdominal colic, paralysis of the hands and forearms, or "wrist drop," increased blood pressure, a lead line in the gums, constipation, anemia, and granular basophilia, as "striking symptoms"; and a fixed, drawn expression, light jaundice, lead in urine, sometimes alimentary dextrosuria, levulosuria, and hematoporphyrinuria, dyspepsia, increased tendon reflexes, vertigo, nausea, metallic taste, and finally emaciation, as "other symptoms."

Hamilton (36) cites the following case as a typical example of mild chronic lead poisoning:

A girl of 19 years has worked three years in the dipping room of a white ware pottery, during which time she has had two attacks of colic. She is pale and has not much strength, partly, her mother thinks, because she eats so little. She is very apt to vomit in the morning if she takes breakfast, and can eat nothing at any meal till she has had a sour pickle to rid her mouth of the sweet taste. She is always constipated and takes cathartics regularly.

Dr. Hamilton calls attention to the digestive tract and the blood as producing the "first symptoms," pallor, loss of morning appetite with a sweetish taste; loss of strength, headaches, and pains in the limbs, and constipation.

Hayhurst (37) gives as "chief features" breakfast anorexia, extending later to all meals; metallic taste; nausea, with or without vomiting; loss of weight; loss of strength; constipation, perhaps alternating with diarrhea; pain in the lumbar region; pain in the joints; headache; drowsiness; insomnia; confusion; blind spells and dizziness. For chronic poisoning he emphasizes the following symptoms: Diseased condition of the gums—usually supplanting the lead line; atrophy, particularly of the most used set of muscles, with accompanying signs of tremors, weakness, muscular incoordination; decreased or absent muscular reflexes, and perhaps fibrillations; vascular hypertension, associated with arterio-sclerosis; cardiac weakness after only moderate exercise; chronic Bright's disease; "rheumatism" of chronic type, particularly of the ankles, feet, and back—a common complaint; weakness of hand grip; basophilic degeneration, which signifies acute intoxication of progressive character, is uniformly absent; so also is Liebermann's test, and lead in the urine. He further says:

> Lead poisoning actually exists when evidence of actual intoxication is added to a history of exposure, or is added to (a) the sign of absorption, i. e., the "lead line," or (b) the absolute sign of elimination, i. e., lead in the urine * * *. The chief constant and early physical sign of lead intoxication is pallor of the face including the lips, which is due more to arterial spasm than to anaemia. The chief symptons are in somewhat descending order, digestive disturbances, insomnia, and weakness.

EARLY DIAGNOSIS.

Many authorities hesitate to state what symptoms or signs would justify an early diagnosis of lead poisoning. Oliver (38) says: "One of the earliest symptoms is colic," qualifying this statement at once by adding, "but for some time previous to the onset of abdominal pain it will be found on inquiry that the patient on getting up in the morning had experienced a disagreeable metallic taste in the mouth, which prevented his enjoying his breakfast—that he felt headachy and rather sick. His features, too, had been altering, for his face had been gradually becoming paler and more expressionless." It would appear from these observations that colic was a rather late symptom and that the symptoms and signs noticed "some time previous" should be recognized as the earliest symptoms.

Linenthal (39), who advocates the early diagnosis of lead poisoning, believes that "a history of exposure to lead justifies the diagnosis of lead poisoning in patients presenting obscure symptoms which can not otherwise be explained." He regards seriously "pallor of the skin, muscular weakness, rheumatic pains, loss of appetite, constipation, or constipation alternating with diarrhea, abdominal pains, general nervousness, and persistent headaches, when occurring in persons exposed to lead, for they may be the precursors to the more serious nerve lesions, such as wrist-drop, encephalopathy, and to the more insidious and less dramatic change in the vascular and excretory systems, that of arterio-sclerosis and chronic nephritis."

Chapman (40) states that "the lead line, wrist-drop, and colica pictonum, together with a history of occupational exposure, readily suggest lead, but the chronic form in which none of these symptoms occur, or at least occur in mild or obscure form, is probably very often overlooked."

"The symptoms," says Rambousek (41), "are very varied and associated with the most different groups of organs * * *. Numerous cases follow an irregular course, in that special symptoms or complications of symptoms are in some especially accentuated, while in others they become less marked or are absent altogether."

Thompson quotes Prof. M. Allen Starr (42) as asserting that "many cases of loss of vigor and so-called neurasthenia are actually due to chronic lead poisoning."

Sommerfeld and Fischer write (43):

Industrial lead poisoning appears as a rule in the chronic form and arises from continuous absorption of the most infinitesimal quantities of lead during a protracted period of time (weeks, months, and even years).

The beginning is insidious, with disturbance of the general health, a sense of weakness, decline of bodily strength; sallow, pale-yellowish hue of the skin; distress in the region of the stomach, eructations, lack of appetite, metallic taste in the mouth, and fetid breath.

The blue line (blue-gray discoloration of the gums), which, however, may be absent, even in the course of a severe attack; lead colic with most obstinate constipation, retention of urine; plumbic arthralgia (lacerating, boring), occurring for the most part paroxysmally, chiefly in the lower extremities, more rarely in the upper, often interpreted as a symptom of rheumatism of the joints; frequently, fibrillar trembling of the fingers. Typical are the lead paralyses, of which disturbances of sensation (paresthesia and anesthesia) take the precedence. Paralysis generally affects the extensor muscles of the arm and hand, with atrophic manifestations; more rarely the flexor muscles. Sometimes also there are paralyses of the extensors and flexors of the lower extremities or muscles of the shoulder. From experience it is known that those groups of muscles are especially affected which are most used in the occupational activity. Transient blindness, but also gradually progressive atrophy of the optic nerve; temporary loss of the special senses of smell and taste; violent, often fatally ending disease of the brain (saturnine encephalopathy), sometimes preceded only by slight premonitory symptoms, as irritability and headache, ringing in the ears, insomnia; more often, slowly increasing mental disturbances precede; epileptiform convulsions, hallucinations; morbid changes in the blood vessels and of the heart and kidneys (contracted kidney); increase of blood pressure and granular degeneration of the red blood corpuscles. Disturbances in the sexual sphere in women; abortion, premature birth, low vitality of the children.

Rosenau (44) states:

> Symptoms of lead poisoning are sometimes vague and readily overlooked. The usual symptoms of chronic lead poisoning are anemia, dyspepsia, depression, constipation, colic; various forms of paralysis, especially paralysis of the extensor muscles of the forearm leading to wrist-drop; a blue line along the edges of the gums, due to the formation of sulphid of lead deposited in the tissues. Optic neuritis may come on. There is an increase in the blood pressure. Chronic lead poisoning leads to arteriosclerosis, fibrosis of the kidneys, and the remote consequence of these changes. Muscular paresis, pain and swelling of the joints, often occur and may be mistaken for "rheumatism."

G. L. Apfelbach (45), in his paper on the "Early Diagnosis of Lead Poisoning with Special Reference to Abdominal Pain," enumerates the following six findings as cardinal symptoms of lead poisoning—namely, constipation, pallor and anemia, colic, stippling, blue line, and tremor. He bases these findings on observations made as follows:

(1) On a series of 934 cases of lead poisoning received in reports from the Illinois Department of Factory Inspection between July 1, 1912, and July 1, 1917; (2) on a series of 72 cases in which he personally made the examinations. In the series of 934 cases constipation was found to be the most constant finding, occurring 335 times, followed next by colic and anemia. In the series of 72 cases constipation was found in 81.9 per cent of them; tremor in 72.2 per cent; pallor and anemia in 65.2 per cent; basophilic degeneration in 51.3 per cent; abdominal pains of varying types in 56.9 per cent, and blue line in 26 per cent.

These are the conclusions arrived at by Dr. Apfelbach:

(1) Manifestations of an intoxication with lead are variable, sometimes presenting one or two of the cardinal signs of this intoxication, which are: Colic, constipation, blue line, tremor, basophilic degeneration of the red cells, and pallor and anemia.

(2) Early diagnosis of plumbism can be established by the history of lead workers and by the presence of constipation plus one or more of the cardinals, fine tremor, blue line, basophilic degeneration of the red cells, colic, and pallor and anemia. Constipation, with pallor and anemia or with colic, presents a suspicious picture which must be developed by the aid of subsidiary findings.

(3) Anemia and fine tremor are very early signs of plumbism.

(4) Since more lead workers suffer from vague abdominal pains and gastric disturbances than from colic, a differential diagnosis of any abdominal pain or colic or gastric disturbances demands the consideration of lead as the possible cause.

(5) There does not seem to be a constant rise in blood pressure in acute or subacute cases of lead poisoning.

METHODS OF CLASSIFICATION AND DIAGNOSIS USED IN THIS SURVEY.

Cases were classified as follows:

1. Positive:
   - A. Acute.
   - B. Chronic.
2. Presumptive.
3. Suggestive.
4. Negative for lead poisoning.

Under the supervision of the officer in charge our field physicians held preliminary and periodical conferences in which the whole subject of lead poisoning was discussed in order that a more uniform diagnosis of degrees of plumbism might be made.

It was decided that only cases presenting symptoms and signs—such as a combination of marked pallor, colic, wrist-drop, lead line, basophilic degeneration, and other conditions—which are recognized as typical of lead poisoning and which almost preclude any doubt even among those inclined to refute the prevalence of lead poisoning, were to be considered as positive cases of plumbism. These cases would readily be diagnosed as plumbism by the general practitioner, even without the history of exposure. Whenever any combination of symptoms and signs could possibly be explained by a condition which the examiner could not, on account of limited facilities, rule out to his own satisfaction, or where some of the more prominent signs of lead poisoning were indefinite or not absolutely indicative of plumbism, so as to create a doubt in the mind of the examiner, the cases were considered presumptive, even though it might be safer perhaps to classify them as positive. In this group are cases that many clinicians would unhesitatingly diagnose as positive. These cases, if seen at a later period—the length of time depending upon length and degree of exposure—and if subjected to further observation and tests, would doubtless present unmistakable symptoms and signs of positive plumbism; but in a cross-section study of this kind where the subjects could not be placed under observation for a definite period of time, and where these employees might discontinue their employment and therefore never develop the more advanced signs, our investigators did not feel justified in classifying them as positive.

The suggestive group includes those who have certain common symptoms which might indicate a degree of lead poisoning. These are cases complaining of symptoms and presenting signs of a similar nature, such as metallic taste, constipation, morning anorexia, headaches, diminished hand grip, anemia, and other symptoms that could not be satisfactorily explained otherwise, but which are, however, common symptoms of many complaints.

TENTATIVE CLASSIFICATION FOR AN EARLY DIAGNOSIS OF LEAD POISONING.

It is not necessary to emphasize the various stages of lead poisoning and any line of demarcation between the degrees of intoxication must of necessity be arbitrary; but it is imperative that we accept some basis for this grouping. An early recognition is vital in preventive medicine in the industrial field. As actual poisoning exists before even the experienced eye can detect its manifestations, it is justifiable to recognize as suggestive of lead poisoning any group of symptoms of a similar nature noted in a number of workers exposed to the lead hazard, until the presence of such symptoms can be explained otherwise. It is obvious that not every complaint made by these workers should be attributed to lead absorption. Where a fairly representative number of workers exposed to lead complain of similar symptoms, which did not exist before they took up their present employment, or which have become aggravated since but which disappear with a change of work, the diagnosis of chronic lead poisoning is warranted, and a study of the conditions to determine or to disprove the presence of the lead hazard should be made.

For the purpose of analyzing records of industrial physicians, labor departments, and future surveys of lead hazards, for the purpose of making a comparison of the data and conclusions thus obtained, a standard terminology for characterizing stages or degrees of lead poisoning is suggested. This terminology might well follow that adopted in the present survey as outlined above.

The suggestive group of symptoms for each subdivision, as a basis for preparing all data, is outlined below. In presenting this outline emphasis is placed upon the necessity, in making a diagnosis therewith, of careful study of each individual case, with due consideration of any personal conditions which might influence the statements of the workers. Special attention is called to the importance of gathering complete preliminary information pertaining to—

1. A history of known or suspected exposure to lead in any form.
2. The personal history and physical examination of the worker, with a view to eliminating conditions which would possibly simulate symptoms of lead poisoning.

As an aid to a decision on the positiveness of lead poisoning it is recommended that a choice of any two or more symptoms, selecting one from each of the following groups, would, in conjunction with the numerous minor symptoms that are always present if these major symptoms are noted, be a reasonable basis for a diagnosis of positive lead poisoning. Should only one of these major symptoms appear, in combination with two or more symptoms of the presumptive group of the same general headings and also in conjunction with the minor symptoms that would be present, a diagnosis of chronic lead poisoning could also be made. Emphasis has been placed on the combination of the so-called major symptoms and the minor symptoms, because it is very unlikely that such major symptoms would ever be found alone in any case of lead poisoning. A combination of minor symptoms invariably accompanies more typical ones.

A. General appearance:
  Marked pallor and profound anæmia.
B. Digestive system:
  Colic.
  Obstinate constipation.
C. Muscular system:
  Muscular incoordination.
D. Nervous system:
  Peripheral motor paralysis of certain extensor muscles (wrist and ankle drop) and atrophy of most used set of muscles.
E. Vascular system:
  Blood—basophilic degeneration with diminished hemoglobin.
F. Special organs and findings:
  Gums—lead line.
  Stools and urine—lead.
  Miscarriage—repeated.
  Liebermann's test—positive.

In a like manner presumptive diagnosis would be suggested by the findings of any three or more symptoms selected singly from each of the following general headings. Here, also, a combination of minor symptoms assists a decision:

A. General appearance:
  Pallor.
  Anemia.
  Emaciation.
  Drawn expression.
B. Digestive system:
  Loss of appetite or repugnance to food.
  Breakfast anorexia.
  Vomiting on eating solid food.
  Sweetish or metallic taste.
  Gastric disturbances.
  Constipation.
  Pain in abdomen.
  Parotitis.
C. Muscular system:
  Loss of strength.
  Malaise and tiring easily.
D. Nervous system:
  Headache.
  Insomnia.
  Mental lethargy.
  Tremor.
  Dizziness.
  Convulsions.
  Mental affections.
  Encephalopathic conditions.
  Arteritis.

E. Vascular system:
   Arteriosclerosis.
   Hypertension.
F. Special organs and findings:
   1. Eyes—
      Impairment of vision, including muscular incoordination.
   2. Joints—
      Various pains.
   3. Blood—basophilic degeneration with diminished hemoglobin.

While it is true that in other industries as well as in potteries workers show on numerous occasions and under varying conditions symptoms which, when taken in conjunction with other symptoms, may be characteristic evidence of some degree of lead poisoning, yet such symptoms would be only suggestive of this particular poisoning. However, if his occupation exposes the worker to a lead hazard, and if any combination of the following symptoms appears among a number of workers so exposed, the association between such symptoms and such exposure would justify the industrial physician in suspecting lead as the causative agent in inducing these symptoms and would justify him in making a diagnosis of suggestive lead poisoning:

Constipation.
Loss of weight.
Loss of strength.
Drowsiness.
Pain in lumbar region.
Pain in joints.
Headache.
Insomnia.
Confusion.
Loss of morning appetite.
Metallic or sweetish taste.

Cases should be classified according to the above outline only after careful elimination of confusing conditions as shown in the history of the worker. Due emphasis must be given to the fact that although these workers are exposed to a lead hazard they are still equally susceptible to diseases and intoxications foreign to their occupation, and that certain of these produce symptoms identical with those of lead poisoning. For instance, a luetic person may complain of headache, joint pains, weariness, and may have arteriosclerosis with hypertension; or certain focal infections may give rise to symptoms simulating lead poisoning. Among women menstrual disorders or uterine displacement may cause constipation, headache, pain in abdomen, anemia, etc. Nor do these few examples illustrate all the conditions which are apt to confuse the diagnostician in deciding the presence or absence of lead poisoning, for other associated processes producing vapors, fumes, gases, and metallic dusts may lead to symptoms resembling those of lead. On the other hand, the facts that these conditions exist does not exclude the suspicion of lead poisoning. The question whether these are caused by the occupation or are concomitant with it must be answered by careful deliberation of the previous history of the individual and by the physical and laboratory findings.

While in the surveys just completed our investigators have been conservative in diagnosing lead poisoning, it is recommended to those who practice medicine where lead poisoning may arise that they make tentative diagnoses on the symptoms outlined under suggestive and presumptive lead poisoning, so that workers exposed to a lead hazard may be given the benefit of early treatment.

After the survey had been completed and careful tabulation of the diagnoses of these workers had been made and studied, it was found that the symptoms given and the diagnoses made conformed remarkably with the outline as given here for future diagnoses of lead poisoning.

Therefore we offer this classification and combination of symptoms and signs as an outline for future work in surveys of this nature.

CASES OF LEAD POISONING FOUND IN THE POTTERY SURVEY.

Notwithstanding the many corrective recommendations made by investigators in the past surveys, the incidence of lead poisoning in the potteries is still high. Managers, and employees as well, apparently believe that facts have been exaggerated and that the lead hazard is practically nil in the potteries. They maintain this belief even after the results of former surveys have been made public.

We have already discussed the symptoms upon which the diagnosis of lead poisoning have been made by leading diagnosticians, and we are now ready to give in tabular form the story of plumbism as we find it in the 92 potteries coming within the scope of our survey. The analysis of these figures, designed to show factors pertinent in causing lead poisoning, is reserved for Part IV of this report, where an attempt is made to show the rate of plumbism according to ware and to size of plant; according to plant hygiene, as it bears upon dustiness, personal facilities, toilet conditions; and according to the personal habits of the workers.

Table XX shows by classification the number of each sex examined, diagnosis by wares and States, and the totals for each.

TABLE XX.—*Distribution of pottery employees by State, ware, sex, and diagnosis.*

	New Jersey.			Ohio.					
	Sanitary.	General.	Total.	Sanitary.	General.	Yellow.	Art.	Tile.	Total.
Number of potteries	15	9	24	1	35	4	4	3	47
Number employed:									
Male	1,480	942	2,422	200	4,575	277	425	694	6,171
Female	79	401	480	0	2,299	71	250	248	2,868
Number exposed:									
Male	173	133	306	15	600	43	61	39	758
Female	11	29	40	0	205	8	20	10	243
Number examined:									
Male	173	125	298	15	571	41	61	38	726
Female	11	21	32	0	181	7	19	18	225
Positive:									
Male	9	7	16	1	52	1	3	0	57
Female	0	1	1	0	10	0	0	0	10
Presumptive:									
Male	9	11	20	0	37	2	3	1	43
Female	2	1	3	0	22	0	0	0	22
Suggestive:									
Male	13	5	18	0	69	4	3	0	76
Female	1	4	5	0	22	2	2	1	27
Negative:									
Male	142	102	244	14	413	34	52	37	550
Female	8	15	23	0	127	5	17	17	166

	Pennsylvania.				West Virginia.			All States.	
	Sanitary.	General.	Tile.	Total.	Sanitary.	General.	Total.	Total.	Total both sexes.
Number of potteries	2	5	1	8	3	10	13	92	....
Number employed:									
Male	780	635	38	1,453	352	2,160	2,512	12,558	17,297
Female	0	375	20	395	12	984	996	4,739	
Number exposed:									
Male	76	89	6	171	35	234	260	1,504	1,902
Female	0	37	1	38	2	95	97	398	
Number examined:									
Male	72	87	6	165	31	216	247	1,436	1,809
Female	0	29	1	39	0	86	86	373	
Positive:									
Male	9	10	1	20	1	32	33	126	139
Female	0	0	0	0	0	2	2	13	
Presumptive:									
Male	3	1	0	4	0	11	11	78	106
Female	0	0	0	0	0	3	3	28	
Suggestive:									
Male	5	4	0	9	1	25	26	129	168
Female	0	0	1	1	0	6	6	39	
Negative:									
Male	55	72	5	132	29	148	177	1,103	1,396
Female	0	29	0	29	0	75	75	293	

Attention is called to the fact that of the total of 1,809 persons examined as exposed to the lead hazard 139 cases of positive lead poisoning are found, of which 126 are men and 13 women. There are 106 cases classified as presumptive cases of lead poisoning, of which 78 are men and 28 women. There are 168 cases of suggestive lead poisoning, of which 129 are men and 39 are women. In all, 1,396 cases are found in which there is no evidence of lead poisoning; of these 1,103 are men and 293 women.

RATES OF PLUMBISM.

In obtaining rates where the line of demarcation between the various groups is not always sharply drawn there are several methods, some of which may be considered satisfactory, provided the method used is made clear and provided the attention of the reader is directed toward the method used at the several points in the discussion.

In many diseases there are so many different stages of progress that differ among different people and at different times and under varying conditions that there may be some doubt as to whether the so-called "border-line cases" should be excluded from consideration in getting rates, or included, and if included, whether they should be placed with those having a disease or ailment or with those not having such disease or ailment. We enumerate below the several methods by which rates may be obtained in the study of the development of plumbism among pottery workers.

If we consider only positive cases of lead poisoning as cases of plumbism, we get a rate of 8.8 per cent for the men, 3.5 per cent for the women, and 7.7 per cent for both, or a rate of 77 per thousand of those examined.

If we include both positive and presumptive cases, we get a rate of plumbism of 14.2 for the men, 11 for the women, and 13.5 for both, or a rate of 135 per thousand.

If we include both positive cases and presumptive cases, and either exclude the suggestive cases or divide them as an unknown group proportionately between the lead and the nonlead groups, we get rates of 15.6 for men, 12.3 for women, and 15 for both, or 150 per thousand.[1]

If we include all cases that are not negative—that is, positives, presumptives, and suggestives—we get rates of 23.1 for men, 21.5 for women, or 22.8 for both, which is a rate of 228 per thousand. This means that 76.8 per cent of the men and 78.5 per cent of the women, or 77.2 per cent of both, were not affected by lead poisoning at the time this survey was made.

In our analysis which follows under Part IV we include only positive cases of lead poisoning and get our rates by finding what per cent this number is of the total number examined, although we give occasionally rates for the other groups in addition to the positive groups. Our interests are not in getting high rates but in finding whether plumbism exists among pottery workers and in getting rates among age, exposure, occupational, and other groups in order to discover whether there are contributing factors which assist the lead used in the various glazes in causing higher rates of lead poisoning than would be found under other conditions.

We wish to call attention, however, to certain measurements typical of the different diagnostic groups which show the effects of lead poisoning. Among these are lengths of exposure, dynamometer readings, variation of systolic pressure, and variation of pulse pressure. The results are such as to lead us to the conclusion that the different diagnostic groups simply represent different degrees of

[1] The rates used in our annual report for the fiscal year ending June 30, 1920, were obtained by this method.

plumbism. For all practical purposes—that is, for purposes of treatment and for an attempt to better the conditions among which the employees must work—there is such a slight difference between the positive and presumptive groups that they may well be considered together. However, we have tried to be conservative in this study, and for that reason give separate rates for these groups. Hence, in the report we speak of rates of positive lead poisoning and of rates of positive and presumptive lead poisoning, so that the reader will know exactly what group is included by such rates and combination of rates.

PHYSICAL EXAMINATION WITH SPECIAL REFERENCE TO SOME IMPORTANT FINDINGS IN PLUMBISM.

Prominent symptoms found among the cases of lead poisoning in this survey compared in the following tables with those enumerated by Apfelbach (45).

	Number.	Per cent.
Prevalence of certain conditions among positive and presumptive cases of lead poisoning:		
Among the men, 201 cases—		
Lead line	120	59.7
Constipation	105	52.2
Colic	68	33.8
Pallor	101	50.2
Coated tongue	84	41.8
Muscle weakness	15	7.5
Tremor	118	58.7
Loss of weight	19	9.5
Wrist-drop	24	11.9
Paralysis	2	1.0
Neuralgia	76	37.8
Rheumatism	109	54.2
Pulse below 65 (164 reported)	7	4.3
Pulse above 95 (164 reported)	22	13.4
Systolic pressure of 15 or over more than Life Extension Institute Standard (196 reported)	65	32.6
Systolic pressure of 15 and over less than Life Extension Institute Standard (196 reported)	20	10.2
Pulse pressure 55 or over	92	45.8
Pulse pressure under 30	4	2.0
Headache	88	43.8
Arteriosclerosis	40	19.9
Among the women, 41 cases—		
Lead line	15	36.6
Constipation	28	68.3
Colic	15	36.6
Pallor	11	26.8
Coated tongue	8	19.5
Muscle weakness	2	4.9
Tremor	10	24.4
Loss of weight	7	17.1
Wrist-drop	2	4.9
Paralysis	1	2.4
Neuralgia	19	46.3
Rheumatism	18	43.9
Pulse below 65 (38 reported)	0	0.0
Pulse above 95 (38 reported)	6	15.8
Pulse pressure 55 or over	12	29.3
Systolic pressure of 15 or over more than Life Extension Institute Standard	8	19.5
Systolic pressure of 15 and over less than Life Extension Institute Standard	3	7.3
Pulse pressure under 30	1	2.4
Headache	29	70.7
Arteriosclerosis	6	14.6

	Number.	Per cent.
Out of 934 cases of lead poisoning Apfelbach enumerates the findings in the number of times reported:		
Blue line	518	55.4
Anemia	341	36.5
Constipation	335	35.87
Colic	295	31.58
Pallor	244	25.48
Coated tongue	215	21.3
Loss of muscular strength	161	17.3
Tremor	135	14.45
Abdominal tenderness	131	14.0
Slow pulse	130	14.0
Nausea	113	12.1
High-tension pulse	74	7.9
Headache	74	7.9
Loss of weight	50	5.3
Albuminuria	27	2.88
Dyspepsia	26	2.8
Wrist-drop	24	2.37
Abdominal pain	18	1.9
Other paralysis	10	1.0
Vertigo	11	1.0
In a critical examination of 72 cases of lead poisoning the following symptoms and signs occurred the following number of times (Apfelbach):		
Constipation	59	81.9
Stippling	37	51.3
Blue line	26	36.1
Fine tongue tremor	39	54.1
Fine tongue tremor	13	18.1
Anemia and pallor	25	34.7
Pallor	8	11.1
Anemia	14	19.4
Colic	23	31.9
Abdominal pain	18	25.0
Neuritis	12	18.0
Diminished strength in hand	7	10.0
Loss of muscular strength	7	10.0
Sciatica	1	1.4
Albuminuria	2	2.8
Convulsions	1	1.4
Cerebral hemorrhage	1	1.4
High blood pressure	1	1.4
Coated tongue	[1]	......

[1] Uncertain.

It is significant to note, after a comparative study of the tables, that no one symptom is constantly present. It seems apparent, also, that certain symptoms are exaggerated by habits of the individual and frequently may be due to such habits; for instance, the tremor in men in all probability is influenced by smoking, chewing, and drinking. In comparing the rate of men with that of females the age factor, the average of which is higher in men, must be considered. In women the high percentage of headaches is probably due to other causes, such as menstrual disorders, etc.

It must be remembered, furthermore, that the data found in text-books on cases of lead poisoning have been collected from well-advanced or acute cases which have presented themselves to the clinics, whereas the cases recorded in this survey are largely early cases which have not necessitated a visit to a physician. This fact may account for our inability to verify the high arterial blood pressure emphasized by some observers. Further reference to this high pressure and a comparison with other trades will be found in this report.

BLOOD PRESSURE.

Methods and averages among pottery employees.—The blood pressures were taken of 1,411 men and 358 women workers in the lead department of the pottery industry. While these blood-pressure readings were taken by several different physicians, the general method in each case was the same. In taking the systolic and the diastolic reading the ausculatory method was used, the patient sitting; and it was the universal practice to read as the systolic pressure the first reappearance of the sound, and as the diastolic the complete disappearance.

Table XXI gives, by sexes and by age groups, the systolic and diastolic pressures and the pulse pressures of the pottery workers examined in this survey. The average systolic pressure for the men is 135.87, the average diastolic pressure is 81.3, with an average pulse pressure of 56.5, when these averages are taken by grouping the measures in class intervals of 10 for the systolic and diastolic pressures and 5 for pulse pressure. The average systolic pressure for women is 123.8, the average diastolic pressure is 74.6, and the average pulse pressure is 49.21.

TABLE XXI.—*Blood pressure of all pottery workers.*

Age.	Systolic.										
	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190 plus.
MEN.											
Under 20	4	8	22	31	26	10	5	1	1	....	....
20-24	....	4	18	31	28	11	5	4	....	....	....
25-29	3	4	26	46	39	22	8	3	3	1	....
30-34	1	2	32	48	58	28	6	4	5	2	....
35-39	1	8	43	46	72	28	12	5	....	....	1
40-44	1	15	31	55	50	36	9	8	2	2	1
45-49	1	8	10	30	34	22	23	7	2	....	3
50-54	....	2	13	22	24	26	11	10	7	3	8
55-59	....	3	7	9	14	16	11	13	8	6	4
60 plus	....	....	4	7	6	9	14	11	8	8	11
Total	11	54	206	325	351	208	104	66	36	22	28
WOMEN.											
Under 20	3	28	37	34	2	4	2	....	....	....	....
20-24	....	12	23	28	5	....	....	....	....	....	....
25-29	....	7	15	21	9	....	....	....	....	....	....
30-34	....	5	11	17	2	....	....	....	....	....	....
35-39	1	2	7	5	4	3	....	1	....	....	....
40-44	....	3	7	5	3	1	2	1	....	....	....
45-49	....	1	2	11	8	4	2	1	1	....	2
50-54	....	....	1	2	5	3	2	....	....	1	....
55-59	....	....	....	1	2	2	1	1	....	....	1
60 plus	....	....	1	1	....	....	....	....	1	1	....
Total	4	58	104	125	40	19	9	4	2	2	3

Age.	Diastolic.									
	Under 50.	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	130 plus.
MEN.										
Under 20	3	11	26	32	23	9	4	....	....	....
20-24	....	3	22	29	28	12	5	1	1	....
25-29	2	7	33	60	37	13	1	2	....	....
30-34	1	10	22	65	54	27	5	1	....	1
35-39	1	8	20	63	85	28	9	2	....	....
40-44	....	7	22	66	67	31	10	7	....	....
45-49	2	1	18	44	40	24	10	1	....	....
50-54	....	3	9	32	43	23	11	4	....	1
55-59	....	2	9	16	27	19	13	4	1	....
60 plus	....	....	8	10	21	19	11	6	2	1
Total	9	52	189	417	425	205	79	28	4	3
WOMEN.										
Under 20	1	17	29	48	10	4	....	1	....	....
20-24	....	3	27	28	10	....	....	....	....	....
25-29	....	2	17	24	9	....	....	....	....	....
30-34	....	1	12	20	3	1	....	....	....	....
35-39	....	2	5	9	4	2	1	....	....	....
40-44	....	2	3	10	6	....	....	1	....	....
45-49	....	....	6	11	10	2	....	2	....	1
50-54	1	....	1	6	5	1	....	....	....	....
55-59	....	....	....	2	1	3	1	....	....	1
60 plus	....	....	1	....	1	1	....	1	....	....
Total	2	27	101	158	59	14	2	5	....	2

According to these figures about 26.3 per cent of the men in the potteries and 13.2 per cent of the women have a systolic pressure which may be considered high, while 6.9 per cent of the men and 4 per cent of the women have a systolic pressure much too low. Taking the normal range of pulse pressure between 30 and 35, we find that 633 of the men and 83 of the women examined have high pulse pressure, while 44 men and 6 women have low pulse pressure. Stated in rates, this means that 47.9, or almost one-half of the men, and 24 per cent, or almost one-fourth of the women, have pulse pressures outside these limits.

Table XXIV shows averages of the various blood pressures by wares, sexes, and age groups. There is, perhaps, little significance to be attached to the figures in this table, and they are included here for reference only.

The effect of plumbism upon the blood pressure.—Tables XXV, XXVI, XXVII, XXVIII show the blood pressure for the positive, presumptive, suggestive, and negative cases of plumbism, respectively, for both sexes and by age groups.

It should first be observed that the ages of these groups vary somewhat. The positive male group has an average of 44.3, the presumptive male group 40.8, the suggestive 41.1, and the negative 37.5. The corresponding ages for the women are 39.2, 31.6, 33.3, and 29.5 years, respectively. There appears also to be an excessive number of pulse pressures of 55 and above. In the male lead groups this amounts to a little over 45.8 per cent of those examined, while in the nonlead groups it amounts to about 43.7 per cent. For the combined male potters 34 per cent of those examined had pulse pressures of 55 and above, while 3 per cent had a pulse pressure below 30. As compared with the pulse pressure of 2,039 male garment workers (see Public Health Bulletin No. 71), we found only 10.5 per cent of those examined to have pulse pressures of 55 and above and 24.4 to have pulse pressures below 30. This department recently examined 1,285 steel workers in the Pittsburgh district, 17 per cent of whom had pulse pressures above 55 and 7 per cent below 30. The department also examined recently 905 chemical workers in New York City; 22.5 per cent of those examined had pulse pressures of 55 and above and 11 per cent pulse pressures below 30.

TABLE XXIV.—*Average systolic, diastolic, and pulse pressures of the pottery workers, by wares, sexes, and age groups.*

MEN.[1]

Age (years).	Sanitary.				General.				Others.			
	Number.	Systolic mean.	Diastolic mean.	Pulse mean.	Number.	Systolic mean.	Diastolic mean.	Pulse mean.	Number.	Systolic mean.	Diastolic mean.	Pulse mean.
Under 20	20	134.1	78.9	55.4	80	123.9	74.6	51.3	8	126.1	65.0	61.1
20-24	27	135.0	73.8	59.9	58	129.0	82.1	49.0	15	130.3	76.9	55.3
25-29	36	140.0	80.3	61.8	90	127.4	75.4	54.4	29	127.8	76.7	55.0
30-34	53	137.0	79.5	60.4	115	129.9	79.9	51.2	18	132.4	77.1	55.3
35-39	39	135.9	78.2	59.6	156	129.6	80.9	50.7	21	131.7	84.0	50.0
40-44	38	139.7	81.3	59.9	153	131.5	82.4	49.7	19	129.2	78.2	53.3
45-49	29	142.7	82.2	61.8	99	138.1	83.6	57.8	12	131.7	80.8	50.8
50-54	23	147.9	84.6	60.9	92	143.9	85.1	58.0	10	141.5	80.0	62.8
55-59	14	153.2	89.3	64.8	74	148.3	86.9	65.8	3	145.0	91.7	55.8
60 plus	4	181.8	95.0	86.8	64	161.7	90.4	75.0	10	169.0	92.3	76.7
Total and average	283	139.93	80.29	61.1	981	135.0	81.9	54.8	145	133.8	79.5	55.9

WOMEN.[2]

Age (years).	Sanitary.				General.				Others.			
	Number.	Systolic mean.	Diastolic mean.	Pulse mean.	Number.	Systolic mean.	Diastolic mean.	Pulse mean.	Number.	Systolic mean.	Diastolic mean.	Pulse mean.
Under 20	1	105.0	75.0	32.5	96	117.9	71.6	45.9	6	120.0	73.3	45.0
20-24	2	130.0	75.0	55.0	58	117.6	70.0	47.4	7	118.1	72.1	46.8
25-29	3	118.3	75.0	47.5	42	123.1	73.1	51.3	4	117.5	72.5	45.1
30-34	1	125.0	75.0	52.5	32	121.9	73.8	48.6	4	122.5	75.0	45.0
35-39	....	....	....	....	18	126.7	70.6	48.0	4	132.5	82.5	52.5
40-44	1	135.0	75.0	67.5	15	121.0	72.3	50.0	5	125.0	79.0	45.5
45-49	....	....	....	....	25	142.3	84.8	57.0	5	139.0	83.0	53.5
50-54	2	145.0	80.0	65.0	9	129.4	73.9	54.7	2	165.0	115.0	45.0
55-59	....	....	....	....	7	142.5	84.1	57.3	1	145.0	75.0	72.5
60 plus	....	....	....	....	3	163.3	111.3	55.0	1	175.0	115.0	57.5
Total and average	10	127.0	76.0	53.5	305	127.8	74.0	49.6	39	128.3	79.4	48.0

[1] Average age for men, 37.6 years.

[2] Average age for women, 32.6 years.

TABLE XXV.—*Blood-pressure frequencies for positive cases, by sexes and by age groups.*

Age (years).	Systolic.											Diastolic.									
	90	100	110	120	130	140	150	160	170	180	190 and over.	Under 50.	50	60	70	80	90	100	110	120	130 and over.
MEN.																					
Under 20	....	1	....	1	1	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....
20-24	....	....	....	1	2	....	....	....	....	....	....	....	....	1	....	2	....	....	....	....	....
25-29	1	1	....	3	2	....	1	....	....	....	....	1	....	1	5	....	1	....	....	....	....
30-34	....	....	4	5	1	2	....	....	1	....	....	....	....	4	2	5	2	....	....	....	....
35-39	....	1	3	1	5	2	1	....	....	....	....	....	....	....	6	6	1	....	....	....	....
40-44	....	1	3	2	8	7	2	1	1	....	....	....	1	2	8	8	5	1	....	....	....
45-49	....	....	2	4	4	....	5	1	....	....	....	....	....	....	7	4	4	1	....	....	....
50-54	....	1	1	4	2	6	3	....	2	....	....	....	....	....	7	8	3	1	....	....	....
55-59	....	1	2	3	1	1	....	1	1	1	1	....	....	1	1	7	2	1	....	....	....
60 plus	....	....	2	1	....	....	1	....	1	1	5	....	....	2	1	1	3	....	3	....	1
Total	1	6	17	25	26	18	13	3	6	2	6	1	1	11	40	41	21	4	3	....	1
WOMEN.																					
Under 20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20-24	....	1	....	1	1	....	....	....	....	....	....	....	2	....	....	1	....	....	....	....	....
25-29	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
30-34	....	....	1	2	....	....	....	....	....	....	....	....	....	1	1	1	....	....	....	....	....
35-39	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
40-44	....	1	....	....	1	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....
45-49	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....
50-54	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....
55-59	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
60 plus	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1	....	....	....	....	....
Total	....	2	1	4	4	....	1	....	....	1	....	....	2	2	1	7	1	....	....	....	....

TABLE XXV.—*Blood-pressure frequencies for positive cases, by sexes and by age groups*—Continued.

Age (years).	Pulse.												Total.
	Under 30.	30	35	40	45	50	55	60	65	70	75	80 and over.	
MEN.													
Under 20	...	1	...	...	...	1	1	...	...	...	...	...	3
20–24	...	...	...	1	...	1	...	...	...	1	...	...	3
25–29	1	...	...	...	2	2	...	1	1	...	...	1	8
30–34	...	2	1	2	1	2	1	2	...	1	1	...	13
35–39	...	...	4	...	1	3	1	2	...	2	...	...	13
40–44	...	...	1	2	4	8	2	2	2	2	2	...	25
45–49	...	1	1	2	2	8	1	3	...	1	1	1	16
50–54	...	1	1	2	2	3	2	4	1	...	1	2	19
55–59	...	1	2	2	...	...	1	2	...	...	1	3	12
60 plus	...	...	...	2	...	1	...	1	...	...	...	7	11
Total	1	6	10	13	12	24	9	17	4	7	6	14	123
WOMEN.													
Under 20	...	...	...	...	...	...	...	...	...	...	...	...	...
20–24	...	...	...	1	...	...	1	...	1	...	...	...	3
25–29	...	...	...	...	...	...	...	...	...	...	...	...	...
30–34	...	...	...	1	...	2	...	...	...	...	...	...	3
35–39	...	...	...	...	...	...	...	...	...	...	...	...	...
40–44	...	...	1	...	1	...	...	...	...	...	...	...	2
45–49	...	...	...	2	...	...	...	...	...	...	...	...	2
50–54	...	...	...	...	...	...	...	...	1	...	...	...	1
55–59	...	...	...	1	...	...	...	...	...	...	...	...	1
60 plus	...	...	...	...	...	...	...	...	...	...	...	1	1
Total	...	...	1	5	1	2	1	...	2	...	...	1	13

TABLE XXVI.—*Blood-pressure frequencies for presumptive cases, by sexes and by age groups.*

Age (years).	Systolic.											Diastolic.									
	90	100	110	120	130	140	150	160	170	180	190 plus.	Under 50.	50	60	70	80	90	100	110	120	130 plus.
MEN.																					
Under 20	...	...	...	2	...	1	...	...	...	...	...	1	...	...	...	2	...	...	...	...	...
20–24	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
25–29	...	...	...	2	...	1	...	1	...	...	...	...	1	2	1	1	...	...	...	...	...
30–34	...	...	4	1	3	4	...	...	...	...	...	...	1	2	7	2	...	...	...	...	...
35–39	...	2	4	3	4	1	1	1	...	...	...	1	3	1	5	6	...	...	...	...	...
40–44	...	1	5	2	2	2	...	1	...	...	...	...	1	2	6	3	...	1	...	...	...
45–49	...	1	1	2	2	2	...	...	...	...	...	...	1	...	3	4	...	...	...	...	...
50–54	...	...	...	1	3	...	2	...	...	...	1	...	...	...	3	3	...	...	1	...	...
55–59	...	...	...	...	2	...	1	2	...	...	...	...	1	...	2	...	2	...	...	...	...
60 plus	...	...	...	...	1	...	1	...	...	1	...	...	...	...	...	...	2	...	1	...	...
Total	...	4	14	13	18	12	5	5	...	1	1	2	8	8	27	21	4	1	2	...	...
WOMEN.																					
Under 20	...	1	2	1	...	...	...	...	...	...	...	...	...	1	1	1	1	...	...	...	...
20–24	...	...	2	1	1	...	...	...	...	...	...	...	...	2	1	1	...	...	...	...	...
25–29	...	...	1	5	2	...	...	...	...	...	...	...	...	4	2	2	...	...	...	...	...
30–34	...	2	1	1	...	...	...	...	...	...	...	...	...	1	3	...	...	...	...	...	...
35–39	1	...	...	1	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...
40–44	...	...	1	1	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...
45–49	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...
50–54	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...
55–59	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	1	...	1	...	...	...
60 plus	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	1	3	7	10	4	...	2	...	...	...	1	...	1	8	9	7	1	1	1	...	...

TABLE XXVI.—*Blood-pressure frequencies for presumptive cases, by sexes and by age groups*—Continued.

Age (years).	Pulse.												Total.
	Under 30.	30	35	40	45	50	55	60	65	70	75	80 plus.	
MEN.													
Under 20	....	....	....	2	....	....	....	....	....	....	....	1	3
20-24	....	....	....	....	....	....	....	....	1	....	....	....	1
25-29	....	....	....	....	....	1	....	....	1	....	....	3	5
30-34	....	....	....	1	2	2	1	3	1	1	....	1	12
35-39	1	1	....	1	1	3	2	2	2	1	1	1	16
40-44	....	1	3	1	....	2	2	2	....	....	2	....	13
45-49	....	....	....	1	1	2	4	....	....	....	....	....	8
50-54	....	....	....	....	2	1	....	1	....	....	1	2	7
55-59	....	....	....	....	....	....	2	1	....	....	1	1	5
60 plus	....	....	....	....	1	....	....	....	1	1	....	....	3
Total	1	2	3	6	7	11	11	9	6	3	5	9	73
WOMEN.													
Under 20	2	1	....	....	1	....	....	....	....	....	....	....	4
20-24	....	....	1	....	1	1	....	....	1	....	....	....	4
25-29	....	....	....	1	1	2	4	....	....	....	....	....	8
30-34	....	....	2	1	1	....	....	....	....	....	....	....	4
35-39	....	....	1	....	1	....	....	....	....	....	....	....	2
40-44	....	1	1	....	....	....	....	....	....	....	....	....	2
45-49	....	....	....	....	....	....	....	....	....	....	....	1	1
50-54	....	....	....	....	....	....	....	....	....	....	1	....	1
55-59	....	....	....	....	1	1	....	....	....	....	....	....	2
60 plus	....	....	....	....	....	....	....	....	....	....	....	....	....
Total	2	2	5	2	6	4	4	....	1	....	1	1	28

TABLE XXVII.—*Blood-pressure frequencies for suggestive cases, by sexes and by age groups.*

Age (years).	Systolic.											Diastolic.									
	90	100	110	120	130	140	150	160	170	180	190 plus.	Under 50.	50	60	70	80	90	100	110	120	130 plus.
MEN.																					
Under 20	1	1	1	....	1	....	....	....	....	....	....	....	1	1	....	2	....	....	....	....	....
20-24	....	1	....	4	4	....	....	....	....	....	....	....	....	2	3	3	1	....	....	....	....
25-29	....	1	....	1	4	2	1	....	1	....	....	1	....	2	2	2	2	1	....	....	....
30-34	....	....	4	3	3	1	1	....	....	....	....	....	2	1	3	5	1	....	....	....	....
35-39	....	2	3	4	8	3	....	1	....	....	1	....	....	2	5	10	4	1	....	....	....
40-44	....	2	6	4	4	5	2	....	....	....	1	....	....	2	8	10	1	1	2	....	....
45-49	....	....	2	3	6	3	4	2	....	....	....	....	....	2	7	3	7	1	....	....	....
50-54	....	....	3	3	1	2	1	....	....	....	1	....	....	1	5	2	2	1	....	....	....
55-59	....	1	....	1	1	3	2	1	2	....	....	....	....	....	3	1	5	2	....	....	....
60 plus	....	....	....	1	....	....	....	1	1	....	2	....	....	....	1	1	2	....	1	....	....
Total	1	8	19	24	32	19	11	5	4	....	5	1	3	13	37	39	25	7	3	....	....
WOMEN.																					
Under 20	1	3	2	1	....	....	....	....	....	....	....	....	2	3	2	....	....	....	....	....	....
20-24	....	2	3	2	....	....	....	....	....	....	....	....	....	5	2	....	....	....	....	....	....
25-29	....	2	2	2	....	....	....	....	....	....	....	....	1	3	2	....	....	....	....	....	....
30-34	....	....	....	1	....	1	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....
35-39	....	1	....	....	....	1	....	....	....	....	....	....	....	1	....	....	1	....	....	....	....
40-44	....	....	....	1	1	....	1	....	....	....	....	....	....	1	1	1	....	....	....	....	....
45-49	....	....	....	2	1	3	1	....	....	....	1	....	....	....	3	3	1	....	....	....	1
50-54	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....
55-59	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
60 plus	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Total	1	8	8	9	3	6	2	....	....	....	1	....	3	13	12	4	5	....	....	....	1

TABLE XXVII.—*Blood-pressure frequencies for suggestive cases, by sexes and by age groups*—Continued.

Age (years).	Pulse.												Total.
	Under 30.	30	35	40	45	50	55	60	65	70	75	80 plus.	
MEN.													
Under 20		1			1	2							4
20-24			2	2	2			2	1				9
25-29			2	2			2			1	1	2	10
30-34	1		1	2	2		2	3		1			12
35-39	2	1	1	6	2	3	3	1		1		2	22
40-44	1	3	1	6	2	4	1	3	1	1	1		24
45-49			1	2	3	1	4	3	3		3		20
50-54			1	2	2	1	2	1	1			1	11
55-59	1				2	2	1	1	1	1		2	11
60 plus					1		1					3	5
Total	5	5	9	22	17	13	16	14	7	5	5	10	128
WOMEN.													
Under 20			1	2	2	1		1					7
20-24			1	2	2	1	1						7
25-29		1			2		3						6
30-34					2								2
35-39				1			1						2
40-44							2					1	3
45-49				2	1		1		1	2		1	8
50-54							1						1
55-59							1						1
60 plus	1												1
Total	1	1	2	7	9	2	10	1	1	2		2	38

TABLE XXVIII.—*Blood pressure of negative cases.*

Age (years).	Systolic.										
	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190 plus.
MEN.											
Under 20	3	6	21	28	24	9	5	1	1		
20-24		3	18	26	21	11	5	4			
25-29	2	2	26	40	33	18	6	2	2	1	
30-34	1	2	20	30	51	21	5	4	4	2	
35-39	1	3	33	38	55	22	10	3			
40-44	1	11	17	47	36	22	5	6	1	2	
45-49	1	7	5	21	22	17	14	4	2		3
50-54		1	9	14	18	18	5	10	5	3	6
55-59		1	5	5	10	12	8	9	5	5	3
60 plus			2	5	5	9	12	10	6	4	6
Total	9	36	156	263	275	159	75	53	26	17	18
WOMEN.											
Under 20	2	24	33	32	2	4	2				
20-24		9	18	24	3						
25-29		5	12	14	7						
30-34		3	9	13	2	1					
35-39		1	7	4	4	2		1			
40-44		2	6	3	1	1	1	1			
45-49		1	2	8	6	1	1	1	1		
50-54			1	2	4	3				1	
55-59				1		1		1			1
60 plus				1					1		
Total	2	45	88	102	29	13	4	4	2	1	1

TABLE XXVIII.—*Blood pressure of negative cases*—Continued.

Age (years).	Diastolic.									
	Under 50.	50–59	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130 plus.
MEN.										
Under 20	2	10	25	29	19	9	4	...	...	...
20–24	...	3	18	26	23	11	5	1	1	...
25–29	...	6	28	52	34	10	...	2	...	...
30–34	1	7	19	49	41	25	5	1	...	1
35–39	...	5	17	47	63	23	8	2	...	...
40–44	...	5	16	44	46	25	7	5	...	...
45–49	2	...	16	27	29	13	8	1	...	...
50–54	...	3	8	17	30	18	9	3	...	1
55–59	...	1	8	10	19	10	10	4	1	...
60 plus	...	...	6	8	19	12	11	1	2	...
Total	5	40	161	309	323	156	67	20	4	2
WOMEN.										
Under 20	1	15	25	45	9	3	...	1	...	...
20–24	...	1	20	25	8	...	...	...	...	...
25–29	...	1	10	20	7	...	...	...	...	...
30–34	...	1	10	15	2	...	...	...	...	...
35–39	...	1	4	9	3	1	1	...	...	...
40–44	...	2	1	8	3	...	...	1	...	...
45–49	...	...	6	8	5	1	...	1	...	...
50–54	1	...	1	4	4	1	...	...	...	...
55–59	...	...	...	2	...	1	...	...	...	1
60 plus	...	...	1	...	...	...	...	1	...	...
Total	2	21	78	136	41	7	1	4	...	1

Age (years).	Pulse.												
	Under 30.	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80 plus.	Total.
MEN.													
Under 20	3	6	10	9	13	18	12	12	3	2	3	7	98
20–24	6	5	7	8	14	15	6	13	4	3	2	5	88
25–29	1	...	12	11	26	24	12	18	11	7	3	7	132
30–34	5	7	11	21	19	20	24	10	6	7	7	12	149
35–39	10	7	17	25	27	26	15	10	9	9	4	6	165
40–44	8	7	12	26	24	30	11	9	7	10	1	3	148
45–49	...	7	4	9	8	20	13	12	8	5	2	8	96
50–54	1	3	4	9	4	16	13	14	5	3	2	15	89
55–59	1	3	1	4	11	5	3	6	6	5	2	16	63
60 plus	2	...	2	2	3	2	5	9	3	5	7	19	59
Total	37	45	80	124	149	176	114	113	62	56	33	98	1,087
WOMEN.													
Under 20	1	4	11	32	21	20	4	5	...	...	1	...	99
20–24	2	...	3	15	16	9	5	4	...	...	...	...	54
25–29	...	2	2	8	11	8	6	...	...	...	1	...	38
30–34	...	...	5	3	8	7	1	4	...	...	...	...	28
35–39	...	1	2	3	7	1	...	3	2	...	...	...	19
40–44	...	1	1	5	2	1	1	...	2	2	...	...	15
45–49	...	...	...	4	3	6	2	3	1	2	...	...	21
50–54	...	...	...	...	2	5	...	2	1	...	...	1	11
55–59	...	...	...	1	1	...	...	...	...	2	...	...	4
60 plus	...	...	...	...	...	1	1	...	...	...	...	...	2
Total	3	8	24	71	71	58	20	21	6	6	2	1	291

There seems also to be a greater number of high systolic pressures among the potters, especially among those having lead poisoning, and in the same groups there seems to be a correspondingly large number of low systolic pressures. Table XXIX gives the average systolic, diastolic, and pulse pressures, by diagnosis and sexes, of those in the pottery industry.

Figure 4 shows graphically what Table XXIX shows numerically.

Table XXX gives the systolic averages for the male pottery workers, for the male workers examined in the other industries mentioned above, and for 963 foundry men examined recently in the vicinity of New York city. In Table XXX also is found the coefficient of variability of the systolic pressure in these eight groups. It should be noted that the highest coefficient of variability occurs among the positive cases of plumbism, where a variability of 0.183 is found. In the male presumptive cases the variability is 0.143, for the male suggestive cases 0.151, and for the male negative cases 0.135. This latter coefficient is higher than that in any of the other industries mentioned, with the exception of the chemical works. A discussion of the age factor will be given later.

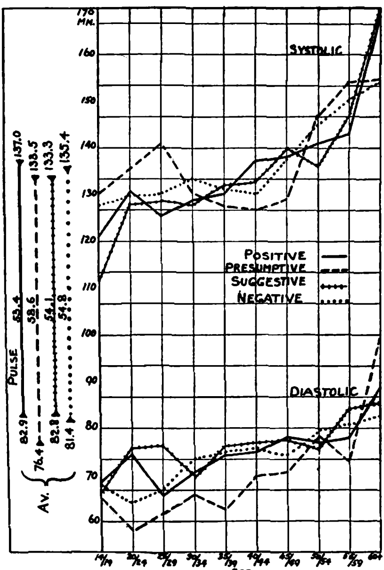

CHART 4.—Systolic and diastolic pressure, by diagnosis and age groups.

Table XXXI shows these same facts for the female workers in the pottery industry, and for 986 garment workers. Again this coefficient of variability is higher in the cases of lead poisoning and lower among the negative groups, and still lower among the garment workers. It is 0.171 for the positive group, 0.158 for the presumptive, 0.172 for the suggestive, 0.121 for the negative, and 0.081 for the garment workers.

These findings do not correspond exactly with those of clinical observers. Thus Norris (46) states that about 80 per cent of all lead workers exhibit for years a high arterial pressure, even when free from symptoms of poisoning. If, on the other hand, Nothnagel and Rossbach (47) are correct when they state that the chief action of lead is exerted on striated muscle, in which it produces a diminished ability to function, a hypotension would be the result, unless some compensatory action intervened.

TABLE XXIX.—*Number of cases and the average blood pressure for each age group, by sexes and diagnosis.*

Age (years).	Positive.				Presumptive.				Suggestive.				Negative.			
	Number.	Systolic.	Diastolic.	Pulse.	Number.	Systolic.	Diastolic.	Pulse.	Number.	Systolic.	Diastolic.	Pulse.	Number.	Systolic.	Diastolic.	Pulse.
MEN.																
Under 20	3	121.7	75.0	47.5	3	131.7	71.7	59.2	4	112.5	72.5	46.3	99	127.4	74.8	53.0
20-24	3	131.7	78.3	55.8	1	135.0	65.0	67.5	9	127.2	78.3	49.7	87	130.7	70.9	52.3
25-29	8	125.0	72.5	55.6	5	141.0	69.0	75.0	10	129.0	79.0	59.5	132	130.7	78.6	54.5
30-34	13	129.6	77.3	51.7	12	130.8	73.3	59.4	12	128.5	76.7	51.7	149	133.6	80.4	54.2
35-39	13	130.4	81.2	52.5	16	128.0	69.1	57.2	22	131.7	83.2	50.5	165	131.0	81.9	51.0
40-44	25	137.8	81.8	56.3	13	127.3	76.5	52.9	24	132.1	83.7	49.3	148	131.3	82.5	50.2
45-49	16	138.1	84.4	55.3	8	128.8	77.5	53.1	20	140.0	84.0	58.5	96	137.8	81.3	56.3
50-54	19	140.8	83.9	57.9	7	147.9	85.0	64.6	11	135.9	82.3	54.3	88	145.6	85.9	59.1
55-59	12	142.5	85.4	58.3	5	151.0	79.0	68.0	11	147.8	90.5	59.3	64	150.8	87.7	61.9
60 plus	11	167.7	95.9	70.7	3	158.3	101.7	62.5	5	171.0	93.0	72.0	59	157.7	89.2	67.6
Total	123	138.4	82.9	56.6	73	134.3	76.4	59.1	128	135.5	82.8	53.9	1,087	135.4	81.4	54.8
WOMEN.																
Under 20	0	0	0	0	4	115.0	80.0	33.8	7	109.3	65.0	47.5	92	118.7	71.9	52.5
20-24	3	121.7	65.0	55.8	4	122.5	72.5	51.3	7	115.0	67.9	46.8	53	117.8	70.7	48.4
25-29	0	0	0	0	8	126.3	72.5	53.1	6	115.0	66.7	50.0	35	123.0	74.4	49.9
30-34	3	121.7	75.0	49.2	4	112.5	72.5	41.3	2	135.0	85.0	47.5	28	122.5	73.2	49.3
35-39	0	0	0	0	2	110.0	70.0	42.5	2	125.0	80.0	50.0	18	128.9	77.2	48.0
40-44	2	120.0	75.0	42.5	2	120.0	80.0	35.0	3	138.3	75.0	66.7	14	120.0	72.9	48.6
45-49	2	130.0	85.0	42.5	1	195.0	115.0	82.5	8	146.3	88.8	60.6	19	136.0	81.3	54.1
50-54	1	155.0	85.0	67.5	1	155.0	75.0	77.5	1	135.0	75.0	57.5	10	134.0	82.0	51.0
55-59	1	135.0	95.0	42.5	2	145.0	95.0	50.0	1	145.0	95.0	57.5	8	142.5	77.5	61.3
60 plus	1	185.0	85.0	90.0	0	0	0	0	1	115.0	95.0	27.5	2	175.0	125.0	62.5
Total	13	131.5	77.3	52.1	28	125.3	77.1	48.0	38	125.3	75.3	52.1	279	123.0	74.1	48.8

TABLE XXX.—*Systolic averages for pottery male groups and for male workers in other industries, by age groups.*

Age (years).	Positive.		Presumptive.		Suggestive.		Negative.		Garment.		Chemical.		Steel.		Foundry.	
	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average
Under 20	3	121.7	3	131.7	4	110.0	99	127.4	40	119.8	32	116.9	67	118.4	20	123.4
20-24	3	128.3	1	135.0	9	127.2	87	130.7	368	124.9	175	122.0	231	122.3	235	129.0
25-29	8	125.0	5	141.0	10	129.0	132	130.7	514	125.4	185	135.2	282	129.1		
30-34	13	128.1	12	130.8	12	128.5	149	133.6	432	124.9	180	125.0	238	132.3	382	128.9
35-39	13	130.4	16	125.0	22	131.7	165	133.8	293	128.0	150	126.1	208	131.7		
40-44	25	137.8	13	127.3	24	132.1	148	131.3	202	134.6	90	142.0	116	135.6	227	135.3
45-49	16	137.5	8	128.8	20	140.0	96	137.0	92	136.3	52	138.5	75	136.9		
50-54	19	140.8	7	147.9	11	135.9	88	145.6	56	138.9	22	133.2	36	137.1	84	134.6
55-59	12	141.7	5	151.0	11	147.8	64	150.8	28	142.8	10	154.0	26	138.5		
60 plus	11	168.6	3	158.3	5	171.0	59	151.3	14	147.1	8	153.8	6	141.7	15	143.5
Total and average	123	138.4	73	134.3	128	135.5	1,087	135.4	2,039	127.15	904	126.6	1,285	130.5	963	131.0
Coefficient of variability	...	.183	..	.143	...	.154	.....	.135	.....	.122	...	.141	.....	.133	...	.118
Age average	...	44.3	..	40.8	...	41.1	.....	37.9	.....	33.55	...	28.6	.....	32.6	...	36.8
Age coefficient of variability	...	.254	..	.257	...	.271	.....	.275	.....	.265	...	.353	.....	.290	...	.316

TABLE XXXI.—*Systolic averages for pottery female groups and for female garment workers, by age groups.*

Age (years).	Positive.		Presumptive.		Suggestive.		Negative.		Pottery.		Garment.	
	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.
Under 20	....	....	4	115.0	7	109.3	92	118.7	103	117.9	225	112.6
20–24	3	121.7	4	122.5	7	115.0	53	117.8	67	118.0	516	113.9
25–29	....	....	8	126.3	6	115.0	35	123.0	49	122.5	167	118.3
30–34	3	121.7	4	112.5	2	135.0	28	122.5	37	122.0	35	117.9
35–39	....	....	2	110.0	2	125.0	18	128.9	22	127.7	23	130.7
40–44	2	120.0	2	120.0	3	138.3	14	120.0	21	122.6	13	125.0
45–49	2	130.0	1	195.0	8	146.3	19	136.0	30	140.3	4	137.5
50–54	1	155.0	1	155.0	1	135.0	10	134.0	13	137.3	1	155.0
55–59	1	135.0	2	145.0	1	145.0	8	142.5	12	142.5	1	155.0
60 plus	1	185.0	....	....	1	115.0	2	175.0	4	165.0	1	175.0
Total and average	13	131.5	28	125.3	38	125.3	279	123.0	358	123.8	986	114.8
Coefficient of variability	....	.171	....	.158	....	.172	....	.121	....	.127	....	.081
Age average	....	39.2	....	31.6	....	33.3	....	28.5	....	29.3	....	23.4
Age coefficient of variability	....	.309	....	.359	....	.392	....	.418	....	.420	....	.232

According to the findings in this survey lead poisoning seems at first to increase the blood pressure materially, but after a time this high blood pressure may or may not be maintained.

The high percentage of cases of hypertension reported by clinicians may be attributed to the fact that the observations of the latter were for the most part made on well-advanced or acute cases which presented themselves to the clinics; whereas the cases recorded in this survey are largely early cases of lead poisoning and chronic cases which have not necessitated a visit to a physician.

Blood pressure according to length of exposure.—In an attempt to find the coefficient of variability of both the systolic pressure and the pulse pressure, according to length of exposure, it is found that the age variation differs so much according to length of exposure that it is hardly possible to get dependable results. For example, the coefficient of variability of the age of the males exposed less than one year is over twice as great as that of those exposed 10 years and more, while the coefficient of variability of the systolic pressure and of the pulse pressure remains somewhat constant. In order to eliminate the age group, it was decided to select a broad age period which would contain a large number of individuals, and so the following table was made from the pressures taken of all males between the ages of 25 and 39.

Variation in blood pressure among the male potters of the age group 25–39 according to length of exposure.

	0–0.9.	1–4.9.	5–9.9.	10 and over.
Average systolic pressure	126.6	133.6	133	132.4
Coefficient variability	.112	.117	.121	.121
Average pulse pressure	53.9	55.9	55	50.5
Coefficient variability	.228	.256	.313	.259

Reference to the above table shows that the coefficient of variability for the systolic pressure increases from 0.112 among those exposed less than one year to 0.121 among those exposed 10 years and over. While the coefficient of variability for the pulse pressure is not a regular series throughout this group, it varies from 0.228, for those exposed for less than one year to 0.259 for those exposed 10 years and over. Although these groups are still not of sufficient size to make these rates entirely reliable, yet they are the largest that can be obtained without making the age period too broad.

Table XXXII shows a summary of these and some other facts and conditions according to the diagnosis. While the coefficients mentioned show a greater amount of variation in systolic pressure among those workers in the pottery industry according to the degree of lead poisoning, there is also shown a greater variation among the same group in the measure of pulse pressure. The coefficient of variability for the positive male group in the measure of pulse pressures is 0.353; for the presumptive male potters, 0.301; for the suggestive male group, 0.311, and for the negative, 0.215. Among the females these coefficients range from the positive cases downward, 0.287, 0.241, 0.236, and 0.190.

TABLE XXXII.—*Summarizing some effects and conditions of plumbism.*

	Men.					Women.				
	Positive.	Presumptive.	Suggestive.	Negative.	Total	Positive.	Presumptive.	Suggestive.	Negative.	Total.
Number	126	78	129	1,103	1,436	13	28	39	293	373
Average age	44.3	40.8	41.1	37.5	38.8	39.2	31.6	33.3	38.5	29.3
Age coefficient of variability	.254	.257	.271	.275	....	.309	.359	.392	.418	....
Average systolic pressure	137.0	133.5	133.3	135.4	....	127.5	127.7	120.1	123.0	123.8
Systolic coefficient of variability	.183	.143	.151	.135	....	.171	.158	.172	.121	.127
Average pulse pressure	53.4	58.6	54.1	54.8	....	52.5	46.8	49.0	48.8	....
Pulse coefficient of variability	.353	.301	.311	.215	....	.283	.241	.236	.190	....
Average length of exposure (1 year)	17.0	15.7	14.0	9.8	11.1	9.9	6.3	5.9	4.0	4.6
Per cent under 1 year	3.4	5.2	3.8	16.5	....	0.0	14.3	10.3	43.8	....
Per cent under 5 years	16.0	15.6	15.3	34.8	....	15.4	62.8	61.5	75.4	....
Per cent under 10 years	26.6	27.3	35.1	50.0	....	53.6	75.0	87.2	87.4	....
Average pulse rate	82.3	82.7	81.3	81.5	81.6	87.7	83.9	85.8	84.8	84.9
Average grip:										
Right	39.1	39.7	41.7	41.9	41.6	23.8	25.0	24.0	25.9	25.9
Left	37.3	39.5	41.2	40.5	40.1	23.3	24.0	23.0	25.0	24.6

It might be argued that these greater variations among the lead cases is due to the greater variation in age. Table XXXII shows the coefficients of variations of the ages of these various groups; they are 0.254 for the positive, 0.257 for the presumptive, 0.271 for the suggestive, and 0.275 for the negatives. This is a gradually increasing series, showing a greater age variation in the negative group. In other words, the positive group with a higher systolic variation and with a higher pulse-pressure variation has the lowest age variation.

Likewise among the women the corresponding age coefficients of variability are 0.309, 0.359, 0.392, and 0.418—again a decreasing series as the intensity of lead poisoning increases, and again the positive group with the highest amount of variation in both measures of blood pressure has the lowest age variation. Table XXXII shows also the per cent of positive, presumptive, suggestive, and negative cases of both sexes according to the length of exposure.

Pulse rate of pottery workers.—The following table shows the frequency of pulse rate of pottery workers by sexes and by occupations.

TABLE XXXIII.—*Pulse rate of 1,077 men and 324 women workers in the potteries, by occupations.*

MEN.

All potteries pulse rate.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Ware cleaner.	Glost-kiln placer.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
130			1				1						2
120-129	1	1	1				3			1			7
110-119			1				4						5
100-109		1	7	3	1		24			5	3		44
90-99	5	8	25	6	7	1	49			10	6	1	118
80-89	14	27	73	12	21	1	194	4		24	16	4	390
70-79	9	34	67	12	20	3	204	3	2	17	17	11	399
60-69	5	3	28	3	3		53			7	6		108
50-59	1						3						4
40-49													0
Total	35	74	203	36	52	5	535	7	2	64	48	16	1,077
Average pulse rate	83.86	80.11	81.45	83.33	82.90	81.00	81.39	80.71	75.00	83.91	81.46	78.75	0

WOMEN.

All potteries pulse rate.	Foreman.	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Ware cleaner.	Glost-kiln placer.	Kiln fireman.	Kiln drawer.	Oddman.	Sagger washer.	Decorator.	Total.
130													0
120-129				1									1
110-119	1				2	4							7
100-109				8	2				1			1	12
90-99	2		2	29	15	19			1			1	69
80-89	5		1	52	23	37			1			2	121
70-79	2		4	47	25	25			1			4	108
66-69				3		2			1				6
50-59													0
40-49													0
Total	10	0	7	140	67	87	0	0	5	0	0	8	324
Average pulse rate	88.00	0	82.14	84.64	85.00	85.23	0	0	85.00	0	0	83.75	0

Table XXXIII gives a summary of pulse rates by occupations and sexes of those examined in this survey. The average pulse rate for men is 81.6 beats per minute. For women the average is slightly higher—84.9. These averages vary among the different occupations, although perhaps little significance should be attached to these differences. The highest average for the men appears to be among the foremen, of whom 35 have an average pulse rate of 83.86 per minute. The lowest average for the men is among the kiln drawers, of whom two have an average rate of 75; but the number of these latter is not sufficient to make this a reliable rate for this occupation.

The highest rate for women appears to be among the forewomen, where the average is 88. The lowest rate is among the dippers, 7 female dippers having an average rate of 81.4 beats per minute.

Table XXXV shows the range for men and women according to kind of ware manufactured, the median, the quartile deviations, modes, means, the average deviations, the standard deviations, and the coefficient of variability for the frequencies shown in Table XXXIII. There is perhaps little of significance to point out here, except that the range for men varies from 55 beats per minute to 135, while that for women varies from 65 to 125. The average rate for men, 81.6, is somewhat higher than might be expected for an average of 1,077 men. The average for women, 84.94, is perhaps also somewhat higher than might be expected for 324 women.

Figure 5 shows the frequency curve for the men and for the women, the horizontal axis of the curves representing the number of beats in each and the vertical axis the frequency of these beats in class intervals of 10. This is reduced to the basis of 1,000 workers for each sex. It should be observed that the frequency curve for the women is slightly to the right of that for the men, which indicates that the pulse rate for women is slightly higher than that for the men.

The effect of plumbism upon pulse rate.—For comparison according to diagnosis Table XXXIV shows pulse frequency rate for pottery workers and for garment workers, by sexes, and for the men employed in the chemical and in the steel industries. It should be noted that the average pulse rate for the men in the pottery industry, which is 81.6, is somewhat higher than that for the garment workers, 77.7, and that for the steel workers, 79.8; and slightly lower than that for the chemical workers, which is 82.5. The pulse rate of the male potters by diagnosis varies not more than 1.4 beats per minute—which fact is perhaps insignificant. The pulse rate for the female potters, 84.9, is also higher than that of the female garment workers, which is 80.6. Among the potters the greatest variation according to diagnosis is about 4 beats per minute, the highest being among the positive cases, and the lowest among the 27 presumptive cases. The small number of cases makes this average rather unreliable, and there is perhaps nothing of significance attached to these differences. The average deviations given vary somewhat according to diagnosis. This coefficient is 0.121 for the positive male cases and 0.100 for the negative male cases. Although the variation in pulse beat is much higher among the positive male cases, as shown by the differences in these coefficients of variability, the rates for the male presumptives and for the male suggestives do not warrant us in making a positive statement that pulse rate varies directly according to diagnosis. In fact, the coefficient of variability for the male garment workers is 0.128, which is higher than that for the positive lead group. A study of the coefficient of variability for the women workers fails to reveal

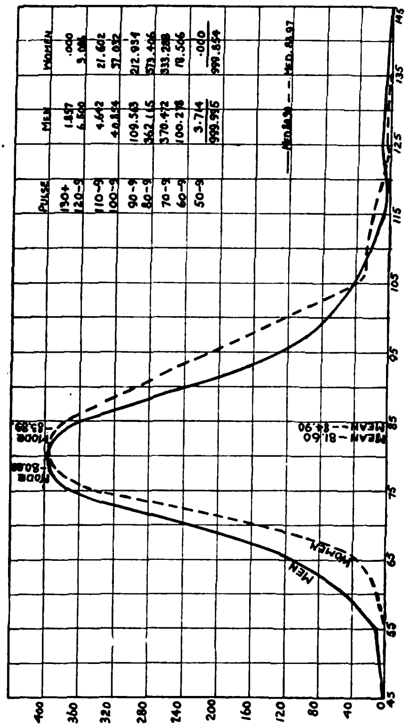

CHART 5.—Pulse rate of pottery workers.

any direct evidence that plumbism produces any greater variation in the pulse rate among the women.

Chart 6 shows the frequency curve of the male workers in the pottery, garment, chemical, and steel industries, reduced to the basis of 1,000 workers for each industry. These groups show the facts represented in Table XXXIV.

TABLE XXXIV.—*Pulse rate of potters and of workers in other industries, by diagnosis.*

MEN.

Pulse rate.	Positive.	Presumptive.	Suggestive.	Negative.	Garment.	Chemical.	Steel.	Potters.
130+	....	....	....	2	2	1	3	2
120-129	1	....	1	5	6	6	8	7
110-119	1	....	2	2	20	14	6	5
100-109	7	3	6	28	71	59	41	44
90-99	17	8	7	86	231	108	99	118
80-89	33	22	34	301	487	339	411	390
70-79	32	19	44	304	686	244	528	399
60-69	18	4	12	74	469	122	158	108
50-59	....	....	....	4	68	11	21	4
40-49	....	....	....	....	8	....	2	0
30-39	....	....	....	....	2	....	....	0
Total	109	56	106	806	2,050	904	1,277	1,077
Average	82.3	82.7	81.3	81.5	77.7	82.5	79.8	81.6
Coefficient of variability	.121	.094	.111	.100	.128	.115	.107	.103

WOMEN.

Pulse rate.	Positive.	Presumptive.	Suggestive.	Negative.	Garment.	Chemical.	Steel.	Potters.
130+	....	....	....	....	4	....	....	....
120-129	....	....	....	1	2	....	....	1
110-119	....	....	....	7	6	....	....	7
100-109	....	2	2	8	33	....	....	12
90-99	6	4	5	54	80	....	....	69
80-89	2	10	12	97	274	....	....	121
70-79	3	11	7	87	488	....	....	108
60-69	....	....	....	6	75	....	....	6
50-59	....	....	....	....	2	....	....	....
40-49	....	....	....	....	....	....	....	....
Total	11	27	26	260	964	....	....	324
Average	87.7	83.9	85.8	84.8	80.6	....	....	84.9
Coefficient of variability	.90	.086	.077	.089	.097	....	....	.087

TABLE XXXV.—*The range, median, quartile deviation, mode, mean, average deviation, standard deviation, and coefficient of variability of the pulse rate of potters.*

MEN.

Potteries.	Pulse rate.								Number reported.
	Range.	Median.	Quartile deviation.	Mode.	Mean.	Average deviation.	Standard deviation.	Coefficient of variability.	
Sanitary	65-105	82.50	7.47	84.00	81.15	8.34	9.94	0.122	109
General	55-135	80.76	6.93	80.00	81.82	8.62	11.19	.137	837
Others	65-105	79.03	6.07	79.00	80.95	6.78	9.68	.119	131
All	55-135	80.70	6.84	80.00	81.60	6.37	10.79	.131	1,077

WOMEN.

Potteries.	Range.	Median.	Quartile deviation.	Mode.	Mean.	Average deviation.	Standard deviation.	Coefficient of variability.	Number reported.
General	65-125	84.41	7.06	84.10	85.35	7.34	10.24	0.120	286
Others	75- 95	84.75	5.94	80.00	81.84	7.21	7.99	.098	38
All	65-125	83.97	7.11	83.89	84.94	7.35	10.10	.119	324

The hand grip.—Before determining the effects of lead poisoning on the hand grip, we give here tables which show the correlation of right and left hand dynamometer readings, in kilograms, for the total 1,295 male and 342 female potters, and these readings are compared with readings for workers in some other trades.

TABLE XXXVI.—*Correlation of right and left hand dynamometer readings, in kilograms, for 1,295 male potters.*

Left hand.	Right hand.											
	Under 20.	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-65	65-69	Total.
65-69										1		1
60-64								1	1	2	1	5
55-59						4		9	13	8	1	35
50-54	1				2	4	17	35	17	2	2	80
45-49			3	1	9	38	95	40	10			196
40-44	2		1	7	55	137	75	23	5	1		306
35-39		1	4	24	219	110	21	7	2			388
30-34		2	14	70	69	16	3	1				175
25-29	2	5	30	22	13	6	1	2				81
20-24	3	1	13	3	1	1						22
Under 20		2	1		1		2					6
Total	8	11	66	127	369	316	214	118	48	14	4	1,295

Average: Left hand=40.1 kilograms; right hand=41.6 kilograms.

TABLE XXXVII.—*Correlation of right and left hand dynamometer readings, in kilograms, for 342 female potters.*

Left hand.	Right hand.								
	Under 15.	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Total.
40-44								2	2
35-39				1	3	2	1		7
30-34			2	9	15	6			32
25-29		3	22	72	25	2			124
20-24	1	12	51	49	3	1			117
15-19	2	27	10	6	1				46
Under 15	8	3	2	1					14
Total	11	45	87	138	47	11	1	2	342

Average: Left hand=24.6; right hand=25.6.

Among male potters the readings for the right hand range from between 60 and 65 kilos to less than 20 kilos, with an average of 41.6 kilos. The readings are from top to bottom for the right hand, and from left to right for the left hand. It is seen that 8 of these 1,295 male potters had grips of less than 20 kilos for the left hand, and 4 had grips of between 65 and 69.

Of the 342 women examined, 2 had grips of from 45 to 49 kilos for the left hand, and 14 had grips of less than 15 kilos. For the right hand, 7 had grips of from 35 to 39 kilos, and 11 of less than 15 kilos. The average for the 342 women was 25.6 kilos for the right hand, and 24.6 for the left.

It is interesting to compare these rates with those found in other trades. Among 3,000 garment workers Schereschewsky found the following rates: Among 2,000 males, an average of 33.6 kilos for the right hand and 31 kilos for the left; among 1,000 females, 16 kilos for the right hand, and 13 for the left. The garment workers are, as a whole, a younger group than the pottery workers, and their trade does not tend to develop the muscles of the hands.

In the examination of 1,285 workers in steel and 903 workers in the chemical industry the average found for the right-hand grip of the

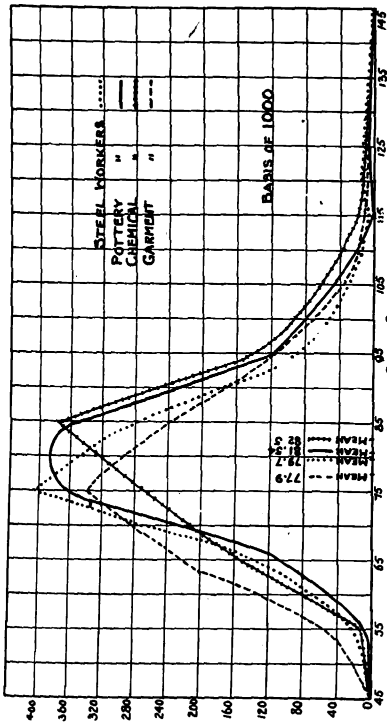

CHART 6.—Frequency of pulse beat among 1,000 men each of four industries. See table.

steel workers is 42.9 kilos, and for the left 40 kilos; for the chemical workers, 41.4 and 39.3 kilos, for the right and left hands, respectively. Both these groups are slightly younger than the pottery workers.

The effect of plumbism as shown by the dynamometer tests—

Tables XXXVI and XXXVII show the right and the left hand dynamometer readings for 1,295 male and 340 female workers, in the lead department of the pottery industry. Table XXXVIII below shows these grip measurements by diagnosis:

TABLE XXXVIII.—*Grip measurement by sexes according to diagnosis.*

MALE.

Grip.	Positive.		Presumptive.		Suggestive.		Negative.		All.	
	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.
Right	117	39.1	67	39.7	122	41.7	989	41.9	1,295	41.6
Left	117	37.3	67	39.5	122	41.2	989	40.5	1,295	40.1

FEMALE.

Grip.	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.	Number.	Kilograms.
Right	12	23.8	26	25.0	36	24.0	268	25.9	342	25.6
Left	12	23.3	26	24.0	36	23.0	268	25.0	342	24.6

This table shows that as the intensity of lead poisoning increases there is a direct decrease of the muscular power of the hand as shown by the dynamometer readings. The male positive group has a right-hand grip measurement of 39.1 kilograms, the presumptive group measures 39.7 kilograms, the suggestive group 41.7 kilograms, and the negative group 41.9 kilograms. Likewise the left-hand grip for the male groups increases from 37.3 kilograms in the positive group to 40.5 kilograms in the negative. The female right-hand grip increases from 23.8 kilograms in the positive group to 25.9 kilograms in the negative, and the left-hand grip from 23.3 to 25. With minor exceptions these readings are consistent and point toward the fact that as the intensity of lead poisoning increases the individual gradually loses muscular power—especially that included in these measurements—provided that there are no other influencing factors at work in some of these groups and not in others.

In order to ascertain whether age is a factor influencing the tendencies shown in Table XXXVIII with respect to dynamometer measurements, approximately 1,000 male negative cases are tabulated in order to find the average dynamometer readings of both right and left hand of various age groups. Results are shown in Table XXXIX:

TABLE XXXIX.—*Dynamometer readings, in kilograms, by age groups for 993 negative cases.*

	Under 20.	20-24	25-29	30-39	40-49	50-59	60 plus.	Average.
Right	38.0	47.0	44.9	43.1	41.6	38.4	32.9	41.6
Left	35.0	44.2	43.2	42.3	39.3	36.5	32.6	39.9

The above table shows that the dynamometer readings increase up to the 25th year from 38 kilograms for the right hand and 35 kilograms for the left to 47 kilograms for the right and 44.2 kilograms for the left, and gradually decrease in each successive age period until those over 60 have a right-hand dynamometer reading of 32.9 kilograms and a left-hand dynamometer reading of 32.6 kilograms.

The rates given in Table XXXVIII for the right and left hand readings of the positive, presumptive, suggestive, and negative groups are adjusted for age grouping to the rates shown in Table XXXIX. The expected dynamometer readings according to age for these various groups and the actual average dynamometer readings for the male groups for both right and left hands are shown in Table XL:

TABLE XL.—*Average expected age dynamometer readings and actual readings according to diagnosis.*

	Positive.	Presumptive.	Suggestive.	Negative.
Right expected	41.8	41.7	41.7	41.8
Right actual	39.1	39.7	41.7	41.9
Left expected	39.8	41.0	41.0	40.6
Left actual	37.3	39.5	41.2	40.5

Table XL shows that only a small portion of the drop in dynamometer reading as we proceed from the negative group toward the positive group can be accounted for by the age of these various groups. In the suggestive group the actual right-hand dynamometer reading is that expected for a group distributed as these suggestive cases are among the various age groups. In the presumptive male groups the actual right-hand dynamometer reading is about two points below the rate expected, and in the positive group it is also about two points below the rate expected, from the distribution of these positive males among the various age groups. In the suggestive group the average left-hand dynamometer reading is about the same as the expected reading. In the presumptive group, however, the actual reading is about one and one-half points below, while in the positive groups it is two and one-half points below, the expected reading. This would indicate that only a small part of the drop in the dynamometer reading as the intensity of lead poisoning increases can be charged to difference in age.

An attempt is made to discover whether occupational differences may partly cause the differences shown in Table XXXVIII. A rather broad age group is selected, where the differences in dynamometer readings are at a minimum. Over 500 negative male cases in this age group give the following averages by occupation:

	Glaze mixer.	Dipper.	Dipper's helper.	Ware carrier.	Glost-kiln placer.	Oddman.	Sagger washer.	Others.
Right hand	46.2	44.8	41.9	39.8	46.0	38.2	32.5	39.4
Left hand	43.0	42.3	39.9	39.5	45.0	39.1	30.7	37.2

These rates are taken in adjusting the dynamometer readings of the various diagnostic groups for occupational differences. The readings expected for these groups, from their distribution among the occupations, are as follows:

	Positive.	Presumptive.	Suggestive.	Negative.
Right hand	43.9	44.1	44.2	43.6
Left hand	42.4	42.7	42.8	42.3

Since there is no drop in these readings as we proceed from the negative group toward the positive, but rather a small rise, we conclude that occupational distribution does not account for the differences shown in Table XXXVIII.

By using the broad age group mentioned above we get the following average dynamometer readings by heights:

	Height (inches).							
	Under 64.	64-65.	66.	67.	68.	69.	70-71.	72 and over.
Right hand	38.3	42.7	43.3	43.7	42.1	43.3	46.4	45.4
Left hand	36.5	40.0	43.2	41.8	41.5	42.5	45.6	43.0

We are not able to find that differences in height affect the rates in Table XXXVIII in any manner. We therefore conclude that the decrease in dynamometer readings is caused by intensity of lead poisoning.

OTHER PHYSICAL DEFECTS NOTED IN THE EXAMINATION OF POTTERY WORKERS.

While it is not intended in this survey to enumerate the physical defects of pottery workers unless they have some possible bearing upon the results of plumbism, yet some defects occur so frequently that it may be well to note them.

Of the 1,436 men examined, 437 were found to have defective vision, 438 diseased gums, 446 defective teeth, 103 defective hearing, 78 diseased tonsils, while 367 suffered with headache, and 2 with epilepsy. Of the 373 women examined, 99 had defective vision, 48 defective gums, 147 defective teeth, 32 defective hearing, 77 defective tonsils, while 143 suffered with headache. One hundred six men and 64 women were found to be mentally depressed.

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PART IV.

CAUSATIVE FACTORS IN PLUMBISM.

It is the purpose in this chapter to analyze the results shown in Table XX, where we get a view in cross section of conditions with respect to plumbism as they existed in the 92 potteries at the time of this survey. It will be shown how the cases of lead poisoning are distributed among the various occupations of the potter, among the various types of ware manufactured by the pottery establishments, among the various plants with respect to the amount of soluble lead used in their glazes, and also among the plants themselves according to the number of employees. It is purposed, also, to show what factors in the manufacture of pottery goods seem to foster plumbism. An attempt is made to discover what relation, if any, exists between cases of lead poisoning and personal hygiene; also to determine whether a correlation exists between lead poisoning and plant hygiene and sanitation. In other words, this part of the investigation is an attempt to discover what effect certain plant conditions and what effect the personal hygiene of the workers may have in producing lead poisoning.

An attempt is made to adjust results in each case according to the effect of the age and sex distribution of the workers and according to the length and intensity of exposure to the lead hazard.

PERSONAL FACTORS.

It should perhaps be noted here that in every ill-effect upon the health of the individual there are exciting causes and contributory causes. In plumbism the exciting cause is lead. The contributory causes are perhaps personal conditions and habits, on the one hand, and plant processes and conditions of sanitation on the other. Personal conditions will first be discussed, such as age, sex, race, and length of exposure, over which the plant owner has little or no control, unless he should choose to hire a select group of factory workers. Later plant conditions and processes, factors for which the plant owner may be considered to be responsible, will be discussed.

AGE.

As age is an inherent factor in every investigation of the health of individuals, first will be shown rates of plumbism according to the different age groups. The five-year groups in which the rates of plumbism are practically constant are taken together in making up

Table XLI. This table shows rates of plumbism for different age groups by sexes.

TABLE XLI.—*Plumbism for different age groups, by sexes.*

MEN.

Age (years).	Positive.	Presumptive.	Suggestive.	Negative.	Total.	Rate of plumbism.	
						Positive.	Positive and presumptive
Average age	44.4	40.7	41.5	37.7	38.8		
Under 20	2	3	4	99	108	1.9	4.6
20-24	4	1	8	94	107	3.7	4.7
25-39	34	35	43	453	565	6.0	12.2
40	86	39	74	457	656	13.1	19.1
Total	126	78	129	1,103	1,436	8.8	14.2

WOMEN.

Age (years).	Positive.	Presumptive.	Suggestive.	Negative.	Total.	Positive.	Positive and presumptive
Average age	39.8	31.4	32.4	28.2	29.3		
Under 20	0	4	7	99	110	0.0	3.6
20-29	3	12	13	93	121	2.5	12.4
30-39	3	6	5	48	62	4.8	14.5
40	7	6	14	53	80	8.8	16.3
Total	13	28	39	293	373	3.5	11.0

Reference to the preceding table shows us that there is a gradual increase in rates as age increases. The rate for cases of positive plumbism for the male workers under 20 years of age is 1.9 or 19 per thousand; for the group 20-24 years of age it is 3.7; for the group 25-39 years of age it is 6; and for those 40 years old and over it is 13.1. Female workers under 20 years have a rate of 0.0; those between 20 and 29 years have a rate of 2.5; those between 29 and 39 a rate of 4.8; while those 40 years old and over have a rate of 8.8. It is perhaps sufficient to note at this point that this increase in the rate of lead poisoning with the increase of age holds true for workers of both sexes. A discussion of sex differences and of the relation of age to the length of exposure follows.

SEX.

Table XLII shows the rate of plumbism, the average age, and the average length of exposure by sexes.

TABLE XLII.—*Plumbism, by sexes.*

Sex.	Number.	Average age (years).	Average years exposed.	Average years exposed.		Number of plants.	Rate of positive plumbism in 65 plants.	Rate of positive plumbism in 92 plants.
				Positive.	Presumptive.			
Male	1,436	38.8	11.1	17.0	15.7	92	9.4	8.8
Female	373	29.3	4.6	9.9	6.3	65	3.5	3.5
Total	1,809	36.9	9.8	16.3	14.2	92	8.2	7.7

The rate of positive plumbism for all males examined is 8.8, and for all females is 3.5. In considering these rates it will be well to note the difference in ages of these two groups, the average age of the male being 38.9, and of the female 29.2. While we have not yet discussed the length of exposure to the lead hazard, the average length of exposure of the males is 11.1 years, and of the females is 4.6.

There are 27 plants in which no women are employed in the departments handling lead glaze. The 388 men employed in these 27 plants have a rate of positive plumbism of 7. An analysis of the age groups of the men employed in these 27 plants shows us that they are slightly underaged to such an extent that an expected rate of 8.1 would result. It is found also that they have been exposed for approximately one year less than the average time for all male workers. In the remaining 65 plants in which both men and women are employed the rate of positive plumbism among the men is 9.4, as compared with the rate 3.5 for the women in these same plants. In using this higher rate it should be remembered that the men are slightly older and have been exposed somewhat longer than those in the 27 plants employing no women. However, when a full analysis is made, considering all the contributing factors which come under our notice, including, of course, those of plant hygiene, we find that it makes little difference whether the comparisons are made among the 92 plants or among the 65 employing both men and women.

The average length of exposure of the positive male group is found to be 17 years and that of the female group 9.9 years. The average length of exposure of the male presumptive group is 15.7 and of the female is 6.3. In connection with this length of exposure it should also be mentioned that in most plants the length of day for the female worker is from one-half hour to one hour shorter than that of the male worker. It would seem that the female reaches these stages of lead poisoning in about half the time required for the male to reach them.

EMPLOYMENT.

Although we have not yet discussed rates of plumbism for the different occupations, it is thought best at this point to compare rates of lead poisoning in at least two occupations in which representative numbers of both men and women are employed. The specific work in these occupations may differ according to sex, yet both are employed in the same rooms and under the same conditions, and without doubt are exposed to about the same intensity. For example, 58 male ware carriers have no positive cases of plumbism, while 62 women ware carriers have a rate of positive plumbism of 4.8. In analyzing these two groups we find that the women are slightly older than the men. Thirty-two of the men are under 20, while only 25 of the women are of a like age. The women have been exposed for a slightly longer period of time. In adjusting these two factors we find that the men have an expected age rate of 5.5 and an expected exposure rate of 4.5, but with an actual positive rate of 0.0; while the women have an expected age rate of 3.3, an expected exposure rate of 3.1, and yet an actual rate of 4.8. Thus the men have a rate materially less than would be expected with respect to the two factors mentioned, while the women have a rate somewhat higher than would be expected.

There are also 71 male dippers' helpers and 149 female dippers' helpers employed in the same room at approximately the same kind of work and under somewhat similar conditions. The men are again slightly underaged and underexposed. One-half of the male dippers' helpers and one-third of the female dippers' helpers are under 20. The expected age and exposure rates correspond closely to the actual positive rate of 5.6 per cent for male dippers' helpers. The women have an expected age rate and an expected exposure rate, which in each case is about one-half of the actual positive rate of 4 for the female dippers' helpers. If we consider the positive and the presumptive cases together, the male dippers' helpers have a rate of plumbism of 8.4 and the women of 13.4.

With the exception of these two groups there are no others with sufficient numbers of both sexes to make a comparison reliable. Our analysis, however, indicates that when conditions of age, length of exposure, and occupation, with its attending conditions, are equal, the rate of plumbism is much higher among women than among men.

As shown by Table IV, over 80 per cent of the pottery workers are native born. It is, therefore, to be suspected that nationality does not play a large part in determining rates of plumbism either by age or by sex. A discussion of rates according to nationality is therefore left until we have made a study of the effect of length of exposure and of rates for the various occupations.

LENGTH OF EXPOSURE.

Table XLIII shows rate of plumbism for different lengths of exposure and lengths of exposure for the different diagnoses, by sexes. After due analysis it is found that the rates are about constant through each period as used in the table.

TABLE XLIII.—*Rate of plumbism for different lengths of exposure.*

MEN.

Years of exposure.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
0-0.9	2	6	4	172	1.1	4 3
1-4.9	14	10	12	214	5.6	9.6
5-9.9	15	11	26	180	6.5	11.2
10 plus	88	51	87	433	13.4	21.1
Total	119	78	129	999	8.9	14.9
Average years of exposure	17.0	15.7	14.0	9.8	....	11.1

WOMEN.

Years of exposure.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism: Positive.	Rate of plumbism: Positive and presumptive.
0-0.9	1	5	4	95	1.0	5.7
1-4.9	3	8	18	113	2.1	8.0
5-9.9	4	7	11	40	6.4	17.8
10 plus	5	8	6	42	8.2	21.3
Total	13	28	39	290	3.5	11.1
Average years of exposure	9.9	6.3	5.9	4 0	....	4.6

It will be observed that the rate of plumbism increases with the years of exposure. The rate of positive plumbism for those males employed in exposed occupations for less than one year amounts to 1.1 per cent. For those employed for more than one year but less than five years the rate is 5.6 per cent. For those employed more than five but less than 10 years the rate is 6.5. For those employed for more than 10 years the rate is 13.4. The corresponding rates for the women workers are 1.0, 2.1, 6.4, and 8.2. This statement is emphasized by the fact that the average length of exposure of the male positive group is 17 years, the presumptive 15.7 years, the suggestive 14 years, and the negative 9.8 years, while the women workers have been exposed 9.9, 6.3, 5.9, and 4 years, respectively.

While the worker is getting more years of exposure, he is also adding more years to his age. For this reason it is sometimes argued that length of exposure and age mean about the same thing, and that consideration of one to the exclusion of the other would be sufficient. This might be true if all workers entered the glaze department of the pottery industry at a given age. On the contrary, when we undertake to analyze the age distribution for each of these exposure periods we find all ages represented. Workers of either sex enter the trade when over 60 years of age. A fairly large number begin work in the lead department when over 40 years of age. While the age of 40 and above is somewhat exceptional, there are sufficient numbers entering in that age group to make age analysis necessary. Table XLIV shows the rates of plumbism for these various periods of exposure adjusted for the age distributions represented by the employees coming under each of these groups.

TABLE XLIV.—*Rates of plumbism according to years of exposure, by sexes, adjusted for age distribution.*

MEN.

	Years of exposure.				Total.
	0-0.9	1-4.9	5-9.9	10+	
Actual rate	1.1	5.6	6.5	13.4	8.8
Expected rate	6.0	7.2	8.0	10 6	8.8
Adjusted rate	1.6	6.8	7.2	11.1	8.8
Average age	28.4	33.3	35.8	44.5	38.8

WOMEN.

	0-0.9	1-4.9	5-9.9	10+	Total.
Actual rate	1.0	2.1	6.4	8.2	3.5
Expected rate	2.9	3.1	4.1	4.4	3.5
Adjusted rate	1.2	2.3	5.5	6.5	3.5
Average age	26.8	28.2	31.4	37.8	29.3

It should be noted that when length of exposure for the male group is adjusted for age we have a rate of positive plumbism of 1.6 for the group exposed under one year, of 6.8 for those exposed more than one but less than five years, of 7.2 for the group exposed more than five years and less than 10, and 11.1 for the group exposed more than 10 years. The corresponding rates for the female workers according to exposure are 1.2, 2.3, 5.5, and 6.5. These rates include, of course, all occupations, and for that reason are hardly comparable between sexes. The rates for the different occupations will be taken up in the next section, and along with this will be discussed the intensity of exposure to which both sexes are subjected.

OCCUPATION.

In our discussion of exposure we said that it is related, as far as length of exposure is concerned, to age of the worker on the one hand, and suggested that, as far as the intensity of exposure is concerned, it may be related to occupation on the other. We have in our early sections discussed at some length the various processes and the various occupational duties of the workers and have shown in a variety of ways that those engaged in these different occupations are exposed to different phases of the glazing process. We have shown the differences in the amounts of dust and the varying amounts of lead in the dust in the various workrooms in which these processes are carried on and in which these employees of the different occupations must work. It is therefore expected that a measure of the amount of plumbism according to occupation will include, in a large measure, the element of intensity of exposure. Table XLV shows the number of cases of plumbism according to the diagnosis of our physicians among the various occupations in the pottery industry. It also shows the reduction to rates of the actual number of cases of plumbism in each occupation by sexes and by diagnosis.

TABLE XLV.—*Plumbism by occupation, sex, and diagnosis.*

Occupation.	Number.				Rate.			
	Positive.	Presumptive.	Suggestive.	Negative.	Positive.	Presumptive.	Suggestive.	Negative.
MEN.								
Foreman	2	3	3	31	5.1	7.7	7.7	79.5
Glaze mixer	11	10	10	81	9.8	8.9	8.9	72.3
Dipper	46	17	30	174	17.2	6.4	11.2	65.2
Dipper's helper	4	2	6	59	5.6	2.8	8.4	83.1
Ware carrier	....	1	1	56	....	1.7	1.7	96.6
Ware cleaner	....	....	....	9	....	....	....	100.0
Glost-kiln placer	49	39	71	548	6.9	5.5	10.0	77.5
Kiln fireman	2	....	1	9	16.7	....	8.3	75.0
Kiln drawer	....	1	....	5	....	16.7	....	83.3
Oddman	7	3	4	55	10.1	4.3	5.8	79.7
Sagger washer	3	2	3	65	4.7	2.7	4.7	89.0
Decorator	2	....	....	11	15.4	....	....	84.6
Total	126	78	129	1,103	8.8	5.4	8.9	76.8
WOMEN.								
Forewoman	....	1	....	9	....	10.0	....	90.0
Dipper	....	1	3	21	....	4.0	12.0	84.0
Dipper's helper	6	14	18	111	4.0	9.4	12.1	74.5
Ware gatherer	3	4	7	48	4.8	6.4	11.2	77.4
Ware cleaner	3	4	9	79	3.1	4.2	9.5	84.2
Kiln drawer	....	1	2	10	....	7.7	15.4	77.0
Decorator	1	3	....	15	5.3	15.8	....	78.9
Total	13	28	39	293	3.5	7.5	10.5	78.5
Grand total	139	106	168	1,396	7.1	5.8	9.3	77.2

A survey of this table shows that the highest rate of positive plumbism among the men is among the dippers. This rate is 17.2 per cent, or at the rate of 172 persons per thousand of the dippers examined in this survey. The next highest rates, where the groups are of reliable size, are among the oddmen and among the glaze mixers, where 10.1 per cent and 9.8 per cent, respectively, of those examined are found to have positive lead poisoning. Among the women the highest rate is found among the decorators, although the number examined is perhaps too small to make this a reliable rate. Moreover, we attempted in this survey to examine only those decorators who came in contact with the lead used in the pottery glaze. The limited number of decorators examined is therefore only a small part of all the decorators. As stated previously in our report, the lead hazard in the decorating department is a rather uncertain element, because in a great many instances lead is not used, while in others it is used with oils and in such ways that ground laying in lead and tinting with lead are not practiced to any great extent. Among the ware gatherers, however, we have a rate of 4.8 per cent out of a total of 62 examined, and among dippers' helpers a rate of 4.0 per cent out of 149 examined. If we combine the positive and presumptive cases among the men, the highest rates are among the dippers, the glaze mixers, and the oddmen, respectively; and among the women, dippers' helpers and ware gatherers, in the order named.

It should perhaps be explained that the rate of plumbism among ware cleaners and among brushers is found to be approximately the same, so that we have included brushers under ware cleaners in the above table. We examined only those brushers who are working in rooms in which they come in contact with lead or with lead dust. We do not include any bisque-ware brushers, who are not exposed to lead.

A careful analysis is made of the occupational groups and of the rates shown in Table XLV, for the purpose of adjusting these rates according to age of employees and according to length of exposure. Table XLVI gives the classification of these rates and shows both the actual rate for each occupation and the expected rate for each age group and for each period of exposure.

TABLE XLVI.—*Actual occupational rate of plumbism and expected rates of these groups affected, by age and exposure.*

Occupation.	Men.			Women.		
	Actual rate.	Expected rate.		Actual rate.	Expected rate.	
		By age groups.	By length of exposure.		By age groups.	By length of exposure.
Foremen	5.1	10.8	10.9	0.0	3.9	4.0
Glaze mixer	9.8	9.7	6.9	....	....	....
Dipper	17.2	8.6	10.4	0.0	4.7	3.6
Dipper's helper	5.6	5.0	4.5	4.0	3.1	2.7
Ware carrier and gatherer	0.0	5.5	4.5	4.8	3.0	3.0
Ware cleaner	0.0	4.0	3.7	3.1	3.4	2.7
Glost-kiln placer	6.9	7.6	10.7	....	....	....
Kiln fireman	16.7	16.5	12.1	....	....	....
Kiln drawer	0.0	5.2	6.5	0.0	4.6	3.8
Oddman	10.1	10.1	6.6	....	....	....
Sagger washer	4.7	9.3	6.9	....	....	....
Decorator	15.4	7.9	5.5	5.3	3.3	3.4
Total	8.8	....	....	3.5	....	....

It will be noted that the actual rate of positive plumbism for foremen, which is 5.1 per cent, is somewhat less than might be expected of this group because of age and because of the length of time they have worked in the lead hazard. The foremen are somewhat older than the average for the male potters, so that a rate of 10.8 might be expected due to their distribution among the various age groups. They have been exposed to the lead hazard somewhat longer than has the average male employee under discussion, such that a rate of 10.9 might be expected because of their length of exposure. The low actual rate for foremen is no doubt due to the fact that their occupation has less hazards as far as lead is concerned.

In some occupations the actual rate is higher than the expected rates; in some it is lower. In other occupations there are hardly sufficient cases to make the rates reliable. However, in six of the male occupations there ought to be a sufficient number of cases to make the comparison of these rates possible. The glaze mixers, dippers, and dippers' helpers have actual rates of positive plumbism higher than might be expected of these various occupations, because of age and because of length of exposure. The ware carriers, glost-kiln placers, and sagger washers have rates somewhat lower than the expected rate. Among the women workers the dippers' helpers and the ware gatherers have rates higher than the expected rates, while ware cleaners have about the rate that might be expected due to their ages and years of exposure. In the other female occupations there are perhaps insufficient numbers for placing any great reliability in the comparison of rates. It seems, however, that in the six male occupations and in the three female occupations mentioned there are sufficient numbers to make a comparison of rates significant.

No attempt is made here to show what the combined effects are of age and of length of exposure upon these occupational rates, largely because we are unable to assign satisfactory weights to these factors. The sex differences among dippers' helpers and among ware carriers have already been noted. There are not sufficient numbers in any of the other occupations to make possible a reliable comparison.

NATIONALITY.

Table XLVII shows plumbism among some of the various nationalities found employed in the potteries included in this survey. There is not a sufficient number of workers of the various nationalities represented to make all the rates reliable, so that rates are given for only Americans, English, Irish, and Italians, and a combined rate for Germans, Hungarians, and Austrians. All other nations are grouped together for a rate of plumbism.

TABLE XLVII.—*Plumbism according to nationality, by sexes.*

MEN.

Nationality.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
American and not given	97	60	102	878	8.5	13.8
English	13	8	8	62	14.3	23.1
Irish	4	2	3	29	10.4	15.8
Italian	0	3	3	34	0.0	7.5
German, Hungarian, and Austrian	6	3	10	64	7.2	10.8
Others	6	2	3	36	12.8	17.0
Total	126	78	129	1,103	8.8	14.2

WOMEN.

Nationality.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism: Positive.	Rate of plumbism: Positive and presumptive.
American and not given	11	26	37	250	3.4	11.4
English		1	1	6	0.0	12.5
Irish	2	1	1	6	20.0	30.0
Italian				1	0.0	0.0
German, Hungarian, and Austrian				9	0.0	0.0
Others				21	0.0	0.0
Total	13	28	39	293	3.5	11.0

As has been shown before, the greater per cent of the workers are Americans. The rate for this group is about the normal rate for the whole group. The 91 Englishmen have the highest rate of positive plumbism, which is 14.3 per cent, and of positive and presumptive, which is 23.1 per cent. The lowest rate is among the Italians, 40 of this nationality having a rate of positive plumbism of 0.0 per cent, and of positive and presumptive of 7.5 per cent. Questions arise as to racial tolerance and to racial susceptibility to lead poisoning.

To ascertain whether nationality is a factor in determining plumbism, or rather whether some races are more susceptible to lead poisoning than others, these figures are analyzed rather carefully. Among the Englishmen are found a relatively larger number of dippers and of those in the more hazardous occupations than is found in the group as a whole. As there are no standards for eliminating the various occupational groups, the rates furnished in this study are taken as a basis for computing the rate of plumbism according to the number of Englishmen in the various hazardous occupations. Positives and presumptives are considered together in making this analysis. This gives us a rate of 14.7 per cent for the expected rate of positive and presumptive plumbism with the occupations of the English workers, provided the same rates exist as in the occupations of the whole group. This is a slightly higher rate than the average rate of positive and presumptive plumbism for the whole study, which is 14.2 per cent.

Moreover, the average age of the Englishmen is 46.5 years, which is about 8 years more than the average age of the 1,436 men examined in this survey. Applying the same methods to the age groups as we have applied to the occupational groups, we get a rate of positive and presumptive plumbism of 16.8 per cent for the English age groups. In the matter of length of exposure it is found that the Englishmen were exposed somewhat longer than the average period for all males examined. Applying methods of standardization again, it is found that the length of exposure for these men gives an expected rate for positive and presumptive plumbism of 17.3 per cent. We have not yet discussed the effect of tea, coffee, tobacco, nor liquors, but it is found that the Englishmen use somewhat more than that used by the average pottery working men, so that a rate of positive and presumptive plumbism of 15.6 per cent might be expected because of the use of these articles.

Summarizing these facts concerning the English male workers, it might be said that they are in more hazardous occupations, they represent an older group, they have been exposed to lead hazards longer, and their personal habits are such that we might expect them to have the higher rate of positive and presumptive plumbism noted in Table XLVII. While there are perhaps no recognized processes of weighing the above rates when we accumulate them into a single factor, yet if we combine the increase of each over that of the rate of positive and presumptive plumbism for all males, we get an expected rate of 23.4, when all factors are considered to have an equal effect in determining the rate of positive and presumptive plumbism. This resulting rate is approximately the same as the actual rate found—namely, 23.1 per cent.

In analyzing also the facts concerning the 40 Italian workers whose rate of positive and presumptive plumbism has been shown before to be 7.5 per cent, we find a large number of these are in the less hazardous occupations, as a relatively few of them are dippers or glaze mixers. Standardizing these groups, we get a rate of positive and presumptive plumbism of 12.5 per cent, which might be expected of a chance group distributed as these Italians are among the various pottery occupations. The average age of the group is 34 years, which is about 5 years younger than the whole group of male workers. The standardized rate of positive and presumptive plumbism for the Italian age group is 13.3 per cent. They have been exposed to the lead hazards for an average of 5.2 years, which would give a rate of positive and presumptive plumbism of 11.0 per cent. While we have not discussed plant hygiene, it is discovered also that the Italians are distributed among plants in which hygienic conditions are slightly above the average. In fact, the rate of positive and presumptive plumbism for the type of plants in which these Italian workers are found is 10.8. Combining these facts—namely, less hazardous occupations, less age of workers, a reduced length of exposure, and better factory conditions under which these men work—it is not surprising that they have such a low rate of lead poisoning. If we accumulate the various reductions, as shown in the above rates, by a simple process of multiplication and equal weighing for all factors, we get a resultant rate of 7.49, which very closely approximates the positive and presumptive rate of 7.5.

Although the number of men in each of these nationalities is not large, it is safe to say that our analysis does not show a race hazard. In other words, no particular race is found to be more susceptible to lead poisoning than another, nor does any race seem to show tolerance for lead poisoning. It is acknowledged, however, that a study of a larger group of these nationalities would make the conclusions more reliable. The facts concerning the other nationalities are not analyzed. Due to the fact that most of the pottery workers are Americans and that we are unable to show racial differences here, no attempt is made in this report to adjust for racial differences.

LENGTH OF DAY.

Table XLVIII shows the rate of plumbism for the male workers according to the number of hours per day. It should be noted that a great many of these men work by the piece and that the length of day varies materially within a given plant and for a given worker, and that these figures represent a typical day for the worker. Where the plants are considered, the time represents a typical time for the majority of the workers within the plant.

TABLE XLVIII.—*Plumbism according to length of day.*

	Length of day.			
	7 hours and less.	8 hours.	9 hours.	10 hours and more.
Number of workers	255	702	310	93
Actual rate of plumbism	7.9	9.8	6.5	11.2
Expected rate for occupation	9.4	8.8	8.1	9.4
Expected rate for exposure	10.5	9.9	7.7	7.9
Number bad conditions	Average.	Below.	Above.	Average.

It will be observed that the rate of positive plumbism for those working 7 hours per day and less is 7.9; for those working 8 hours, it is 9.8; for those working 9 hours it is 6.5; and for those working 10 hours or more, it is 11.2. These rates increase as the length of day increases, with the exception of those working a 9-hour day. The conditions are therefore analyzed a little further in order to discover whether there are other factors which would tend to affect these rates of positive plumbism for those working different hours per day. Those employed for 9 hours per day are in occupations slightly less hazardous than are those employed for the other lengths of day. Those working on a 9-hour schedule have had a less exposure than those working under the other lengths of day. It is found also that those plants in which the 9-hour schedule seems to prevail have fewer bad conditions which would tend to affect the health of the worker and to increase the rate of positive plumbism. Reference to the table shows us that the expected rate for the occupation of the 9-hour group is 8.1, and for the length of exposure of this same group it is 7.7. The age distribution for each group is about normal. An adjustment of these rates would tend to increase the rate of plumbism for those working 9 hours per day, and it would also tend to decrease about equally the rates given in Table XLVIII both for those working both 7 hours per day and less and for those working 8 hours per day. This would tend to give us an increasing rate of positive plumbism as the length of day increases. The glost kiln men, who work less than 7 hours per day, have no positive cases of lead poisoning among the small number of examinees. Those kiln men who have a 7 hour day have a rate of positive plumbism of 7.3 per cent while those with an 8-hour day have a positive rate of 8.8 per cent. Those in the 7-hour group are slightly overaged and overexposed, so that an adjusted rate would be less than 7.3 per cent. There are not enough kiln men employed 9 or more hours per day to give a reliable rate. These results indicate that length of day increases the probability of getting lead poisoning.

TIME AND PIECE WORK.

In trying to show the difference in the rate of plumbism for those workers who are hired by the piece and for those who work by the day certain difficulties present themselves. The first is that the pieceworker, as a rule, is the man who hires the rest of the crew who work under his direction. He therefore sets the pace himself. The main difference perhaps is that the timeworker, though he may not be allowed more time for lunch, will take more time for getting drinking water, for visiting toilets and washrooms, and for getting in, where possible, short periods of rest and recreation. Our observations confirm this statement. In a measure, then, the pace setting may be reversed, and the pieceworker in order to maintain his speed must employ more helpers. However, 844 male pieceworkers have a rate of positive plumbism of 9.1, while 461 male timeworkers have a like rate of 5.8. These same pieceworkers have a rate for positive and presumptive plumbism of 15.3, while the timeworkers have a rate of 10.4. Likewise 23 women working by the piece have a positive and presumptive rate of plumbism of 13, while 277 female timeworkers have a rate of 10.8.

Analysis of the male timeworkers shows that they are slightly underaged and slightly underexposed, as far as occupational hazards are concerned; whereas the pieceworkers are slightly overaged and slightly overexposed. These two items, however, are insignificant in adjusting the rates. In the matter of length of exposure the timeworkers are underexposed and the pieceworkers are overexposed to a degree sufficient to account for a considerable part of the differences in rates noted. Evaluating for these differences, it still appears that pieceworkers have a higher rate of lead poisoning than timeworkers have.

PERSONAL HABITS.

EATING IN THE WORKROOM.

Table XLIX gives the rates of plumbism by sexes for those who eat regularly in the workrooms where lead is present and for those who do not.

TABLE XLIX.—*Plumbism for those who eat in the workrooms where lead is present.*

Eat in workroom.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
MALE.						
Do regularly	89	54	84	742	9.2	14.8
Do not	37	24	45	361	7.9	13.1
FEMALE.						
Do regularly	6	17	24	93	4.3	16.4
Do not	7	11	15	200	3.0	7.7

As shown in this table, the rate of positive plumbism for those males who eat regularly in the workroom is 9.2 and for those who do not it is 7.9. For the female the rates are 4.3 and 3.0, respectively. If we include positive and presumptive cases, we get a rate of 14.8 for those males who eat in the workrooms and of 13.1 for those who do not. The corresponding rates for the females are 16.4 and 7.7. We find after analysis that those who eat in the workrooms have about the same distribution among the various occupations of the pottery industry as those who do not. This is true for both sexes. However, the men who eat in the workrooms are slightly underaged and slightly underexposed, as compared with the group that does not eat in the workroom. This is perhaps sufficient to increase the difference in positive rates noted between these groups by as much as 1 or more per cent. The women who eat in the workrooms are somewhat older and longer exposed than the women who do not eat in the workrooms. The average age of the women who eat in the workrooms is 32.4. These two factors would tend to decrease the difference in rates of positive plumbism between these two groups of women workers by as much as a fraction of 1 per cent. It is perhaps sufficient to state that where groups of equal age, exposure, and of like occupations are considered a slightly greater difference in the rates for the two groups would result for the men and a slightly less difference would result for the women than those shown in Table XLIX.

It is evident that the rates of plumbism are higher for those who eat in workrooms where lead is present than they are for those who eat elsewhere. There is every reason to suspect that if we eliminate eating in the workrooms we may be able to reduce the amount of lead poisoning after a reasonable length of time. There is no good reason for claiming that our rates are refined to the extent that an estimate can be made of the exact amount of such reduction.

USE OF MILK, TEA, COFFEE, TOBACCO, AND LIQUORS.

In discussing personal habits among the workers and in trying to find what effect they may have upon the rate of plumbism among pottery workers, it is perhaps necessary to acknowledge that we are unable to get reliable data upon certain habits which are probably factors and which should be considered. While our investigators saw factory workers putting glaze-covered fingers into their mouths and saw men stroking their beards and leaving lead glaze in the vicinity of the mouth, yet it is impossible to get sufficient reliable data concerning habits of this kind which will lend themselves readily to statistical analysis. It is necessary, therefore, to confine a discussion of personal habits largely to habits of eating and drinking. During an examination of the individual, therefore, data were collected with reference to the use of milk, tea, coffee, tobacco, and intoxicating liquors. Data collected concerning these matters and the rates of plumbism for those accustomed or addicted to the use of these various articles are shown in Table L.

TABLE L.—*Plumbism according to certain personal habits of the workers, by sexes.*

Personal habits.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
Drink milk:						
Male	21	19	18	249	6.8	13.0
Female	....	1	5	31	0.0	3.1
Drink tea:						
Male	56	32	49	417	10.1	15.9
Female	4	9	15	74	3.9	12.8
Drink coffee:						
Male	92	68	104	788	8.5	15.2
Female	11	23	29	206	4.1	12.7
Chew tobacco:						
Male	44	33	43	412	8.3	14.3
Female	....	....	1	1	0.0	0.0
Smoke:						
Male	63	48	85	647	7.5	15.2
Female	1	....	1	....	50.0	50.0
Use liquors to excess:						
Male	15	3	8	79	14.3	17.1
Female	....	1	4	7	0.0	8.3
Drink tea and coffee:						
Male	50	32	45	353	10.4	17.1
Female	3	7	9	58	3.9	13.0
Chew and smoke:						
Male	28	20	28	245	8.7	15.0
Female	0	0	0	0	0.0	0.0
Use tobacco to excess:						
Male	34	19	25	252	10.3	13.0
Female	0	0	0	0	0.0	0.0
Drink tea or coffee and chew or smoke and use liquors: Male	45	23	48	360	9.4	14.3
Actual rates:						
Male	....	....	....	....	8.8	14.2
Female	....	....	....	....	3.5	11.0

This table shows us that the rate of plumbism for those who drink milk is somewhat lower than it is for those who drink tea. For those who drink coffee it is somewhat higher than the rate for the whole group. For those who drink liquors to excess the rate is considerably higher than it is for the whole group. For those who drink both tea and coffee the rate for both sexes is considerably higher. For those who drink tea or coffee and who either chew or smoke and who use liquors the rate is slightly higher than it is for the whole group. It seems, therefore, that these figures indicate that the use of milk is a deterrent. Tea, coffee, tobacco, and liquors, especially when used to excess, tend to increase the rate of lead poisoning. The milk drinkers seem to distribute themselves quite normally among the age groups, periods of exposure, and occupations as far as both sexes are concerned.

A further analysis is made of the tea drinkers in order to find whether the increased rate noted among the men and women who drink tea might be due to some other factors. The men who belong to this group are distributed rather evenly throughout the various occupations, so that no increased rate may be expected because of their following more hazardous occupations. They are, however, slightly older than the average of the whole group of men working in the potteries, so that an expected rate of 9.1 is found, because of their distribution among the various age groups. They have been exposed to lead hazards somewhat longer than the average male potter so that an expected rate of 9.9 would result because of this factor. As far as these two factors are concerned, they seem to account for the higher rate of positive plumbism—namely, 10.1—among the male tea drinkers.

It is found that the women who drink tea are in less hazardous occupations, and that they are underaged and underexposed, as compared with the whole group of women. All these factors would tend to decrease materially the rate of plumbism in this group, so that unless there are other factors, it would appear that the women workers who drink tea have a higher rate of plumbism than might be expected of them. We are not able to tell how much of the tea drinking is due to a desire upon the part of the victims to rid themselves of a metallic taste resulting from lead poisoning, and therefore whether it is an effect rather than a cause.

A further analysis of the excessive users of tobacco is made in order to find whether the increased rate of plumbism noted among this group may be due to some other factors. They are distributed through the various age groups rather normally, so that the expected rate of plumbism on account of age is not increased. They have a normal distribution among the various occupations, so that the increased rate is not due to occupational hazards. In the matter of years of exposure they are slightly overexposed as compared with the whole group of male workers, so that an expected rate of 9.4 would result because of length of exposure. As far as other causative factors are concerned, those affecting the men who use tobacco to excess seem to be about normal.

Although we are not able to make a definite statement in regard to the effect of tea upon plumbism, our analysis seems to enable us to say that the higher rate of plumbism for those using tobacco to excess, as shown in Table L, can not be charged to age, length of exposure, or additional occupational hazard. Our results fail to confirm the contention that the use of tobacco tends to allay lead poisoning.

In analyzing the group known as "those using liquors to excess" we find that they are slightly overaged, so that an expected rate of 9.9 would result, because of their distribution among the various age groups. They are also slightly overexposed, so that a rate 9.6 might be expected, due to their length of exposure. In analyzing their distribution among the various occupations it appears that they are in slightly more hazardous occupations than the average male in the whole group examined in this survey. An expected occupational rate of 9.5 would result, due to their distribution among the various occupations.

With respect to the analysis of the smokers, it is found that they are slightly underaged, that they have about a normal distribution among the occupations, and they are slightly overexposed as compared with the whole group of male workers included in this report. These three factors perhaps balance each other, so that the smoking group may be considered normal as far as these influencing factors are concerned.

TRADE HAZARDS.

INQUIRY INTO THE EFFECT OF SOLUBLE LEAD IN THE GLAZE.

Up to this point we have discussed plumbism mainly from the viewpoint of the individual and from his personal habits. We shall now inquire into the relation of plumbism with respect to the amount of soluble lead used in the various glazes examined. As we have stated before, we collected 107 samples of glaze from 87 plants. The amount of soluble lead in these glazes varies from 0.0 per cent to 45.70 per cent, and no leadless glazes were found.

Throughout this report we have referred to lead as the exciting cause of plumbism, and our purpose here is to discover whether a larger amount of lead in the glaze has a tendency to cause a higher rate of plumbism. Table LI shows the distribution of cases of lead poisoning according to the diagnosis among plants having a per cent of soluble lead of less than 12 and among those having 12 per cent or over of soluble lead. This point of division is selected because it divides the modal group in Table XVII, where it is shown that 65 plants have from 10 per cent to 14 per cent of soluble lead in their glaze.

TABLE LI.—*Plumbism according to the amount of soluble lead used in the glaze.*

Per cent of soluble lead.	Number of plants.	Sex.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism. Positive.	Rate of plumbism. Positive and presumptive.
12	60	M.	104	70	102	714	10.5	17.6
		F.	12	26	31	188	4.7	14.8
0-11.9	27	M.	21	7	24	357	5.1	6.8
		F.	1	2	6	102	.9	2.7
No report	5	M.	1	1	3	32	2.7	5.4
		F.	0	0	2	3	.0	.0
Total	92	M.	126	78	129	1,103	8.8	14.2
		F.	13	28	39	293	3.5	11.0

A survey of this table brings out the fact that the 60 plants having over 12 per cent of soluble lead in the glaze have a rate of positive plumbism of 10.5 among the men and 4.7 among the women. Those plants having less than 12 per cent of soluble lead in the glaze have a rate of positive plumbism of 5.1 among the men and of 0.9 among the women. The five plants which failed to furnish sample of the glaze have a rate of 2.7 per cent of positive lead cases among the men and none among the women. If we combine positive and presumptive cases, we get a rate of 17.6 for the men and 14.8 for the women where the glaze contains over 12 per cent of soluble lead, and 6.8 for the men and 2.7 for the women where it contains a less amount of soluble lead. In analyzing the differences between these two groups, the one working in glaze containing 12 per cent and over of lead and the other working in glaze containing less, we find about the normal distribution for both sexes as far as occupation is concerned. However, both the men and the women are about two years underaged and about one year underexposed in the plants having the higher per cent of soluble lead in the glaze. This would tend to increase by a slight amount the difference shown in Table LI.

Further analysis by using more than two classes of the per cent of soluble lead in glaze shows that there is not a direct correlation between the amount of soluble lead used and the rate of plumbism. In fact, some of the plants have a very high per cent of soluble lead in glaze and a reasonably low per cent of plumbism. There are so many factors affecting plumbism that a further analysis of conditions is necessary. This will be discussed under plant hygiene. Under similar conditions, however, we may expect lead poisoning to decrease as the soluble lead content of the glaze decreases and to disappear entirely if leadless glazes are used.

PLUMBISM BY WARES.

In Table XX the cases of plumbism are enumerated under the various kinds of ware manufactured by those potteries coming under our survey. In Table LII we have a summary of the cases of lead poisoning according to diagnosis distributed among the various wares which are being manufactured. Since there are very few plants manufacturing yellow ware, art ware, and tile, these are included together, so that we have in this table the headings "General Ware," "Sanitary Ware," and "Others."

TABLE LII.—*Plumbism by ware, sex, and diagnosis.*

Ware.	Men.				Women.				Rate of plumbism.	
	Positive.	Presumptive.	Suggestive.	Negative.	Positive.	Presumptive.	Suggestive.	Negative.	Positive.	Positive and presumptive.
General	101	60	103	737	13	26	32	246	8.6	15.2
Sanitary	20	12	19	238	0	2	1	8	6.8	11.6
Others	5	6	7	128	0	0	6	39	2.6	5.8
Total	126	78	129	1,103	13	28	39	293	7.7	13.5

It will be observed that the rate of positive plumbism for general ware is highest, being 8.6 per cent; that sanitary ware comes next, with a rate of 6.8 per cent; and the other ware is lowest, with a rate of 2.6 per cent. These rates do not follow the rates worked out in Table LI for the amount of soluble lead in the glaze, inasmuch as plants under the heading "Others" usually have a rather high per cent of lead in the glaze samples which they gave us for analysis. It is claimed by the chemists of these plants that for certain types of ware a glaze with a low content of lead is in use. There are also certain factors of plant hygiene which we shall consider later and which enter as factors in determining rates of plumbism. The general ware plants have a number of unhygienic conditions not found in the other groups. It is found that the general ware plants and the sanitary ware plants have age and length of exposure conditions slightly above normal, while those in the other group are about three years underexposed and four years underaged. These other factors help us to account for a large part of the differences in the rates of plumbism noted in these two groups.

SIZE OF PLANT.

Table LIII shows by sexes and by diagnosis the number and the rate of lead cases according to the size of the plant.

TABLE LIII.—*Rates of plumbism according to size of plant.*

Size (employees).	Men.				Women.				Rate of positive plumbism.	
	Positive.	Presumptive.	Suggestive.	Negative.	Positive.	Presumptive.	Suggestive.	Negative.	Men.	Women.
0-50	1	2	3	29	0	0	2	2	2.9	0.0
51-100	5	7	6	89	2	1	2	6	4.7	18.2
101-250	43	40	53	597	6	10	20	160	5.9	3.1
251-500	38	18	48	262	2	8	9	68	10.4	2.3
501	39	11	19	126	3	9	6	57	20.0	4.0
Total	126	78	129	1,103	13	28	39	293	8.8	3.5

We observe that plants having 50 or less employees have a rate of 2.9 of positive plumbism for men. It is stated by the chemists of these plants that for certain types of ware a glaze with a low content of lead is in use. Plants having between 51 and 100 employees have a rate of 4.7 positive plumbism, those employing 101 to 250 persons have a rate of 5.9 per cent, those employing between 250 and 500 have a rate of 10.4 per cent, and those employing more than 500 have a rate of 20.0. Corresponding rates for women workers are 0.0 per cent, 18.2, 3.1, 2.3, and 4.0 per cent. The rates for men for both positive and presumptive plumbism are 8.6, 11.2, 11.3, 15.3, 25.6, and for women they are 0.0, 27.3, 8.2, 11.5, and 16.0. With the exception of plants having from 51 to 100 employees, there is among both sexes a gradual increase in positive and presumptive plumbism, and among the men in positive plumbism as the size of the plant increases. The small number of women in both the lower groups of plants give unreliable rates as only four women were examined in plants of 50 or less employees, and only 11 in plants having from 51 to 100 employees. With these exceptions it may be stated in a general way that the larger plant has a greater per cent of lead poisoning.

The sex distribution is given in the above table. The age and occupational distributions are about normal for each group. It might be supposed that the larger plants retain their employees for a greater number of years and on this account plumbism accumulates there. It might be stated here that the average length of exposure in the small group of plants is 10.1 years and in the next larger it is 11.3, then 9.4 years, 8.8 years, and in the larger group of plants 10.9 years. It seems, therefore, that as far as length of service is concerned, no credit is to be given to larger plants because of greater years of exposure. However, a greater actual exposure may be obtained in the same length of time in a large plant than may be obtained in a small plant.

For example, the glaze mixer in a small plant is usually exposed to the lead hazard for no more than two or three hours per day, whereas in the larger plant he may be exposed to lead continually. In one small plant with less than 100 employees the glaze mixing is done once a week normally, but at the time of the survey mixing was being done every three weeks. The mixing process occupies about an hour. In another small plant glaze mixing occupies about one hour per week. In a third small plant the process of mixing dry materials occupies about one hour twice a week and during the operation the glaze mixer spends probably half of the time in the room. The handling of the dry lead occupies no more than five or ten minutes of each glaze-mixing period, so that the mixer is not exposed to the dry lead dust to exceed 20 minutes in a week. In several small plants the average number of mixtures of glaze per week is about five, and the length of time of mixing varies from 20 to 40 minutes. In the larger plants, however, the glaze mixer works full time, the hours of actual exposure varying from 15 to 42 per week.

Likewise the dipper in the small plant has a less actual exposure than he has in the large plant. In one small plant the dipper carries in the bisque ware, and during that time does not come in contact with lead; in another the dipper is actually dipping about three days per week, and in another there are two dippers on part time. In a fourth the dipper is obliged to work at a different occupation part of the time, because there is not enough work at that pottery to keep him busy at his particular trade. In the larger plants the dipper has little opportunity to get away from the lead hazard. The glost-kiln placer in the small plant often works half of the time in the bisque kiln, where no lead hazard exists. In the larger plant he is kept busy setting ware, in an atmosphere of lead dust. What is true concerning the exposure in these occupations is also true, in a great measure, in all other hazardous occupations in the pottery industry.

The significance of this distribution of cases of plumbism according to size of plant has already been referred to. In a previous section we showed the advantage of size of plant with respect to the installation of sanitary facilities. The recommendations which we shall give under section V will cover these points carefully. There is another cause operating against conditions in the larger plants which will be taken up more fully under the discussion of plant hygiene. This has to do with the responsibility of cleaning up the various rooms of the plant and with keeping certain sanitary conditions in operation under the prevailing system of piecework.

PLANT HYGIENE.

In the previous pages of this section we have discussed those factors which have to do with the worker and his personal habits, and we have concluded with a discussion of plumbism with respect to the amount of lead used in the glaze, with the rates of plumbism among the different wares manufactured, and with respect to the size of the plant. With the exception of these three latter points, our attempt has been to include only those factors over which the employer has little or no control.

Hygienic conditions in the potteries have already been discussed in a previous section, and certain tables have been presented to show what conditions were found and what desirable facilities and conditions were absent in these several plants coming within the scope of our survey. We will attempt now to deal more particularly with those conditions in the plant over which the employer may be expected to have control and for which he should be held responsible. Our first study is an attempt to find whether a combination of bad conditions with respect to air dustiness, personal facilities, toilets, and certain hazards appears to be responsible for high rates of lead poisoning. If so, plumbism will then be studied with respect to dust and the various conditions which would tend to create dust and which would be recognized as factors in making dust a hazard in the incidence of plumbism.

Personal facilities will be discussed later, such as the provision of proper drinking vessels and water containers; provision of a place to eat lunches; washing facilities; provision of soap and towels; provision of special clothing; furnishing of lockers and of bathing facilities, and the matter of keeping the workers instructed in the dangers arising from the use of lead.

We shall also discuss the toilet provisions, together with their adequacy and availability and sanitation, and the connection which these various plants have with proper sewage disposal. We shall also discuss certain hazards, including those of cold, heat, moisture, and fatigue, and shall show the rates of plumbism as affected by all the foregoing conditions, as well as by the pieceworking method in use in certain plants.

Briefly stated, it is the purpose to show here what effect these conditions may have upon the health of the worker, especially with reference to his having lead poisoning. The per cent of plumbism will be shown in plants where sanitary conditions are considered poor as compared with those where sanitary conditions are satisfactory. Plumbism will be related to as many of these conditions as possible, in order to determine, if at all feasible, whether any of the incidence of plumbism may be attributed to plant conditions. An attempt will be made so far as possible to analyze these conditions with respect to each other and with respect to matters of age, exposure, and occupation as set forth in the previous pages.

An attempt is made to combine the effects of several of these plant conditions by taking 10 of those considered most prominent. These include dirty ware boards, splash and spill of glaze, dry sweeping, sweeping during working hours, poor ventilation, poor illumination—all these having to do with air dustiness—bad toilets, and such personal facilities as open water pails, eating in the workrooms, and poor washing facilities. Eight plants are found with as many as eight of these ten conditions. The 162 persons examined in these eight plants have a rate of positive plumbism of 18.5 per cent and a positive and presumptive rate of 34 per cent. Twenty-nine plants are found with not more than three of these conditions, where the 489 persons examined have a rate of positive plumbism of 3.3 per cent and a positive and presumptive rate of 6.3 per cent. Personal factors do not change these rates materially. There are many other unhygienic plant conditions, although perhaps of minor importance, which have not been eliminated, so that the whole difference in these rates may not properly be charged to the conditions enumerated above. It is perhaps sufficient to note that the difference in these rates may be expected to be greatly reduced by an elimination of these unsatisfactory conditions of plant hygiene.

Chart 7 shows in graphic manner the relation of positive plumbism in 92 plants with the incidence of the 10 conditions enumerated above. In this figure the 92 plants are arrayed from that having the highest rate of positive plumbism at the left of the figure to those with no positive plumbism at the right of the figure. Those plants with no positive plumbism are arrayed according to the number of unhygienic conditions. The curve showing the number of unhygienic conditions is smoothed by a moving average. These curves run surprisingly close together.

If the foregoing analysis indicates, as it seems to do, a higher rate of plumbism in plants where there is a larger number of insanitary conditions, then, in all probability, these single conditions may share in the series of rates showing the incidence of lead poisoning. On the other hand, certain factors which have been included may be given undue weight. Further analysis, then, becomes necessary in order to estimate relative values of single factors. Even then caution must be exercised in accepting these rates as final, because it must be

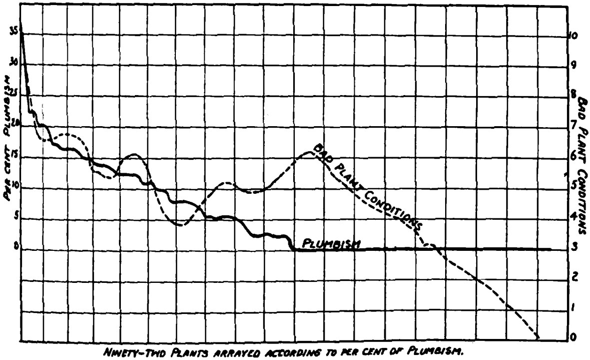

CHART 7.—Comparison of per cent of positive plumbism in potteries with 10 plant hygiene conditions.

remembered the limitations of this survey do not permit that refinement of analysis which can segregate a single factor from all others to the extent that we have its individual weight uninfluenced by the presence of other factors. The best that such analysis as we are able to use can show is that our series of rates of plumbism is about constant as we separate or combine for effect of unhygienic conditions.

AIR DUSTINESS.

In considering air dustiness there are several factors which need separate attention. First there are sources of dust, which include lack of cleanliness of ware board, splash and spill of glaze, and open glaze containers. Then there are factors which have to do with stirring up dust so that it becomes suspended in the air, where it is breathed into the lungs of the workers. These include dry sweeping and sweeping during work hours or while workers are present. Lack of respirators, poor ventilation, and poor illumination all have to do with the prevention of dust hazards and need consideration, as well as does the dust content, both with respect to number of particles in the air and the amount of soluble lead.

We first attempt to find whether air dustiness, including all the factors enumerated above, has an effect in producing high rates of plumbism, and if so, to determine later whether any part of such rates may be charged to a single factor.

In trying for an estimate of the effect of the nine factors enumerated which have to do with the source and amount and lead content of dust in these potteries, certain difficulties arise. The first difficulty is that no plant is found which has none of these factors, and only one plant is found which has them all. By taking plants with an amount of dust exceeding 200,000 particles per cubic foot and those with ware boards creating sufficient dust to cause annoyance or complaint and those plants with considerable splash and spill and in which dry sweeping is practiced, we get a group where approximately 200 persons were examined for lead poisoning in which the rate of positive plumbism is found to be 12.0. The positive and presumptive rate is 23.9. An analysis of this group shows us that the workers are slightly overaged and slightly overexposed as compared with all the potters, but engaged in slightly less hazardous occupations. That is, there are fewer dippers and fewer glaze mixers than would be expected in a group as large as this. The sex distribution is about equal. It seems, therefore, as far as personal factors other than personal hygiene are concerned, that they do not play a large part in this high rate of plumbism.

If we consider a group of plants having no more than one of the four conditions mentioned above and some of the other five conditions enumerated, we get a rate of positive plumbism of 1.1 and a positive and presumptive rate of 3.1 in a group of approximately 350 examinees where the occupational rate is normal and where the age and exposure rates are slightly under the average for the whole group of potters and where the sex distribution is about normal. This would tend to increase slightly the positive rate of 1.1 as found for this group. If we select a group of plants in which the dust count is less than 200,000 particles per cubic foot, in which the ware boards are kept clean, and concerning which no complaint is made in regard to dustiness from them, where the floors are well watered before they are swept, and where the conditions about the dipping tub are clean, but where some other dust factors exist, we get a rate of positive plumbism of 0.8, and a positive and presumptive rate of 2.3, out of about 130 persons examined. An analysis of this group shows that they are of average age, slightly underexposed as far as length of exposure

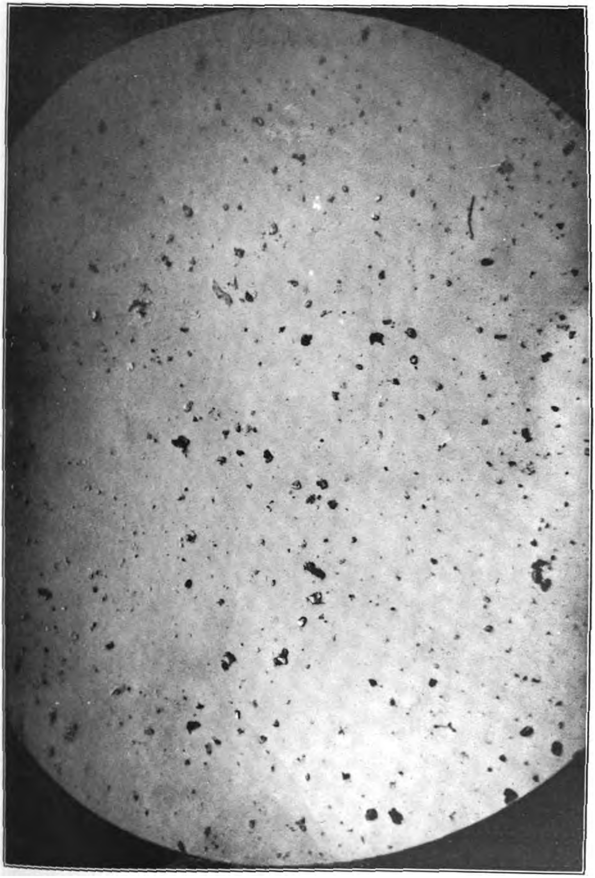

FIG. 47.—DUST SAMPLE.

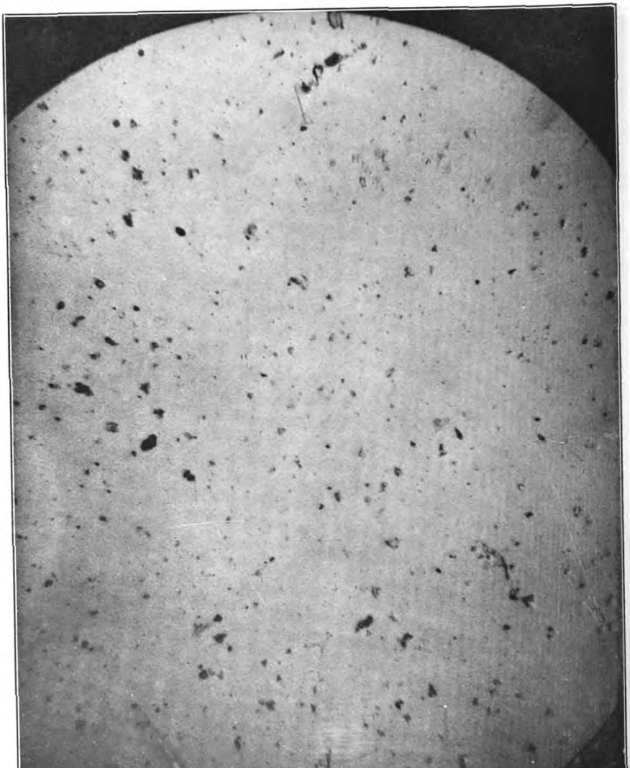

FIG. 48.—DUST SAMPLE.

is concerned, in slightly more hazardous occupations, and of normal sex distribution. It does not appear that personal factors would change this rate materially. We are not able at this point entirely to eliminate the effect of bad toilet conditions and lack of personal facilities, and thus to isolate air dustiness and to say that the differences in rates is to be charged to conditions of air dustiness alone.

Of course, it is to be remembered that these groups are small, but they are as large as it is possible to select and yet have the groups well defined as far as different elements of dustiness are concerned. It should be noted also that we have not as yet presented data with reference to the effect of other conditions of plant hygiene, including toilet facilities and other hazards studied in connection with this report. It would appear, however, that if these latter factors do not affect to any great extent the rates shown in this summary, dustiness plays a rather large part in the amount of plumbism in such a way that where there is a large amount of dust carrying a sizable lead content the rate of plumbism is sufficiently oversized to make it worth while for plant managers to expend time and money in the elimination of dust hazards and to induce the employee to be especially careful about his work, so that as little dust as possible may be stirred up where it can be breathed and ingested.

Having seen that rates of plumbism are high where groups of these factors concerning air dustiness are present, we will now try to find what effect single factors seem to have in making differences in rates. Our first analysis is concerning the dust itself, with respect to its content both as to number of particles and as to soluble lead.

DUST COUNT.

Several dust samples were collected from each plant included in this study. However, some samples were spoiled or broken in shipment, so that we have records for 66 plants. The distribution of these plants is about normal for the whole group, so that results obtained from a study of samples collected from these plants should be indicative of the results of the whole group of plants.

Table XIX gives the distribution of the potteries by rooms, according to the number of particles of dust, and according to the amount of lead in each cubic foot of air. Appendix E gives in detail the results of the examination of 346 samples taken during the course of the survey. It is our purpose here to analyze these figures and to discover, if possible, what effect the amount of dust and the per cent of soluble lead in the dust have upon the lead poisoning of the workers.

Table LIV shows the relation between dust count and lead poisoning by rooms. Under "Dipping room" are included all employees who are stationed for a greater part of the time in the dipping room, where these dust samples were taken. This includes dippers, dippers' helpers, very frequently ware cleaners, and sometimes ware carriers also. Under the "Glost-kiln room" are included glost-kiln placers, sagger washers (provided they were placed in the kiln room), oddmen (if it was found that they spent the greater part of their time in this room), and any others whose place of work in any particular plant seemed to be in the glost-kiln room. Those included under "Glaze-mixing room" are glaze mixers, glaze sifters, and glaze foremen, if their particular occupation seems to be in the glaze-mixing room.

TABLE LIV.—*Dust count and positive and presumptive plumbism, by rooms.*

	Absolute.						Per cent plumbism.		
	Under 200,000.[1]		200,000–500,000.[1]		500,000 up.[1]				
	Number of cases of plumbism.	Number examined.	Number of cases of plumbism.	Number examined.	Number of cases of plumbism.	Number examined.	Under 200,000.[1]	200,000–500,000.[1]	Over 500,000.[1]
Dipping room	7	100	37	217	40	229	7.0	17.1	17.4
Glost-kiln room	7	65	7	142	45	403	10.8	5.0	11.2
Glaze-mixing room	3	10	2	6	7	24	30.0	33.3	29.2
Total	17	175	46	365	92	656	9.7	12.6	13.9

[1] Number of particles of dust in 1 cubic foot of air.

Reference to this table shows that seven cases of positive and presumptive lead poisoning are found out of 100 of those examined who work in dipping rooms where the dust samples show less than 200,000 particles of 10 microns or under to each cubic foot of air. Thirty-seven cases are found out of 217 examined where the air dustiness amounts to between 200,000 and 500,000 particles of dust per cubic foot of air. Where there are over 500,000 particles of dust per cubic foot in the dipping room, 40 cases of positive and presumptive lead poisoning are found out of 229 examined. This gives a rate of positive and presumptive plumbism of 7.0 per cent of those in the dipping room, where the dust count is less than 200,000, of 17.1 where the dust count is over 200,000 and less than 500,000, and 17.4 where the dust count is over one-half million.

In the glost-kiln rooms the corresponding rates are 10.8, 5.0, and 11.2 per cent. In the glaze-mixing rooms the corresponding rates are 30.0 33.3, and 29.2 per cent. In the combined rooms where the dust count is less than 200,000, 17 cases of positive and presumptive lead poisoning are found out of 175 examined—which is a rate of 9.7 per cent. Where the dust count is between 200,000 and 500,000, 46 cases of positive and presumptive lead poisoning are found out of 365 examined, which gives a rate of 12.6 per cent. Where the dust count is above 500,000 particles per cubic foot, 92 cases are found out of a total of 656 examined, which gives a still higher rate of positive and presumptive plumbism—13.9. The positive and presumptive rates are 9.7, 12.6, and 13.9.

SOLUBLE LEAD IN DUST.

Table LV gives the rate of positive and presumptive lead poisoning according to the amount of soluble lead in the dust. This covers the same samples and the same rooms as those included in Table LIV. The comparisons are made for dust containing less than 5 per cent of lead, for that containing above 5 per cent and less than 10 per cent, and for that containing over 10 per cent.

TABLE LV.—*Positive and presumptive lead poisoning according to amount of soluble lead in dust.*

	Per cent of soluble lead.						Rate.		
	0-4.9.		5-9.0.		10+.		0-4.9.	5-9.9.	10+.
	Number of cases of plumbism.	Number examined.	Number of cases of plumbism.	Number examined.	Number of cases of plumbism.	Number examined.	Per cent plumbism.	Per cent plumbism.	Per cent plumbism.
Dipping-room......	17	107	21	185	45	268	15.9	11.4	16.8
Glost-kiln room.....	32	273	25	157	20	193	11.7	15.9	10.4
Glaze-mixing room..	2	11	2	11	10	21	18.2	18.2	47.6
Total.........	51	391	48	353	75	482	13.0	13.6	15.6

In the dipping room 17 cases of positive and presumptive lead poisoning are found out of a total of 107 persons examined where the amount of lead in the dust is found by our analysis to be less than 5 per cent. Twenty-one cases of positive and presumptive lead poisoning are found out of 185 examined in the dipping room where the per cent of lead in the dust samples varies between 5 and 10 per cent; and 45 cases of positive and presumptive lead poisoning are found out of 268 examinations where the dust in the dipping room has 10 per cent and over of lead. The corresponding rates of positive and presumptive plumbism are 15.9, 11.4, and 16.8 per cent. In the glost-kiln room these rates are 11.7, 15.9, and 10.4 per cent. In the glaze-mixing room they are 18.2, 18.2, and 47.6 per cent. This gives a total of 51 cases of positive and presumptive lead poisoning out of 391 examinations where there is a smaller amount of lead in the dust, 48 cases out of 353 of the next class, and 75 cases out of 482 examinations where there is a greater amount of lead in the dust. The rates of positive and presumptive plumbism for these three different amounts of lead in the dust are 13.0, 13.6, and 15.6 per cent, respectively.

While these rates may not increase in all rooms as the number of dust particles increases nor as the per cent of lead in the dust increases, partly on account of an insufficient number of cases and partly on account of other hygienic factors which we have not yet analyzed, yet the totals do. An attempt to analyze these various groups according to age, length of exposure, and occupation shows that they are about normal with the whole group, and therefore with each other, so that differences are not produced by these three factors. In those rooms where the dust count is less than 200,000 particles per cubic foot and where the per cent of soluble lead in the dust is less than 5, the rate of positive lead poisoning is about one-third as high as it is in the rooms where the dust count is over 500,000 particles and the per cent of soluble lead in the dust over 10. It is evident, therefore, that amount of dust and amount of soluble lead in the dust are contributing factors, and any attempt to eliminate dust should result finally in a reduced number of cases of lead poisoning. A more explicit statement and a further attempt to analyze results is reserved until we have made a study of the various other factors having to do with dustiness such as have been enumerated in the beginning of this section on "Plant hygiene."

WARE BOARDS.

We have already furnished information in regard to the cleanliness of ware boards as we found them during our survey. In some plants these boards are not cleaned and give rise to considerable dust when they become dry, so much that the workers complain about them. Table LVI, given below, shows the rates of plumbism according to cleanliness of the boards upon which the ware is carried from the dipping tubs.

TABLE LVI.—*Plumbism with respect to cleanliness of ware boards.*

Condition.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
Clean	45	41	90	673	5.3	10.1
Fair	5	6	3	79	5.4	11.8
Dirty	78	59	63	481	11.4	20.1
Total	128	106	156	1,233	7.9	14.4

Where the ware boards are kept reasonably clean, the rate of positive plumbism is 5.3 per cent; where the condition of the ware boards is fair, the rate of positive plumbism is 5.4; and where they are never cleaned or are dirty enough to be complained about, the rate of positive plumbism is 11.4. The positive and presumptive rates are 10.1, 11.8, and 20.1.

The groups included in Table LVI are analyzed carefully and are found to have a regular and normal distribution as far as age groups, periods of exposure, occupations, and sexes are concerned, so that these factors should not produce any variations in the rates given.

Again, we find higher rates where hygienic conditions are not observed. To just what extent dirty ware boards are responsible for higher rates is of course not possible to measure. Undue weight can not be given to this or to any other single factor as long as it is associated with other factors that can not entirely be eliminated from a partial share in the results. It is safe, however, to conclude that proper cleanliness would result in less dust and in fewer causes for high rates of plumbism.

SPLASH AND SPILL.

In some plants a noticeable amount of glaze is found to be splashed about the dipping tub during the process of dipping and during the process of filling the tubs with glaze. When the splash or spill of glaze is allowed to dry, it gives rise to considerable dust which affects possibly all dippers, dippers' helpers, and ware carriers. In plants where carelessness of this kind seems to prevail, the rate of positive plumbism is found to be 8.6, as opposed to a rate of 6.1 in plants where more care is observed. The positive and presumptive rates are 15.0 and 11.1. An analysis of these two groups shows that there are little differences as far as personal factors are concerned. The difference in rates is sufficient to classify splash and spill as contributing factors in plumbism.

DRY SWEEPING AND SWEEPING DURING WORKING HOURS.

In plants where dry sweeping seems to prevail and where the amount of water used is insufficient to lay the dust a rate of positive plumbism of 9.7 is found. In the other plants the rate of plumbism is 6.9. The positive and presumptive rates are 15.8 and 12.7 per cent. The two groups in these plants are about normal, with the exception that there are a large number of kiln men in the rooms where dry sweeping is practiced. As the rate of plumbism for this occupation is a little below that of all males examined, the elimination of this factor would tend to increase the rate of plumbism where dry sweeping is practiced. There is a smaller proportion of women in these plants, at least in the rooms where dry sweeping is done, sufficient to offset the occupational differences noted due to an excess of kiln placers.

In plants where sweeping is permitted during work hours the rate of plumbism is found to be 8.6, as opposed to 6.6 in those plants in which the time of sweeping is delayed until the workers have left the building. The positive and presumptive rates are 15.7 and 10.9. As women usually leave from a half hour to an hour earlier than the men, they are seldom present when sweeping is going on. Moreover, very few women are employed in the kiln rooms, where sweeping needs to be done during the work period, so that sex does not appear here as a factor. The age and exposure factors appear to be about the same in these two groups. The occupational differences are slight, with the exception that a few more kiln men work where sweeping is done during the work hours, which would tend to increase slightly the differences between the rates given for these two groups.

It thus appears that the method and the time of sweeping, where dust is involved, contribute toward an increase in lead poisoning. The exact effect is not of necessity shown by differences in rates, nor can we estimate with any degree of exactitude how much smaller the number of cases of lead poisoning would have been had the sweeping been done in a satisfactory way. We must content ourselves with saying that it would have been less.

ILLUMINATION AND VENTILATION.

We have already discussed the adequacy of these two factors in our description of plant conditions. Ventilation is included with dustiness, because by means of proper ventilation a great deal of the dusty air of the work rooms can be removed. Without adequate artificial ventilation dust remains in these rooms, to be stirred up day by day, so that the worker is continually breathing air in which dust has accumulated for some time. Illumination is included in connection with these other factors because poor illumination prevents the worker from seeing the dustiness of the air, so that he is not able to detect its presence because of poor lighting. Moreover, for a like reason, he is not able to judge when the room is clean. Approximately half of the employees work in poorly lighted rooms. The rate of positive plumbism among this group is 10.8. The positive and presumptive rate is 19.4. We find upon examination that the group is about normal with respect to age, length of exposure, occupation, and sex. About one-fourth of the whole group is working where the ventilation is unsatisfactory. The rate of plumbism in this group is 12.1. The positive and presumptive rate is 24.0. This group, upon examination, is found to be distributed normally among the various age groups, periods of exposure, occupations, and sexes. Where either or both of these factors exist, there are quite a number of the conditions referred to in this section under the head of "Dustiness," so that it is not possible to get a group of sufficient size where the illumination is bad and another of sufficient size where the illumination is good, but where the previously enumerated factors regarding the dustiness are alike. The same is true in getting together a group where ventilation is good and another where it is bad. There seems to be no doubt, however, that bad ventilation and poor illumination are factors needing attention if we wish to reduce plumbism.

OTHER DUST FACTORS.

The use of open glaze containers in the glaze-mixing rooms and the lack of respirators were taken up in combination with all dust factors, so that rates will not be given here showing plumbism for the presence or absence of these two items.

GENERAL SUMMARY REGARDING THE EFFECT OF DUSTINESS.

We have now analyzed for the effect of dust count and dust content, for conditions of ware board and for splash and spill, for dry sweeping, and for sweeping during work hours, and finally for bad ventilation and for poor illumination. It is difficult to evaluate each of the items mentioned above in order to determine its degree of responsibility in the group of similar factors of alleged influence in causing plumbism. However, all these present about the same series of increasing rates of lead poisoning as unsatisfactory and undesirable conditions prevail. It is logical to conclude that individual factors share in the results shown for the group as a whole and that each is entitled to a share of attention when corrective measures are under consideration.

As we have previously said, we would not presume to postulate that these differences which our figures show in rates of plumbism indicate definitely the effect of these various phases of air dustiness. It is not possible to refine rates to the point where we can say the elimination of a given factor will reduce plumbism by a definite amount. It is an unassailable conclusion, however, that an elimination of these unhygienic conditions will in time bring a reduction in the amount of plumbism and a reduction sufficient to make an attempt at hygienic conditions worth while.

PLAN FACILITIES FOR EMPLOYEES.

We have shown before the presence and absence of certain facilities which contribute toward the welfare of the worker. These include the supply of drinking water, the manner in which it is kept available, the drinking facility, the rooms and other facilities for eating lunches, the washing facilities, the use of soap and towel, instructions in regard to hazards, the use of special clothing, of lockers, and of bathing facilities. This section takes up the discussion of those items which have to do with the individual with respect to drinking, eating, and keeping clean. We shall furnish rates of plumbism with respect to this group of items, in an attempt to show, if possible, what may be considered as contributing toward a higher rate of lead poisoning among the workers.

In trying to get an estimate of the effect of the nine factors which have to do with facilities furnished at the plants for the welfare of the employees the same difficulties arise as in getting an estimate of the effect of the factors concerning dustiness. No plant is found in which all these facilities are present, and only one plant is found in which they are entirely lacking. If, however, we consider the facility for providing drinking water, the facility by which water reaches the individual, the lunch-room facility, and the washing facility as being the most prominent ones, we are able to get 17 plants in which these items are considered as reasonably satisfactory. In these plants 271 workers were examined, who agree with those examined in the other 75 plants, as far as sex and occupational distribution is concerned, but who are slightly underaged and about two years underexposed as compared with this larger group. The rate of positive plumbism where these facilities are good is 2.6, as compared with 8.7 for the other group. The positive and presumptive rates are 7.7 and 14.6. It should be recognized that these differences in the rate of plumbism are not to be charged entirely to the presence or absence of good facilities, because the factors enumerated under "dustiness" also enter here in such a way that an adjustment of rates can not be made which would eliminate all factors other than personal facilities.

This means, then, that differences in rates between these two groups may be charged partly to differences in lengths of exposure, partly to differences in the adequacy of personal facilities, partly to conditions of dustiness, and partly to toilet and sewer conditions, which latter effect will be discussed later. However, our series of rates is of significance, and it is to be realized that personal facilities are factors worthy of consideration in an attempt to reduce the presence of lead poisoning among pottery employees.

Again we take up the separate items in the group in order to discover whether each of the various plant facilities has a responsibility of its own in determining the amount of lead poisoning. A discussion of each separate facility follows.

WATER CONTAINERS.

A record was made of the sources of supply of drinking water. In most plants city water is available, but in a very few cases the water has to be carried from wells, which in some instances are situated on the property of the plant, and in others upon adjacent property.

Some differences are found in the rates of plumbism with respect to the kind of vessel in which the drinking water is kept. In some plants there are taps, so that it is not necessary to have water kept in any kind of vessel. In other plants water needs to be carried into the workrooms and is kept sometimes in open pails, at other times in closed pails or bottles, and occasionally in some kind of cooler. An attempt is made in Table LVII to show the frequency of lead poisoning with respect to the method of keeping drinking water available for the workers as far as pails are concerned.

TABLE LVII.—*Plumbism with respect to method of keeping drinking water.*

	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
Covered pails	13	1	15	116	9.0	9.7
Open pails	81	54	98	666	9.0	15.0

Where covered pails are used, the rate of positive and presumptive plumbism is 9.7 per cent; where open pails are used, the rate is considerably higher, being 15.0 per cent. The positive rates are each 9.0 per cent. Occasionally the plants have taps, also some covered pails and some open pails, so that it is not possible completely to separate the groups of workers according to the method of keeping drinking water available.

An analysis of these groups shows that they have about the normal sex distribution and about the normal age distribution. Those using open pails are slightly underexposed as far as years of exposure are concerned. Those using covered pails are about normal with respect to length of exposure and to occupation, although it should be noted that they are few in numbers. With respect to occupation those in the group using open pails are distributed a little more heavily among the more hazardous occupations, about sufficient to balance the rate of exposure, so that the rate shown in Table XLII should be correct as far as these factors are concerned.

DRINKING CUPS.

An attempt, therefore, is made to show the rate of plumbism with respect to the types of drinking vessels. A very few plants furnish individual cups. In these the rate of positive plumbism is 7.4 per cent. Bubblers and other sanitary devices for drinking were found in a few places, in which the rate of positive plumbism is 6.0 per cent. In the majority of plants, however, involving over 80 per cent of the workers, common cups are in use, and in these plants the rate of positive plumbism is 7.9 per cent. Table LVIII shows these facts in a classified manner.

TABLE LVIII.—*Plumbism with respect to drinking facilities.*

	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
Individual cups	4	2	3	45	7.4	11.1
Bubblers, or fountains	11	2	11	160	6.0	7.1
Common cups	124	102	154	1,190	7.9	14.4
Total	139	106	168	1,396	7.7	13.5

Since most of the workers are included in the plants using common drinking cups the other groups are small, and it is difficult to analyze them with any degree of satisfaction. The few individuals comprising the small groups are distributed among such a variety of other factors that it is not possible to divide them in such a way that any good basis of comparison would result.

Again we wish to imply that differences in rates are not to be interpreted as chargeable entirely to drinking facility. Although the positive rate is 0.5 per cent higher and the positive and presumptive rate 3.3 per cent higher where common cups are in use, it is not to be presumed that their elimination would bring about a reduction in rates of plumbism by any amount shown in Table LVIII. There are other conditions of plant hygiene that need to be considered and which it may not be possible to eliminate so that the effect of a single factor may accurately be obtained.

LUNCH ROOMS.

We have already shown that about 1 plant in 12 has lunch-room facilities and that some of these rooms are poorly lighted and are not well cleaned, so that they may not be classed as good as far as usefulness is concerned. Some plants provide hot plates, so that the worker may have hot coffee, and this facility is frequently found upon his workbench. Thus while continuing his work he may have near at hand a hot drink, made perhaps in an open vessel, which he may drink from an open cup, into which dust can easily settle, so that with each drink he may be getting a small dose of lead. This facility, then, intended as a welfare provision may easily become a contributing factor toward lead poisoning.

We have shown previously the rate of plumbism for those who eat in the workrooms where lead is present. In a few instances eating in the workroom is forbidden by regulations, but frequently the regulations are not enforced. In some plants there seems to be no other place for the worker to eat, unless he takes the time to go home. The absence of proper lunch rooms no doubt brings about a great deal of the eating observed in the various workrooms of the plant. On account of the higher rate of plumbism noted among those who eat in the workrooms, it appears that absence of lunch rooms and eating places of proper type becomes a contributing factor to lead poisoning.

WASHING FACILITIES.

Investigation is made into the rates of plumbism for those plants having poor washing facilities and for those where the washing facilities seem to be satisfactory. In plants where the washing facilities are poor the rate of positive plumbism is found to be 8.7, while in the other plants it is 6.6. The positive and presumptive rates are 15.7 and 10.3. These two groups are about equal in size, each comprising approximately one-half of the total number of workers, with about the same sex distribution. There seem to be no marked differences in the occupational distribution, nor in that of age, nor in that of length of exposure. Those plants, however, which have poor washing facilities have also quite a number of other unhygienic conditions, so that as compared with those having better washing facilities the differences noted in the rates of plumbism given above can not all be charged to washing conditions. In addition to the poor facilities for washing there is usually a lack of soap and towels. In some plants the use of soap is not permitted in the facility furnished by the plant because the facilities are such that it is necessary to wash the hands in the same tubs where the ware boards are washed and because the glaze which settles in these tubs is collected and transferred to the dipping tub, to be used once more.

Further analysis of the group having poor washing facilities is impracticable because the hygienic conditions are so distributed that it is not possible to get two groups of plants similar in many respects, one group of which has good washing facilities and the other poor. It is perhaps sufficient to point out here that lack of proper washing facilities seems to assist in producing higher rates of plumbism.

OTHER PERSONAL FACILITIES.

Lack of special clothing for certain processes and lack of lockers and of bathing facilities prevail throughout most of the plants, but the lack is more generally noticed in those plants where the rate of plumbism is highest. Where special clothing is used, it is both necessary and possible for the worker to change from work clothes to street clothes at the end of the work period, for by so doing he does not carry a great amount of lead glaze and dust to his home. Where lockers are provided, it is possible to protect his street clothing from dust during the work period. Where lockers are of the double type, it is possible to keep street clothing in one section and work clothing in the other, and thus to take every precaution to keep street clothing clean and free from lead glaze. Where special clothing is furnished, with the double type of locker and in addition shower baths or some other bathing facilities, it is possible for the worker to leave the plant entirely clean and his dosage of lead ends when he leaves the plant. These facilities and combinations of facilities for cleanliness are so rare that the large majority of workers are compelled either to wear their work clothes to their homes or to change in the workroom, where their street clothing hangs all day and where their work clothing remains until the beginning of the next day's work. Lack of bathing facilities also renders the change of clothing less beneficial than it might otherwise be.

INSTRUCTIONS.

As we have pointed out before, instructions regarding the dangers of lead and the proper personal habits which should be observed and the other contributing factors that should be avoided are so seldom given in a methodical and effective way that the employees work under dangerous conditions because of either ignorance or unconcern. It seems to be taken for granted that the worker would either learn of the hazards from his fellow workmen or that he would not discover them at all. At any rate, lack of instruction seems to prevail where plant hygienic conditions are quite unsatisfactory and where rates of plumbism are high.

GENERAL SUMMARY OF THE EFFECT OF PLANT FACILITIES.

We now see why no item in the group of plant facilities can be discarded as having no responsibility in contributing toward higher rates of lead poisoning. It is not to be assumed that each item is to be considered as a contributing cause proportionate to the differences in rates shown between satisfactory and unsatisfactory conditions, but combined they show conditions that may certainly be responsible for lead poisoning. Objection may be raised that this difference in rates is a mere coincidence, and thus there might result a different interpretation. It is for this very reason that we analyze each group to find, if possible, whether differences in rates may be charged to other known factors. After elimination, or evaluation of these other factors, it is difficult to see where mere coincidence would enter often enough to reduce the reliability of our rates to any marked degree. Our attempt is always to discover contributing factors, if any exist, and then to point these out in such a way that other possible causes may not be overlooked, yet so to label those needing correction that factory workers and plant owners may be advised properly as to their hazardous effects.

As far as personal facilities are concerned, it is perhaps sufficient to note that facilities for eating, drinking, and keeping clean all show higher rates where conditions are not satisfactory, and they are therefore not free from responsibility as contributing factors; and that when unsatisfactory facilities are taken together there results an increase in the series of rates, as poor facilities become the rule rather than the exception. Our purpose in making rates for component parts and for the group as a whole is to strengthen the conclusion that such unhygienic conditions have an undoubted relation to the increase of lead poisoning in the plant.

TOILETS AND SEWERS.

Since constipation seems to be a prominent symptom of lead poisoning, it is suspected that toilet facilities and provisions for removal of toilet wastes need to be studied carefully in order to determine, if possible, whether conditions that promote the regular use of toilets have anything to do with the rates of plumbism found in this survey.

The majority of these potteries are situated in cities or near enough to the various city sewer systems to be connected with adequate methods of removing sewage. The number of employees in those plants not connected with sewer systems makes a comparison between plants having sewer systems and those having no systems rather unreliable.

Several conditions are necessary in order to define toilet conditions as good, fair, or bad. Among these are matters of sanitation, which have to do with cleanliness of the toilet rooms, good sewer connections, ample lighting, and proper ventilation. They need to be considered also as to whether they are adequate—that is, of a sanitary type—and whether there is a proper ratio of toilet facilities to the number of employees using them. Again there is the matter of availability, as to the distance of the toilet room from the worker, which is a point worth considering, as is the position of the room, especially with respect to whether it is on the same floor with the worker. It is also important to know whether the toilet building is outside so that the worker is exposed to the weather in going to and from such toilet. In other words, it is necessary to know whether the conditions of the toilets are such as to promote their regular use. If toilet rooms are unsanitary, poorly lighted, poorly ventilated, not flushed frequently; if the ratio of workers to each seat is too large; if these rooms are on the second floor or on the roof, as they sometimes are; if they are several hundred feet away from the usual position of the worker; if they are outside and the worker has to go out in all kinds of weather to reach them; or if there is no privacy about them, so that the seats are not in separate compartments;

such conditions, whether they exist singly or connectedly, do not promote a prompt and regular use by the pottery worker. This is especially true if he is working by the piece, and it is also true of the timeworker if his foreman works by the piece. All the above conditions were considered in deciding whether toilet conditions are good, fair, or bad, both by our workers in the field and by our own research workers in making up the following table:

TABLE LIX.—*Lead poisoning by diagnosis according to toilet conditions at plant.*

Condition.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
Good	17	13	44	434	3.5	5.9
Fair	37	18	36	331	8.8	13.0
Bad	85	75	88	631	9.7	18.2
Total	139	106	168	1,396	7.7	13.5

A study of this table shows us that where the toilet conditions are considered good the rate of positive plumbism is 3.5; where they are considered fair the rate is 8.8; while where toilet conditions are considered bad the rate is 9.7. The positive and presumptive rates are 5.9, 13.0, and 18.2. Combining good and fair toilets, we get a rate of 5.8 of positive plumbism and a rate of 9.1 of positive and presumptive, which rates are each about one-half of those for bad toilets. It should be stated also that frequently in a plant toilet conditions would be found good for some workers and bad for others, so that it is necessary to split up different groups of workers, either by sexes or occupations, as the case might be, in order to evaluate properly the results of toilet conditions.

An attempt is made to analyze the conditions affecting these two groups; namely, the group where the toilet conditions are considered bad and where the rate of positive plumbism is 9.7, and the group where the toilet conditions are considered reasonably satisfactory and where the rate of plumbism is 5.8. These groups are found to be about normal as far as sex and age distributions are concerned. In the matter of exposure the group using bad toilets is slightly underexposed as far as length of exposure is concerned and has slightly fewer occupational hazards, and therefore less intensity of exposure, although these two items are perhaps insufficient to add materially to the differences in the rates of plumbism.

It is hardly fair to charge the differences shown in Table LIX wholly to toilet conditions, because there are about the potteries so many other unhygienic conditions that contribute toward making up differences in rates of these two groups. Where bad toilet conditions are found, there are often some of the other contributing factors which we have already analyzed, so that even after the elimination or the evaluation of these other factors it is not possible to refine our rates to the point where we are able to say that elimination of bad toilets will decrease plumbism to the rates shown for good toilets, However, although we are not able to estimate the extent of such reduction, we are warranted in drawing a conclusion, which seems unassailable, that a reduction will occur in due time. The nearest approach we can get to the effect of bad toilets (to the exclusion of all other factors) is to group together as many plants as possible where other hygienic conditions are equal, one part of which group has good toilets and the other part bad toilets. When that is done. rates continue to be from two to three times as high for bad toilets as for good ones, as is shown in the discussion which follows. Our discussion in this paragraph is intended merely to caution the plant owner not to get the impression that merely overhauling or rebuilding the toilets about the plant and putting them in a condition that will promote their use would cut the rate of lead poisoning to one-half or one-third the former amount. We wish to show, since we find it to be true, that bad toilet conditions are factors which demand attention, and to impress our firm belief that if proper toilet facilities are furnished by the plants and if the workers will give due attention to the use and care of such toilets, one of the chief contributing factors of lead poisoning will be eliminated, and reduced rates of plumbism will result.

Twenty-eight plants are found in which the dustiness is considered to be the same throughout, if we take into consideration the chief factors producing dust—namely, dirty ware boards, dry sweeping, sweeping during work hours, splash and spill, and dust count. Fifteen of these plants have bad toilets. In the 15 plants having bad toilets the sex distribution, length of exposure, and distribution of employees among the various occupations are about normal. In these plants 229 people have a rate of positive plumbism of 8.7 and a rate of 14.4 for positive and presumptive plumbism. In the 13 plants where toilets are good the sex and age distribution are about normal. They are underexposed as far as length of exposure is concerned, but overexposed as far as distribution among the various occupations is concerned, these two factors about balancing each other; 203 persons have a rate of 1.9 for positive plumbism and of 3.9 for positive and presumptive plumbism.

Thirty-six plants are found where the personal facilities seem to be about equal throughout, if we consider the more important factors of places to eat, drinking-water systems, and washing facilities. Fifteen of these plants have bad toilets, and 21 of them have satisfactory toilets. In the 15 plants having bad toilets the sex, age, exposure, and occupational distribution is approximately normal with the whole group of workers examined. The rate of positive plumbism of the 328 persons examined here is 9.4, while the positive and presumptive rate is 19.0. In the 21 plants having good toilet systems the sex and age distributions are about normal. The workers are, however, slightly underexposed, but in slightly more hazardous occupations, the differences about balancing each other. The rate of positive plumbism of these 368 employees is 4.6 and that of positive and presumptive plumbism is 8.9.

In the above analysis we have in the one case eliminated as far as possible dust conditions, and in the other we have eliminated as far as practical the effect of absence of proper personal facilities, in which case the rate of positive plumbism for those groups having bad toilets is about 9 per cent, or a little less than that for all plants where bad toilets are found. Among these two groups where toilet conditions are considered good the rates are somewhat lower than they are in all the plants having good toilet conditions.

An attempt is made to analyze the situation further by selecting as many plants as possible where both the conditions of dustiness and the personal facilities are about equal. Eight such plants are found, four of which have bad toilets. The real test of the effect of bad toilets should be shown in an examination of groups of this kind; that is, in groups where plants are alike with the exception of the toilet conditions. It is not possible to find a group sufficiently large to make these rates reliable. The figures are given, however, as worthy of consideration.

In the four plants having bad toilets the age, sex, and exposure distribution is about normal for the whole group of workers. They are distributed in the occupations so that a slightly lower expected rate of plumbism would result because of occupation. The 40 persons examined in these four plants have a rate of positive plumbism of 15.0 and a positive and presumptive rate of 32.5.

Those examined in the four plants where toilet conditions are considered good have about normal sex, age, and occupational distribution. They are, however, about three years underexposed, sufficiently to cause a slight change in the expected rate of plumbism for the group. These 46 people have a rate of positive plumbism of 4.3 and positive and presumptive rate of 8.7. If we adjust this rate for underexposure, it would be perhaps 1 per cent higher. It will be noted here that the rate of plumbism where toilets are bad is about three times as high as the corrected rate of plumbism where toilet conditions are considered good, in these eight plants where other factors have practically been eliminated. It should be observed, however, that the small number of plants and the small number of those examined make these rates unreliable for close comparison, and they should be kept in mind only for the purpose of noting that where bad toilets exist the rate of plumbism is higher than where better conditions are found, and that these rates are sufficiently consistent to help us reach a conclusion warranted only by considering the previous analysis.

In summarizing this analysis it should be kept in mind that while the personal factors are somewhat consistent throughout the various groups that are being compared the total differences between the rates in each case may not properly be charged entirely to toilet conditions, because of the impossibility of eliminating the other unhygienic conditions about the factory without reducing numbers down to a point where rates would be meaningless. However, sufficient analysis has been given here to show that bad toilet conditions are without doubt contributing factors in producing plumbism and that careful consideration ought to be given by plant proprietors to this contributing factor. After discussing certain hazards found in our survey of the potteries we will include toilet conditions with all other bad hygienic conditions about the plant for the purpose of finding rates of plumbism with reference to the number of unhygienic conditions found in these various plants.

OTHER HAZARDS.

Besides these various hygienic conditions already discussed there are certain other factors which we found during the course of our survey. Certain plants have a heat hazard, or perhaps a fatigue hazard, or a cold hazard, or a wet hazard. In nearly every plant some one of these conditions is found, although not always in a pronounced degree.

The heavy work in connection with kiln placing, which involves carrying as much as 85 pounds of ware upon the head, climbing a ladder, and placing this material at the top of a kiln, is usually fatiguing. The monotonous work of brushing, cleaning, and fettling has in it the elements of fatigue. In certain plants there is a continual splash about the dipping tub, so that the dippers and helpers frequently stand in damp or wet places during the course of the day. There are certain processes in connection with the emptying of kilns and in the sifting of glaze upon heated ware which might be styled a heat hazard. Upon occasions we find poorly heated buildings and workers exposed to draft after heated operations, such that a cold hazard may result. However, in our discussion in this part of the survey we have included only the pronounced hazards. In four plants having a pronounced heat hazard, employing 175 people, a rate of positive plumbism of 12.0 is found. In analyzing the conditions of this group of male workers and comparing them with that found in the plants as a whole, we find that they are about normal as far as age distribution is concerned, that they are about three years underexposed, and that they are in slightly more hazardous occupations, as a larger number of them are dippers, or enamelers as they are sometimes called. These factors perhaps offset each other, so that our rate of plumbism would not be changed materially in this group.

Four plants are found in which there is a pronounced cold hazard. Eighty-two people employed in these plants have a rate of positive plumbism of 17.1. The sex distribution and the occupational distribution are about even. The workers are, however, about two years overexposed, but not sufficiently to call for this exceedingly high rate of plumbism. However, the high rate is no doubt affected by other unhygienic conditions about the plant, as each of the plants included above has a large number of unhygienic conditions.

Four plants are found where a pronounced wet hazard exists. The 55 people examined in these plants have a rate of positive plumbism of 21.8. The sex and occupational distribution are found to be about normal, although the workers are about two years overexposed and are working under a very high number of other unhygienic conditions.

It is not possible to eliminate the other factors in a satisfactory way without reducing the groups down to numbers insufficient to make rates comparable and reliable.

In investigating the fatigue hazard we find a rather large group working under conditions which were enumerated by our investigators as being hazardous. The rate of positive plumbism for this group is 10.9, which rate is not affected by sex, length of exposure, nor occupational distribution. It is found, however, that those included in these fatiguing processes are working in plants where a large number of plant hygienic conditions are unsatisfactory. Therefore, the high rate for this group is probably largely attributable to these other factors. In connection with the study of fatigue we should, perhaps, call attention to our reference to piecework made earlier in this section. A further analysis of the fatigue hazard, as well as of the others included above, will be made in a final summary of plant conditions.

SPECIAL PROCESSES.

In 11 of the plants surveyed our investigation deals with some special processes, such as machine dipping, use of tunnel kilns, spraying of either liquid or dry glaze on cold or hot ware, addition of glue or gelatin to glazes, and painting the glaze on the ware by using a hand brush.

Table LX shows the number of these plants, with the various special processes and the rate of plumbism for each process and the rate of plumbism for the persons examined in these plants. Table

LXI shows the number of plants employing these various special processes and the rate of plumbism for persons occupied only in that part of the plant using such processes.

TABLE LX.—*Number of plants and kind of special processes and rate of plumbism for all workers examined.*

Number of plants.	Kind of special processes.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
						Positive.	Positive and presumptive.
3	With automatic dipping machine.......	1	0	0	24	3.8	3.8
4	With continuous kiln....................	1	2	1	41	2.2	6.7
2	Glaze sprayed or sifted on hot ware.....	11	2	7	76	11.5	13.5
2	Air spray painted or machine sponge...	....	1	2	33	0.0	2.8
2	Glue in glaze, painted on ware..........	....	....	2	13	0.0	0.0

TABLE LXI.—*Number of plants and kind of special processes and rate of plumbism for special occupation.*

Number of plants.	Kind of special processes.	Occupation.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
							Positive.	Positive and presumptive.
3	With automatic dipping machine.	Dippers...	....	....	1	14	0.0	0.0
4	With continuous kilns...........	Kiln men.	....	1	0	4	0.0	20.0
2	Glaze sprayed or sifted on hot ware.	Dippers...	7	0	4	56	10.4	10.4
2	.....do............................	Kiln men.	2	0	0	2	50.0	50.0
2	Air spray painted or machine sponge.	Dippers...	....	....	2	17	0.0	0.0
2	Glue in glaze, painted on ware...	...do.......	....	....	0	3	0.0	0.0

Although in most of the special processes there is not a sufficient number of persons employed to make the results as reliable as we might desire, yet the tables show us that in plants having automatic dipping machines the rate of positive plumbism for all workers is 3.8 and for the dippers operating these machines it is 0.0. In the four plants having continuous tunnel kilns the rate of positive plumbism for all employees is 2.2.

There are two plants which spray a base coat with a liquid glaze, by the use of an air compressor, and then afterwards sift dry glaze on the hot ware after it has been withdrawn from the kiln. It will be noted that the rate of positive plumbism for all workers in these two plants is 11.5, while for dippers, or enamelers as they are called, in these plants the positive rate is 10.4. Of the four kiln men examined in these plants, two, or half of those examined, are found to have positive lead poisoning. Two plants are found in which an air spray is used in putting on a base coat and in which the other coats are either painted on or applied by machine sponging. In these plants the positive rate for all workers is 0.0, and for all dippers is 0.0. Two plants are found which use glue or gelatin in the glaze, in an attempt to avoid dust in the dry glaze, and in which ware is painted with this pasty mass by use of a hand brush. The tables show that the rate of plumbism in these two plants is 0.0, and for the dippers employed therein is 0.0.

SUMMARY OF PLANT CONDITIONS.

We have now seen the probable relationship between certain groups of working conditions and plumbism. Thus in our analysis of air dustiness a ratio was approximated between good and bad conditions of ware boards, between dry sweeping and wet or watered sweeping, between plants with a high dust count and those with a lower dust count, and finally for such combinations of dusty conditions as it is possible to make. In like manner we have shown rates for different conditions of personal-service facilities and for groups of facilities. We have shown rates where bad toilet conditions seem to predominate and rates where good conditions are found. We have shown rates where certain other hazards exist. In each case an attempt has been made to evaluate for such personal factors as age, sex, length of exposure, and occupation, and to eliminate as far as possible the effects of other unhygienic conditions. As pointed out before, it is not to be assumed that these rates are refined to the point of giving an accurate relationship between these alleged contributory causes and the rates of plumbism found in the various plants. The probability is, however, that they point with sufficient clearness to such conditions as causative factors, to show that in any program for elimination of plumbism where lead is retained as a component part of the glaze such factors must of themselves be brought up to standard requirements essential to the maintenance of plant hygiene.

We repeat that in analysis of good and bad conditions which might have a relationship to the incidence of lead poisoning the factors responsible in part for plumbism have not necessarily been exhausted. There are unrelated factors, some of which we have noted and some of which we may have overlooked. Some of these are immune from analysis, perhaps, because difficult to measure or detect and unrelated to other factors capable of being grouped. It has always been our purpose, however, to analyze and evaluate or eliminate when possible, so that the effect of a single factor may be as clear as it is possible to make it. Plant conditions do not lend themselves as readily to evaluation as do personal factors, because of certain difficulties in measurement.

In the pages that follow an attempt is made to correlate as many of these salient features as possible and to show their combined effects. Thus, air dustiness, personal-service facilities, toilet conditions, and certain hazards are combined, as well as eliminated and evaluated, for the purpose of showing rates for combinations of conditions and of assisting in placing responsibility for high rates of plumbism upon plant sanitation, so that neither plant managers nor plant employees may shirk their respective responsibilities in furnishing sanitary conditions and in keeping and observing hygienic regulations. Our explanations are given in detail, so that the reader will not jump at the conclusion that to mend a given condition will bring an immediate and definite reduction in plumbism. Our rates, then, are only danger signals that are entitled to careful consideration, and should be given sufficient heed if the dangers arising from the use of lead are to be overcome. The whole purpose of our study will be defeated if snap judgments are formed without due consideration and without a careful reading of all we have to say regarding the causative factors of plumbism. We ask the reader to use the same statistical caution and studious care in reading this report that we have in assembling the facts and in analyzing them.

Table LXII gives a summary of several of the related conditions previously mentioned and of some others enumerated under Appendix D.

TABLE LXII.—*Plumbism according to conditions at plant.*

Condition.	Positive.	Presumptive.	Suggestive.	Negative.	Rate of plumbism.	
					Positive.	Positive and presumptive.
With common drinking cup	124	102	154	1,191	7.9	14.4
Without common drinking cup	15	4	14	205	6.1	7.9
With bad toilets	85	75	88	631	9.7	18.2
Without bad toilets	54	31	80	765	5.8	9.1
With common drinking cup and bad toilet	82	74	87	595	9.8	18.6
Without common drinking cup and bad toilet	57	32	81	798	5.9	9.2
With open water pail	81	54	98	666	9.0	15.0
With covered water pail	13	1	15	116	8.9	9.6
With (a) common drinking cup, (b) bad toilet, and (c) open water pail	51	44	50	364	10.0	18.7
Without all of (a), (b), and (c) above	88	62	116	1,032	6.8	11.6
With (d) poor illumination	103	82	90	680	10.8	19.4
Without (d) poor illumination	36	24	78	716	4.2	7.0
With (a), (b), (c), and (d) above	46	31	33	209	14.4	24.1
Without all of (a), (b), (c), and (d) above	93	75	135	1,187	6.2	11.3
With (e) dirty ware board	78	59	63	481	11.4	20.1
Without (e) dirty ware board	61	47	105	915	5.4	9.6
With (a), (b), (c), (d), and (e) above	39	28	21	132	17.7	30.5
Without all of (a), (b), (c), (d), and (e) above	100	78	147	1,264	6.3	11.2
Without any of (a), (b), (c), (d), and (e) above	3	1	7	112	2.4	3.2
With (f) bad ventilation	46	45	40	248	12.1	24.0
Without (f) bad ventilation	93	61	128	1,148	6.5	10.8
With (a), (b), (c), (d), (e), and (f) above	18	17	7	52	19.2	37.3
Without all of (a), (b), (c), (d), (e), and (f) above	121	89	161	1,344	7.0	12.2
Without any of (a), (b), (c), (d), (e), and (f) above	3	1	7	112	2.4	3.2
With 16 and over bad conditions	57	41	37	212	16.4	28.2
With from 11 to 15 bad conditions	77	61	107	831	7.2	13.0
With from 0 to 10 bad conditions	5	4	24	354	1.3	2.3

In addition to the facts already noted, it will be observed that plants having combinations of certain bad conditions have also higher rates of plumbism. Plants having both common drinking cups and bad toilet conditions have a rate of positive plumbism of 9.8, as compared with a rate of 5.9 for other plants. Plants having open water pails in addition to these two conditions have a rate of positive plumbism of 10.0, as opposed to 6.8 for plants without these three conditions. Plants where the illumination is considered poor have a rate of positive plumbism of 10.8, as opposed to a rate of 4.2 for those where the illumination is considered adequate. Plants having all four of the bad conditions named above have a rate of positive plumbism of 14.4, as compared with the rate of 6.2 for plants not having all four of these conditions. Plants having dirty ware boards in addition to these four bad conditions have a rate of positive plumbism of 17.7, while plants with some but not all of these five conditions have a rate of plumbism of 6.3, and plants without any of these five bad conditions have a rate of 2.4. Plants having bad ventilation have a rate of positive plumbism of 12.1, as compared with the rate of 6.5 for those where the ventilation is considered adequate. Plants with all six of these bad conditions have a rate of positive plumbism of 19.2; those plants with some but not all of the six have a rate of 7.0; and plants without any of these six conditions have a rate of positive plumbism of 2.4.

Plants having 16 and more of the bad hygienic conditions noted in Appendix D have a rate of positive plumbism of 16.4. Those having from 11 to 15 of the bad conditions have a rate of positive plumbism of 5.3, and those having 10 or less of these conditions have a rate of positive plumbism of 1.3. The corresponding positive and presumptive rates are 28.2, 13.0, and 2.3 per cent.

In Appendix D an array is made of the 92 plants, from that with the highest rate of plumbism down to that with the lowest.

This varies from 37.1 per cent of positive plumbism and 71.4 of positive and presumptive plumbism to no plumbism of any kind. These 92 plants are then divided into three groups, about equal in size. Speaking specifically, there are 31 plants in the upper group, 30 in the middle group, and 31 in the lower group. The unhygienic conditions already mentioned, and some others—a total of 26—are included in this table. If a plant has one of these conditions, a star appears opposite the plant in question. For example, the plant at the top of the list, with the highest rate of plumbism, has 25 stars, which indicate that 25 out of 26 conditions are found in this plant. The plant at the bottom of the list, with 0.0 rate of plumbism, has 10 such conditions. Plants are found with as few as two of these conditions, noted in Appendix D.

Table LXIII shows a summary of the conditions existing in the three groups outlined above. In the 31 plants having the highest rate of plumbism the average length of exposure of the workers is 12.6 years, the average per cent of soluble lead in the glaze is 14.5, the rate of positive and presumptive plumbism for the group of workers examined in this group is 27.6, and the plants have on an average 15 of these bad conditions. In the middle group workers were exposed for an average length of 11.0 years, the average per cent of soluble lead used in the glaze is 14.1, and the rate of positive and presumptive plumbism for the group of workers is 8.3, this group having an average of 12 of the bad conditions. In the lower group the average length of exposure is 9.3 years, the average per cent of soluble lead used in the glaze is 12.7, the rate of positive and presumptive plumbism 0.0, and the average number of bad conditions in these 31 plants is 9.6.

These groups are similar as far as occupational distribution is concerned. The upper group averages about two years older than the group as a whole. The lower group is underaged by about the same amount.

TABLE LXIII.—*Summary of the three plant groups as given in Appendix D.*

Group.	Number of plants.	Average size.	Length of exposure.	Per cent of soluble lead in glaze.	Average of number of bad conditions.	Rate of positive and presumptive plumbism.
Upper one-third	31	221	12.6	14.4	15.1	27.6
Middle one-third	30	180	11.0	14.1	11.8	8.3
Lower one-third	31	134	9.3	12.7	9.6	0.0

In Table LXIV an attempt is made to split each of these groups into two, making a total of six groups arrayed according to the rate of plumbism.

TABLE LXIV.—*Rates of plumbism and average number of bad plant conditions when plants in Appendix D are divided into six groups.*

Group.	Number of plants.	Rate of positive and presumptive plumbism.	Average number of bad conditions.
Upper one-sixth	15	37.8	16.7
Fifth one-sixth	16	21.0	13.6
Fourth one-sixth	15	11.9	12.2
Third one-sixth	15	3.8	11.3
Second one-sixth	16	0.0	10.3
Lower one-sixth	15	0.0	8.3

In this table it is noted that the upper group of 15 plants, with a rate of plumbism of 37.8, has an average of approximately 17 of the plant conditions given in Appendix D. The next group, with a rate of positive and presumptive plumbism of 21.0, has an average of about 14 of these bad conditions; the next lower group, with a rate of positive and presumptive plumbism of 11.9, has an average of 12 such conditions; the next lower group, with a rate of positive and presumptive plumbism of 3.8, has an average of approximately 11 of these bad conditions; and the next two lower groups, with a rate of plumbism of 0.0 per cent, has 10 in the one case and 8 in the other of the bad conditions mentioned in Appendix D.

The Pearson coefficient[1] between the rate of positive and presumptive plumbism of these 92 plants as shown in Appendix D, and the number of bad hygienic conditions as shown in this same table is found to be 0.666. This signifies that where the rate of plumbism is high the chance that the number of bad conditions will be high also is about two out of three.

Chart 8 shows in graphical form the relation mentioned in this last paragraph—namely, that between the rate of lead poisoning in these 92 plants and the number of unhygienic conditions with which the workers must come in contact. The plants are arrayed so that the plant having the highest rate of positive and presumptive plumbism is at the left of the figure and those with a 0.0 rate are at the right. No smoothing is employed in the curve which shows the rate of plumbism.

It should be noted that these plants are arrayed in order of rate of positive and presumptive plumbism, except that the plants with the 0.0 rate of plumbism are arrayed in order of number of unhygienic conditions. The curve showing the number of unhygienic conditions is smoothed by a moving average. A study of figure 8 shows that these curves follow each other rather closely and strengthen the significance of the Pearson coefficient, 0.666, in placing a large responsibility upon plant conditions for the causes of lead poisoning found in the survey.

A COMPARISON OF THIS INVESTIGATION WITH THE FORMER SURVEYS.

In a previous chapter we have called attention to the surveys made by Hamilton and by Hayhurst and others. Doubtless there are those who will want to compare the results obtained to determine whether as time passes, improvements have resulted in working conditions, and the lead hazards of the industry have been made less injurious to the workers. Such a comparison can hardly be made, because of the differences in the manner of making the surveys. While these studies are all rather recent, they are separated by sufficient time so that no investigation enroached upon the plan of the other. The investigation conducted by Dr. Hamilton is a period investigation, and the

[1] Perfect correlation according to the Pearson coefficient is 1.000.

cases of lead poisoning which she reports are those developing in the years 1910 and 1911. Her cases of plumbism, it would seem, represent the cases of lead colic and attacks of lead poisoning, and her rates no doubt indicate attack rates. The investigation conducted by Dr. Hayhurst is a status investigation and shows the conditions he found in existence in the plants at the time of his investigation.

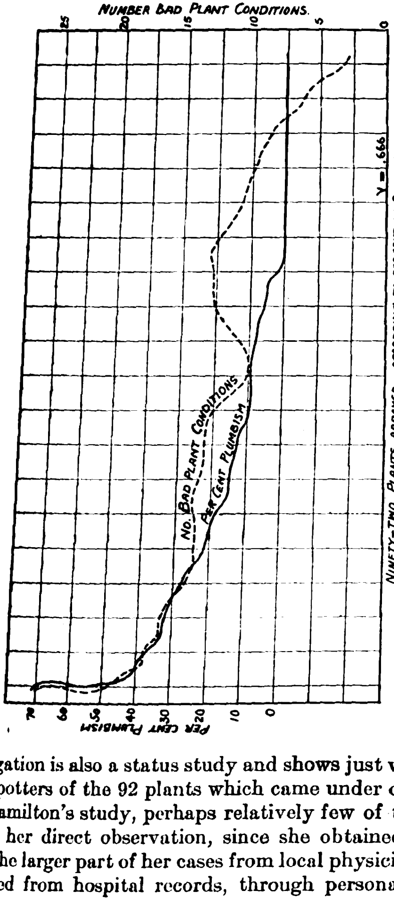

CHART 8.—Comparison of per cent of plumbism in potteries with number of bad plant conditions.

Our investigation is also a status study and shows just what we found among the potters of the 92 plants which came under our study.

In Dr. Hamilton's study, perhaps relatively few of the lead cases came under her direct observation, since she obtained information concerning the larger part of her cases from local physicians.[2] Others were obtained from hospital records, through personal questioning

[1] Bulletin of the U. S. Bureau of Labor No. 104, p. 42.

and examination, from reports of fellow workers, and a few, from certain labor organizations.[3] There is no record in her survey of the exact number of physical examinations made, nor of the manner of making an examination, nor of the exact diagnosis for lead poisoning. In Dr. Hayhurst's study it seems that the greater number of cases reported by him were found by direct physical examination, although some of the cases included were reported to him and were diagnosed as lead poisoning upon hearsay evidence. In our study every case of lead poisoning which we report was found by a careful physical examination and by a careful diagnosis. Table LXV shows in detail the differences of these three investigations.

TABLE LXV.—*Scope of each survey.*

	Hamilton.	Hayhurst.	Present study.
Date	1911-12	1914	1919-20.
Kind	Period	Status	Status.
Location	9 States	Ohio	New Jersey, Ohio, Pennsylvania, West Virginia.
Number of plants	68	47	92.
Number of employees.	No record	8,146	17,297.
Number exposed	2,505	2,585	1,902.
Number examined	No record	No record	1,809.
Number of cases reported.	179 in 1910; 331 in 1911	Found and reported, 109	Found, 270.
Rate	1910, 7.2; 1911, 13.2	4.2	15.0.
Directed by	Labor Department	Ohio State Board of Health.	United States Public Health Service.
Sources	Reports from: (1) Physicians, (2) hospital records, (3) questioning and examinations, (4) reports from fellow workers, and (5) labor unions.	Physical examinations and by reported cases not observed.	Physical examinations.

It should, perhaps, be pointed out that of the total 17,297 employees we found 1,902 engaged in occupations where they are exposed to a lead hazard, while in Dr. Hayhurst's study out of 8,146 persons employed in the 47 plants under discussion as many as 2,585 are stated to be exposed to a lead hazard. In other words, we find 11 per cent of the pottery employees exposed to lead hazards, while Dr. Hayhurst found approximately 32 per cent exposed. Of these, 1,902, we examined 1,809, or 95 per cent, of those exposed. We did not willfully fail to examine any exposed person. We found 139 cases of positive lead poisoning among the 1,809 persons examined, or 7.7 per cent of those examined were found to be suffering from positive plumbism. Our positive and presumptive rate is 13.5. Dr. Hayhurst found only 109 out of 2,585, or 4.2 per cent, of those examined and reported upon. In the absence of any diagnosis we do not know what he includes. It seems to us that he has included an oversized number of employees in order to get 2,585 exposed persons. If we take our rate of 11 per cent

[3] Bulletin of the U. S. Bureau of Labor No. 104, p. 8.

of his total number employed, 8,146, his 109 cases would give a rate of plumbism of 12.2. This differs by a less amount from our positive and presumptive rate of 13.5. This difference, however, might be explained because of a difference in diagnosis or because of a different distribution among occupations or sexes, or because of a difference in the selection of plants, or because of his large list of decorators. In other words, a different set of samplings might be expected to effect, in a small way, some differences in the results of these investigations.

It is difficult to make a comparison between our rates of plumbism and the rates found by Dr. Hamilton, on account of the differences which we have pointed out in the manner of making these surveys. Table LXVI gives in more detail the differences in the results of these investigations. In this table we have made a comparison by age distribution, by length of exposure, and by occupation. We have no data showing sex distribution of either of the two earlier studies.

TABLE LXVI.—*Results of each survey.*

	Hamilton.			Hayhurst.			Present study.		
	Reported.	Lead cases.	Rate.	Examined and reported.	Lead cases.	Rate.	Examined.	Positive lead cases.	Rate.
AGE (YEARS).									
Under 20	......	......	......	75	5	6.7	218	2	0.9
20-39	......	......	......	2,035	66	3.2	355	44	5.1
40-44	......	......	......	324	19	5.9	235	28	11.9
45-49	......	......	......	78	8	10.3	173	18	10.4
50	......	......	......	55	11	20.0	328	47	14.3
Total	......	......	......	2,585	109	4.2	1,809	139	7.7
EXPOSURE (YEARS).									
0-0.9	......	38	......	......	6	......	239	3	1.0
1-4.9	......	36	......	......	35	......	392	17	4.3
5-9.9	......	63	......	......	25	......	294	19	6.5
10 plus	......	49	......	......	43	......	720	93	12.9
Total	......	186	......	......	109	4.2	1,695	132	7.8
OCCUPATION.									
Glaze mixer	......	......	......	51	9	17.7	112	11	9.8
Dipper	365	92	25.2	245	31	12.7	292	46	15.8
Dippers' helper	221	27	12.2	205	19	9.3	220	10	4.5
Ware cleaner	......	......	......	311	2	.6	104	3	2.9
Glost-kiln placer	464	19	4.1	474	36	7.6	707	49	7.0
Sagger washer	......	......	......	45	4	8.9	73	3	4.1
Decorator	20	3	15.0	1,217	7	.6	32	3	9.4
Other	......	......	......	37	1	2.7	269	17	6.3
Total	1,070	141	13.2	2,585	109	4.2	1,809	139	7.7

In Dr. Hamilton's study no full record is given of the age distribution of those coming under her investigation. The figures furnished here from Dr. Hayhurst are taken from the Ohio Public Health Journal of October, 1919. Our age groups are made to conform in class interval to those of Dr. Hayhurst. Perhaps we should point out that there is included here in the 20–30 age period about four-fifths of all the workers included in the Hayhurst study. Both distributions, however, agree in the gradually increasing rate of plumbism, as the age of the worker advances. Under length of exposure neither the Hamilton nor the Hayhurst studies show the rates for the various periods of exposure. Under the occupational distribution it should be observed that almost half of the Hayhurst cases are decorators, among whom he found an extremely low rate of plumbism—only 0.6 per cent. In our survey we are unable to find that the colors used in decorating contain a great amount of lead, or at least of soluble lead compound. The colors are generally mixed with oil, and most decorators do not come in contact with the lead used in glazing. There is seldom any tinting or ground laying in lead. We therefore examined only such decorators as seem to come in contact with the lead used in the glaze.

The Hayhurst rate is less than that found in our study. His rate for dippers' helpers is over twice as high as ours, while for glost-kiln placers it is about the same as ours. The rate for sagger washers is double ours. The rates found by Dr. Hamilton, 25.2 for enamelers and millworkers and dippers, 12.2 for dippers' helpers, and 15.0 for decorators, are all higher than ours; however, as pointed out before, it is difficult to make a comparison between these two studies, on account of the different ways in which these investigations were made.

In making the above comparisons we have not attempted to find fault with the manner of conducting these former surveys nor with the results obtained by them, but we have tried to point out the essential differences in the manner and method of conducting these investigations, so that anyone interested in making a comparison of the results of the three studies will have before him the reasons why a close comparison of the rates can not be made.

GENERAL SUMMARY.

It has been shown how these cases of lead poisoning are distributed among the various occupations of the pottery; how they are distributed among the various types of wares manufactured by the pottery establishment, and how they are distributed among the various plants with respect to the various amounts of soluble lead used in their glazes. The distribution of plumbism has also been shown according to various unhygienic conditions found in the plant, and it has been pointed out how these conditions, without doubt, are factors fostering plumbism. We have pointed out how certain personal habits, including eating and drinking, have affected the rate of plumbism among pottery employees. We are not able to charge any given per cent of lead poisoning or of the causes of lead poisoning to the plants and to plant conditions and the remaining per cent to the personal habits of the employees. We are not willing to say that one contributes more toward the incidence of lead poisoning than does the other. The recommendations to be made will affect both the employer and the employee.

Incidental remarks have been made concerning the responsibility of keeping the plants clean and of having certain sanitary conditions about the plants in operation. It seems to the investigators that under the prevailing system of piecework the responsibility for these matters is not definitely placed. The dipper, for example, is somewhat interested in turning out as many pieces as possible of dipped ware. The size of the output is the basis upon which he is paid. He receives pay from which he in turn pays his helpers. His department represents in a way an independent organization within the pottery institution. Likewise the kiln-placing and certain other operations as well are conducted rather independently of each other. The cleanliness of the rooms and the time of cleaning them in some instances may be charged to employees, rather than to the plant management. Each foreman, while in a way responsible for his special room or department, may not be especially interested in certain hygienic conditions which our survey shows to be of importance. A definite placement of responsibility ought then to be determined upon both by the plant owners and by the employees as to the matter of placing and keeping the pottery establishment in hygienic condition.

In this connection it might be pointed out that very little instruction is given to the pottery worker concerning the hazards in which he works and concerning the habits that he should form and the precautions which he should observe in handling lead glaze. In fact, it seems to the investigators that those in charge of the plants are either indifferent, or careless, or ignorant in regard to lead hazards. In reply to our inquiries a few of the plants denied having any lead hazards and denied having any cases of lead poisoning among their workers. For example, one plant says: "We use no soluble lead." In later correspondence this same plant says: "We use about 23 per cent of white lead." Our analysis of the glaze from this plant shows a content of 22.64 per cent of total lead and of 21.77 per cent of soluble lead. This plant also had one case of presumptive plumbism. In several of the other plants cases of lead poisoning were found where the existence of cases had been denied. One plant said that we would find that "the supposed cases of lead poisoning in potteries is rather a sort of myth." Four cases of positive lead poisoning were found among the employees of this firm. However, whatever may be the attitude of the plant managers and of the workers, we have furnished information concerning the hazards of lead and the conditions that foster lead poisoning. Sufficient cases have been diagnosed and sufficient data have been collected regarding plant conditions and concerning the habits of workers to warrant us in making certain definite recommendations, which, if carried out, should tend to reduce the possibilities of lead poisoning to a minimum.

PART V.

MEANS AND METHODS OF REDUCING THE HAZARD OF LEAD IN THE POTTERY INDUSTRY.

In this research in the pottery occupations certain factors have been shown which should be considered in the light of their effect in inducing lead poisoning among workers in certain processes where lead is used. It has been difficult to place the responsibility for these conditions, nor is it deemed best for us to try to place it. We are more interested in calling attention to the hazards present and in pointing out preventive measures for the elimination or control of these hazards.

If lead is used, certain precautions must be observed.

The worker who is really anxious to protect himself should heed the following advice:

INDIVIDUAL MEANS AND METHODS.

FOOD.

1. Always eat a good breakfast before going to work. Drink plenty of milk. The presence of food in the stomach helps to prevent the lead from getting into the system.
2. Take a lunch or drink milk in the middle of the forenoon and in the middle of the afternoon.
3. Never eat or drink in the workroom.
4. Do not keep drinking water in uncovered vessels in the workroom. (If you drink from such vessels you drink diluted glaze.)

CLOTHING.

1. Never wear street clothes nor street shoes in the workroom; keep them in closed, ventilated, individual lockers in some other part of the building.
2. Never keep work clothes in lockers used for street clothes. Never wear work clothes to your home; you expose your family to lead poisoning by doing so.
3. If you work in dust, wear a respirator.

CLEANLINESS.

1. Do not chew tobacco or gum while at work.
2. Do not expectorate on the floor.
3. Do not wear a beard. If you wear a mustache, keep it short and do not stroke it during working hours.
4. Keep hair covered in the workroom.
5. Keep dirty fingers away from the mouth and nose.
6. Before eating and before leaving the plant always wash hands and face with hot water and soap. Use a brush on the hands and clean the fingernails. Rinse the mouth.

7. Use individual soap and towels.
8. Always take shower before putting on street clothes.
9. Keep body clean:
   (a) Outside, by bathing in warm water at least twice a week;
   (b) Inside, by drinking plenty of water. Keep your bowels moving at least once a day; regularity in time of movement helps to maintain health; constipation invites lead posioning.
10. Keep teeth clean and in order. See a dentist periodically. A man with bad teeth and gums is seldom healthy.
11. Do not stir up dust; always insist on moist sweeping and moist dusting of work benches and walls.

STIMULANTS.

1. Never drink alcohol in any form; it greatly increases the danger and severity of lead poisoning. Excessive use of any stimulant lowers resistance and increases danger of lead poisoning.

FRESH AIR.

1. Always insist on plenty of fresh air in the workroom.

MEDICAL AID.

1. Learn all you can about lead, its compounds, their uses, their effects upon the human body, so that you may continue your work without danger and intelligently protect yourself and your family.
2. Consult a physician if you notice the frequent occurrence of the following symptoms:
   (a) Loss of appetite.
   (b) Indigestion.
   (c) Constipation.
   (d) Nausea.
   (e) Vomiting.
   (f) Pains in stomach.
   (g) Disturbed sleep.
   (h) Dizziness.
   (i) Weakness of arms, limbs, or body.
   (j) Muscular cramp.
   (k) Neuritis.
   (l) Loss of weight.

WORKROOM PRACTICES.

Remember that if you do not look out for your own health, you can not expect anyone else to look out for it.

1. Don't dust off your workbench with your apron or with anything that will raise dust. If you must remove dust, do it by a wet method.
2. Don't clean off ware on work apron.
3. Avoid splashing or spilling of glaze, both when carrying and when dipping, lest the glaze be raised as dust later.
4. See that ware boards are kept clean and free from glaze so that no dust will be raised in handling them.
5. Avoid raising or scattering dust in any operation—sweeping, brushing, fettling, walking, lifting, or moving ware, saggers, or other equipment and materials.

All these are precautions which the individual may take to safeguard himself against the hazard of his trade or occupation. These same precautions are of further importance because they also conduce to the maintenance of health, which would manifestly be materially increased if certain plant facilities and working conditions were raised to high standard of industrial hygiene and sanitation.

It has been shown in the early part of this report that the ordinary features of plant hygiene have been woefully neglected in the potteries. When grouped the improvements needed are so numerous as to give the impression that the cost of their installation would be prohibitive. It is not our purpose here to dictate a program for plant hygiene which should be accepted in its entirety by each and every pottery; we would, however, emphasize the fact that working conditions have a direct bearing upon the health and efficiency of the worker, upon the quantity and quality of his production, and hence are vital factors in production cost. It is obvious that the worker is handicapped in carrying out the foregoing recommendations in full if the personal service facilities which are found in all modern plants are not provided. We have seen that they are not provided in the majority of plants studied.

PLANT MEANS AND METHODS.

WATER.

It is good policy and an economic practice to install and to maintain an adequate supply of pure drinking water; bubblers, conveniently placed, and water of always palatable temperature.

BATHING FACILITIES.

As an aid toward the elimination of the hazard of lead poisoning to the pottery worker adequate and ample bathing facilities should be provided in all potteries. These facilities should consist of adequate dressing rooms, with lockers provided (either two lockers per man or one with a partition divided into two distinct and separate compartments), sufficient in size to accommodate on the one side the working clothes and equipment of the worker and on the other his street clothing.

Sufficient washbasins or bowls and ample shower baths, with running hot and cold water, should be provided for the use of the workers. Individual soap and towels should be used. It should be a part of the plan of the plant management to educate the employees to appreciate the many advantages gained by the use of bathing facilities and by the elimination of common soap and common towels.

TOILET FACILITIES.

If accumulated for a year the average time lost in going to poorly located toilets would more than pay for installations in places more convenient as to location and distance from the place of work. Old-fashioned privy vaults are not tolerated to-day in any community where public health is appreciated and should not be found in any plant where sanitary ware is manufactured. The use of them is both poor economy and bad advertising. All toilets should be located with regard to the number of workers and the distance from their place of work. Careful supervision of the condition of the toilets should be maintained as to cleanliness, heat, ventilation, light, repair, and supplies, and other factors, the absence of which tends to discourage the use of the toilets.

The plant management should impress upon the employee the dangers resulting, where there is a lead hazard, from prolonged delay in the use of toilet facilities. If this delay could be overcome it is quite possible that the number of cases of plumbism would decrease.

CUSPIDORS.

Ample provision of cuspidors, well distributed throughout the plant, with strict supervision of their daily cleaning and sterilization is a sanitary necessity to prevent the spread of sputum-borne diseases. Expectoration, except in such cuspidors, should be prohibited.

SPECIAL CLOTHING.

Workers should be encouraged in the use of overalls, aprons, caps, head covers, and respirators. It is to the interest of the plant to impress upon the workers the advantages of this special clothing.

LUNCH ROOMS.

In many plants with large personnel it has been found profitable and beneficial to install cafeterias or restaurants. Employees are thereby encouraged to eat away from their work and have the privilege of obtaining their meals at low cost. In the larger potteries such facilities should be instituted.

If the number of workers be too small to warrant the installation of a restaurant, a lunch room should nevertheless be provided and should be centrally located, but not adjacent to any hazardous process that creates dust, smoke, or fumes. Tables, chairs, water, heat, light, and ventilation should be provided, and the room should be made as attractive as possible. In some plants it has been found wise to have the lunch room in combination with the recreation room, with pianos, phonographs, and other facilities for amusement as added attractions to induce the workers to eat in lunch room.

Educating the worker as to the danger of eating in the workrooms and of failing to wash before eating is, however, as essential as the provision of cafeterias and lunch rooms if the plant management expects to decrease the amount of lead poisoning.

PLANT HYGIENE.

ILLUMINATION.

It is hard to justify on any grounds the maintenance to-day of workrooms where the light, either natural or artificial, is so inadequate as to increase the occupational health hazard, as well as to interfere with speed and accuracy in production. There are on the market simple measuring instruments by which every plant manager may ascertain for himself the degree of illumination at the work plane of his employees.

By simple determinations and at a slight cost improvements in lighting may be introduced, the production of the worker increased, and losses from spoilage decreased.

Careful consideration must be given to the processes in each plant as to the amount of illumination required. Care must be taken to avoid the creating of poorly illuminated areas, which tend to cause the sweeper to fail to remove trade waste or dust or which encourage carelessness in cleaning and consequent dustiness. It is these poorly illuminated areas that harbor increased plant dustiness, with its corresponding injury to the worker.

It will be found possible in many cases to improve the illumination by removing obstructions, cleaning and painting the walls, regular cleaning of glass windows, doors, and skylights, and the careful distribution of artificial lights. In artificial illumination care must be given to type, intensity, distance from the plane of work, position, maintenance, and glare.

VENTILATION.

Ventilation is fundamental to plant hygiene.

In most plants to-day the natural ventilation is seldom satisfactory, and this is true of the pottery plants, yet few had provisions for artificial ventilation.

Pottery managers should carefully analyze air conditions, determining the adequacy or inadequacy of the ventilation by the number of cubic feet of air per worker, the number of fresh-air openings, air conditions as to temperature and humidity, the rate of motion of air into the room and the character of the processes therein, and air dustiness or other forms of contamination.

Natural ventilation should be improved, and in all processes where dust is created artificial ventilation should be installed.

DUST AND DUST PREVENTION.

The total loss caused by dust to employers and employees through respiratory diseases and lead poisoning can not be estimated in dollars and cents. That the loss is great is proved by the sick benefits and death benefits paid for this class of diseases by the various organizations of employees.

If the plant management and employees could be brought to realize that the greatest danger they have in the pottery industry is a preventable one—namely, dust—and if they gave careful consideration to the annual losses caused thereby, we feel sure that the following practices would be discontinued:

1. Dry sweeping.
2. Sweeping during work hours.
3. Dirty ware boards.
4. Open glaze containers other than dipping tubs.
5. Lack of care in handling material so as to prevent dust.
6. Splashing and spilling of glaze.
7. Brushing, polishing, and fettling without provisions for the removal of the dust created.

Stringent rules should be made and enforced to prevent the above practices, and in turn the plant management should install the following modern improvements and methods in the plants:

1. Wet sweeping after work hours.
2. Scraping and cleaning ware boards to remove all glaze and dust before reuse.
3. Mixing all glaze and handling material under an exhaust in so far as practicable.
4. The use of some impervious material for dipping-room walls and floors and arranging them so that they can be washed down periodically.
5. Exhausts and hoods on all dust-creating processes, such as polishing, brushing, and fettling.
6. Keeping all lead compounds and compounds in dry or fine granular condition in covered bins or bowls.

PLANT BUILDINGS.

To outline a plant program for the adaptation of plant buildings to sanitary usage, so as to reduce the hazards from lead, would necessitate a list of changes which to any pottery manager would appear costly and hence, in the thought of trade, prohibitive. There are certain changes which must, however, appeal even to such critics as essential. Old buildings so occupied as to cause excessive carrying of raw glaze or of unfired glazed ware or long carrying from tub to racks and from racks to kilns might profitably be rearranged so that a continuous routing of ware would be possible; in fact, the introduction of overhead carriers would be both profitable and safe. In other plants where the floors, workbenches, and walls are of rough surfacing, collecting and holding the dust after sweeping, a resurfacing to obtain a smooth surface is both feasible and essential.

The same improvement might reasonably be introduced in the dipping rooms or wherever splashing and spillage contributes to the lead hazard. We have already noted the need for better lighting and ventilation. Where natural lighting can not be improved because of the lay-out of the plant, artificial lighting may be introduced; and with both methods improvements may be effected by careful attention to the cleanliness of globes, reflectors, and windows. In plants where the carrying of liquid glaze is an objectionable practice, the installation of a pipe-carriage system might advantageously be made.

PLANT PROCESSES, EQUIPMENT, AND MATERIALS.

The most fundamental innovations, in some instances costly, but which in the long run yield profit in excess of the installation costs, decrease the lead hazard, aid in the cleanliness and sanitation of the plant, and save labor, are:

1. Fritting the lead.
2. Use of leadless glazes and substitutes for lead.
3. Use of the least soluble compounds of lead.
4. Automatic ware dipping.
5. The continuous kiln.
6. The mangle.

These are discussed in detail in Section II, Part V.

PLANT MANAGEMENT.

In a last analysis the responsibility for working conditions rests with the management. Sanitary conditions are a part of the economy of production. While it is to the interest of the worker to maintain his health and a higher state of productive efficiency, it is even more to the interest of the plant manager; he must produce, both through quantity and quality of work, profits for the stockholders. It is to his interest, therefore, to see that the workers are not only kept in the mental condition where good will becomes an asset, but are also in the physical condition wherein such good will may be expressed in muscular activity that yields production at the lowest possible cost. The wise plant manager will see the extravagant possibilities that attend the maintenance of working conditions so deleterious to the worker's health. Plant problems are simple where there is a mutual understanding and cooperation both in shaping management policies and in the discipline that must attend the enforcement of such policies.

REGULATIONS.

In order to produce the best hygienic and sanitary conditions in the plants and so far as possible to check lead poisoning, plant managers must formulate regulations and provide means for their enforcement. Such regulations should cover the sweeping and cleaning of the plant, eating in the workrooms, expectorating on the floors, use of common drinking cups and open water containers, handling of materials, temperature of workrooms, and rest periods—where the nature of the work or the strain of posture in performing it necessitates their introduction and observance. Foremen and others that employ workers should be required to see that all workers are instructed as to the particular hazard existing in the process in which they are engaged.

MEDICAL AND SURGICAL CARE.

Medical and surgical relief for the employees, as we have seen, is practically lacking in the potteries. A few larger plants, only, have separate and distinct medical and surgical departments. All the larger plants should have such service. Where separate departments would not be feasible for the smaller plants, group relief methods should be adopted to provide the same advantages.

With medical supervision installed, the following special services should be rendered:

1. Complete physical examination of all workers at the time of employment and periodically thereafter.
2. Placement and replacement of workers, to be made on the basis of their physical condition. To this end, all workers exposed to a lead hazard to be given a physical examination monthly.
3. Personal as well as printed instructions given to the applicant, as to the lead hazard in the pottery industry.
4. Hospital care should be provided for the treatment of incipient cases of lead poisoning. After hospitalization, necessary arrangements should be made to transfer the worker to other duties where there is no lead hazard, and similar arrangements should be provided for incipient cases.
5. Careful study of plant hygiene and safety, coordinated with a comprehensive analysis of plant and medical records, that hazards may be ascertained and programs for their elimination may be adopted.

MODERN IMPROVEMENTS IN POTTERY PRODUCTION WHICH LESSEN THE LEAD HAZARD.

It is not our intention to indicate all the mechanical and physical changes which might be introduced in the pottery industry to improve working conditions and to eliminate the most serious hazards. Labor-saving devices, cost reduction provisions, provisions for increasing output, and like means all are improvements which might, in their adoption, bring increased returns, both to the pottery employees and to the pottery owners, enabling them thereby to institute other changes which would eliminate all hazards resulting from the use of lead. There are, however, three further types of plant improvements which might well be introduced, if not in the form in which they appear in certain plants, yet in the application of the principles underlying them. These three means of improvement may be noted under the headings:

A. Reduction in the amount of lead used in the glaze.
B. Continuous kilns.
C. Mechanical means for dipping.

In attempting to reduce the lead hazard, plans have been successfully worked out, involving first a low lead content and substitutes for lead; second, leadless glazes, and third, a fritted glaze.

GLAZE WITH LOW LEAD CONTENT.

While American potters are inclined to use a high per cent of lead in their glaze, as compared with European potters, and while many maintain that a leadless glaze is not practicable, yet it is possible to lower the lead contents of the glaze, and also to use compounds of lead, less soluble.

In many instances lead oxide may be used in place of white lead (carbonate), since it gives an excellent glaze and is less soluble. In other instances a smaller amount of lead may be used in the glazes by the addition of zinc oxide; in glazes in which zinc oxide is a regular constituent a larger portion of it may be added. In fact, it is hardly a mooted question whether a fritted glaze or a leadless glaze could not be substituted or used in all pottery work. American potteries have many lessons to learn in the mixing of glaze, from abroad, where a lower content gives results.

LEADLESS GLAZES AND SUBSTITUTES FOR LEAD.

Leadless glazes are said to be used with good results in some European potteries. Such glazes are easy enough to formulate, but have certain objectionable features, for which they have been condemned by the pottery makers of America. These objections are almost unsurmountable, with the present method of firing, but many of them would be removed by the application of scientific methods of glaze making and firing. In brief, the objections are as follows: Leadless glazes have less gloss and brillancy; have medium or short heat ranges and higher temperature to fusibility, hence require a higher content of boric oxide than glazes containing lead and are less adaptable for underglaze or overglaze work.

Zinc oxide, which is often used as a substitute for lead, improves color, gives more gloss, gets away from egg-shell finish, helps to correct crazing, gives longer heat range and easier fusibility, obviating use of a large quantity of lead and boric acid.

Objections to its use are that it lessens the possible range of overglaze colors and increases solubility of glaze in caustic washing solutions used in hotels and elsewhere.[4]

FRITTED GLAZES.

Many efforts have been made from time to time to produce a good fritted glaze. This seems to be the common ground on which all investigators meet as to the best method of eliminating lead poisoning from the pottery industry.

We share the conviction that a vast improvement might be made in the reduction of the lead hazard if the lead were fritted and if the fritted glaze were uniformly used. To the end that the feasibility of such plans might be determined, the Service consulted with R. L. Stull, at the Ceramic Laboratory, United States Bureau of Mines, who has been working in the field for some time. Mr. Stull's report follows:

FRITTING THE LEAD.

In order to reduce the hazards of lead poisoning in potteries using glazes of the whiteware type, it is advantageous to frit all of the lead. If the frit is properly constituted it is practically insoluble to most dilute chemical reagents and thereby eliminates the possibility of lead poisoning to workmen who come in contact with the glaze. However, the weighing of the frit, its mixing and fritting operations, offer opportunities for lead poisoning; but these operations are usually confined to two or three workmen, so that the number of employees coming in contact with soluble lead is reduced to a minimum. Much can be done in the way of education. If the workmen who prepare the frit understand the causes and effects of lead poisoning and are compelled to take proper precautions, no contraction of lead poisoning need occur.

There are three ways by which the frit may be changed so as to include all the lead. First, the lead may molecularly replace part or all of the whiting in the original frit or, second, it may replace parts of the whiting, zinc oxide, and barium carbonate, if the two latter are present. This can generally be done without changing the general frit formula to its oxygen ratio. Third in "high lead" glazes maturing at low temperatures the amount of raw lead in the glaze may be so great that there are not sufficient replacement RO's (Whiting, zinc oxide, etc.) in the frit to take care of the lead. In such a case it becomes necesssary to construct an entirely new frit, which should contain sufficient alumina and silica introduced in the form of feldspar clay and flint to form a well-balanced frit low enough in solubility to be harmless. Glazes Nos. 1 and 1A represent a case in which all the lead is introduced into the frit by molecularly replacing part of the whiting.

Batch composition, glaze No. 1.

	Per cent.
Frit	42.35
Feldspar	8.01
Whiting	5.72
White lead	19.89
China clay	6.58
Flint	17.45

Formula, glaze No. 1.

$$\left.\begin{array}{l}0.11\ K_2O\\ .11\ Na_2O\\ .53\ CaO\\ .25\ PbO\end{array}\right\}\left.\begin{array}{l}0.25\ Al_2O_3\\ .40\ B_2O_3\end{array}\right\}2.8\ SiO_2$$

$$1.00\ RO$$

[4] Abstracts from Notes on Pros and Cons of use of Zinc Oxide in Glazes, by P. C. Purdy, vol. 17, pp. 520-526, A. C. S., 1919.

Batch composition, frit for No. 1.

	Per cent.
Feldspar	17.20
China clay	6.65
Borax	21.65
Whiting	17.01
Boracic acid	11.51
Flint	25.98

Formula, frit for No. 1.

$$\left.\begin{matrix}0.12\ K_2O\\ .22\ Na_2O\\ .66\ CaO\end{matrix}\right\}\left\{\begin{matrix}0.22\ Al_2O_3\\ .80\ B_2O_3\end{matrix}\right\}2.6\ SiO_2$$

1.00 RO

Combining weight=296.3.

Since it requires 0.5 molar equivalents of frit for the glaze, the 0.25 PbO ÷ 0.5 = PbO may be substitutes for 0.5 CaO in the original frit formula. The formula for the new frit for 1A then becomes:

$$\left.\begin{matrix}0.12\ K_2O\\ .22\ Na_2O\\ .16\ CaO\\ .50\ PbO\end{matrix}\right\}\left\{\begin{matrix}0.22\ Al_2O_3\\ .80\ B_2O_3\end{matrix}\right\}2.6\ SiO_2$$

1.00 RO.

Combining weight=379.3

and the batch composition for frit for 1A:

	Per cent.
Feldspar	14.29
Borax	18.00
Whiting	3.43
White lead	27.62
China clay	5.52
Boracic acid	9.56
Flint	21.58

The introduction of 0.5 molar equivalent of the new frit into the glaze formula, together with the proper amounts of feldspar, whiting, china clay, and flint, gives a glaze of the same composition when fired as glaze No. 1.

Following is the batch composition of the new glaze in which all the lead is fritted:

Batch composition, glaze 1A.

	Per cent.
New frit	54.67
Feldspar	8.01
Whiting	12.98
China clay	6.70
Flint	17.64

Glaze No. 2 represents a condition where the lead is substituted for part of the whiting and all the zinc oxide.

Following are the batch compositions and formulæ of the glaze and frit:

Batch composition, glaze No. 2.

	Per cent.
Frit	54.37
Feldspar	6.76
Whiting	3.65
White lead	18.83
China clay	4.71
Flint	11.68

Formula, glaze No. 2.

$$\left.\begin{matrix}0.10\ K_2O\\ .15\ Na_2O\\ .27\ CaO\\ .15\ ZnO\\ .33\ PbO\end{matrix}\right\}\left\{\begin{matrix}0.22\ Al_2O_3\\ .30\ B_2O_3\end{matrix}\right\}2.5\ SiO_2$$

1.00 RO.

Batch composition, frit for No. 2.

	Per cent.
Feldspar	15.32
Borax	26.32
Whiting	6.89
White lead	10.67
Zinc oxide	5.58
China clay	7.11
Flint	28.11

Formula, frit for No. 2.

$$\left.\begin{matrix}0.10\ K_2O\\ .25\ Na_2O\\ .25\ CaO\\ .25\ ZnO\\ .15\ PbO\end{matrix}\right\}\left.\begin{matrix}0.2\ Al_2O_3\\ .5\ B_2O_3\end{matrix}\right\}2.5\ SiO_2$$

1.00 RO

Combining weight=298.

Since the glaze requires 0.6 molar equivalent to the frit and since the frit formula contains 0.15 PbO, 0.15 PbO×0.6, or 0.09 PbO, is brought into the glaze by the frit. The 0.33 PbO in the glaze formula less 0.09 PbO introduced by the frit leaves 0.24 PbO which is introduced into the glaze in the form of white lead and which is to be incorporated in the frit in order that all the lead shall be fritted.

The 0.24 PbO÷0.6 gives 0.4 PbO to go into the frit formula and replace 0.4 equivalent of the other members in the RO. This may be done by replacing 0.25 ZnO. 0.15 CaO=0.4 RO, which gives the following as the formula and batch composition of the new frit:

Formula, frit for 2A.

$$\left.\begin{matrix}0.10\ K_2O\\ .25\ Na_2O\\ .10\ CaO\\ .55\ PbO\end{matrix}\right\}\left.\begin{matrix}0.2\ Al_2O_3\\ .5\ B_2O_3\end{matrix}\right\}2.5\ SiO_2$$

1.00 RO

Combining weight=358.

Batch composition, frit 2A.

	Per cent.
Feldspar	12.91
Borax	22.17
Whiting	2.32
White lead	32.93
China clay	5.99
Flint	23.68

Following is the batch composition of the new glaze, in which 0.6 equivalents of the new frit is used. The formula of the glaze is the same as No. 2.

Batch composition of glaze 2A.

	Per cent.
Frit 2A	66.28
Feldspar	6.86
Whiting	6.48
Zinc oxide	3.75
China clay	4.78
Flint	11.85

No. 3 may be called a "high lead" glaze in which part of the lead is fritted and part is added to the glaze batch as white lead.

Batch composition No. 3.

	Per cent.
Frit	42.60
Feldspar	6.52
Whiting	1.76
White lead	30.23
China clay	3.78
Flint	15.11

Formula, glaze No. 3.

$$\left.\begin{array}{l}0.09\ K_2O\\ .07\ Na_2O\\ .24\ CaO\\ .60\ PbO\end{array}\right\}\begin{array}{l}0.14\ Al_2O_3\\ .14\ B_2O_3\end{array}\Big\}2.3\ SiO_2$$

1.00 RO

Batch composition, frit for No. 3.

	Per cent.
Feldspar	16.15
Borax	15.53
Whiting	10.46
White lead	29.98
Flint	27.88

Formula, frit for No. 3.

$$\left.\begin{array}{l}0.10\ K_2O\\ .14\ Na_2O\\ .36\ CaO\\ .40\ PbO\end{array}\right\}\begin{array}{l}0.10\ Al_2O_3\\ .28\ B_2O_3\end{array}\Big\}2.2\ SiO_2$$

1.00 RO

Combining weight=290.8.

In the glaze, 0.5 equivalent of the frit is introduced, which accounts for 0.2 PbO and leaves 0.4 PbO to be added as white lead. The 0.4 PbO ÷ 0.5 = 0.8 PbO. This added to the 0.4 PbO already in the frit formula gives 1.2 PbO. Since the formula is based upon unity RO, all the PbO can not be taken care of simply by replacement of other members in the RO. It therefore becomes necessary to construct a new frit. In order to frit such a large quantity of lead and produce a frit relatively low in solubility, it is necessary to frit a large portion of the glaze ingredients.

The following is an illustration showing how the problem of fritting all the lead in glaze No. 3 was solved under practical working conditions:

Formula, frit for No. 3A.

$$\left.\begin{array}{l}0.1125\ K_2O\\ .0875\ Na_2O\\ .0500\ CaO\\ .7500\ PbO\end{array}\right\}\begin{array}{l}0.1125\ Al_2O_3\\ .1750\ B_2O_3\end{array}\Big\}2.2\ SiO_2$$

1.00 RO

Batch composition, frit for No. 3A.

	Per cent.
Feldspar	16.21
Borax	8.66
Whiting	1.30
White lead	50.13
Flint	23.70

Combining weight=341.

Batch composition, glaze No. 3A.

	Per cent.
Frit 3A	82.14
Whiting	6.02
China clay	3.89
Flint	7.95

ADVANTAGES OF FRITTED GLAZE.

Besides reducing the hazards of lead poisoning, the advantages of fritting the lead are that it reduces the temperature of the fritting and gives a frit that grinds more readily to a fine condition. In case of No. 3 glaze, where it becomes necessary to frit a larger proportion of the materials, it tends to lower the maturing temperature of the glaze.

All substances are volatile at some temperature and pressure. During fritting, the lead, borax, and boracic acid lose most by volatilization, especially during the fusion and gas-evolution stages. However, it is not evident that the loss of lead in fritting is any greater than that which occurs in the glaze during the glost fire, when the lead is added to the glaze in the raw or unfritted form.

During the fusion of the frit, the lead oxide, as well as the borax and borac acid, enters into solution and becomes more or less combined chemically with other components, and in that condition the rate of volatility is much reduced.

From what we have stated in sections I and II it will be seen that among the advantages of fritted lead are the following:

1. If frit is properly constituted, it is practically insoluble to almost all dilute chemical reagents, and the possibility of lead poisoning to workmen who come in contact with the glaze is thereby eliminated.

2. By the use of frit, the lead hazard is limited to the few workmen engaged in making the frit.

3. Fritted lead can be used as such for working glaze or in various concentrations, thereby lessening the total amount of soluble lead present in a glaze compound, and hence decreasing the possibility of lead poisoning.

CONTINUOUS KILN.

Continuous kiln firing has not yet been introduced generally, but its success has been demonstrated. The tunnel kiln appears to be the most successful type of continuous kiln, but its general adoption by the industry is prevented by lack of capital and by the objections of some of the workers and plant executives. The exposure to lead poisoning in a kiln room is greatly reduced by the substitution of the continuous kiln for the ordinary intermittent kiln.

In tunnel kilns saggers are not necessary, and by dispensing with saggers the tunnel kiln eliminates the lead hazard attendant upon sagger washing and the fatigue hazard that accompanies the loading of kilns. The heat hazard is also reduced, and risk from exhaust or escaping gases is minimized.

Moreover, it is alleged that these advantages follow from the use of the tunnel kiln, not only without increased cost but at an actual reduction in the operation charges, because of the use of less fue- and the elimination of wastes and of seconds in the ware.

At one time when the field work of the survey was conducted one continuous kiln was found in operation, and since that time informal tion has been received that 11 more have been installed in various plants.

As we have said in previous sections of this report, many of the workmen in and around the kilns are affected with plumbism. It is for the protection of these workmen that we mention the tunnel kiln and enumerate its advantages.

AUTOMATIC WARE DIPPING.

Automatic ware dipping is successfully accomplished in glazing tile, but mechanical dipping has not to any extent replaced the hand dipping of earthenware, as far as we have been able to ascertain.

However, one manager interviewed claims to have perfected a device for dipping all ware except "jugs" (meaning any ware similar to a jug or pitcher). This device, he says, has been successfully operated. He is now working to perfect it for all ware. In connection with this device he has compounded an acid solution which will so even the surface of all ware that one standard dilution of glaze will properly coat it. He has the very good idea of transferring the dipped ware directly from the dipping device to the cars which run through the tunnel or continuous kiln. This will do away with the ware boards and the handling of dipped ware after it has dried, and will thus eliminate much of this present potential source of glaze dust.

THE MANGLE.

The English mangle is not only a labor-saving device, but it reduces the dangers from exposure to lead. The dipped ware from the tub is placed directly upon the shelf of the mangle and is carried up, dried, and conveyed on an endless wheel to a helper, whose duty is to remove the superfluous glaze on a grating, equipped with a suction draft from a blower, which carries away the dry glaze dust.

APPENDIX A.

CLAGUE-OLIVER ELECTROLYTIC TREATMENT FOR LEAD POISONING.

OPINIONS ON THE EFFICIENCY OF THE TREATMENT AND SOME RESULTS NOTED IN THE POTTERY SURVEY.

TREATMENT FOR THE PREVENTION AND CURE OF LEAD POISONING.

The Clague-Oliver electrolytic treatment of plumbism consists in placing the patient with the feet immersed in a foot bath of normal salt solution, which is 60 grains of salt to a pint of warm water, and with the hands and arms resting in a comfortable manner in a hand bath of the same solution and then inserting the positive electrode from a 110-volt direct current in the foot bath and the negative electrode in the hand bath. The patient should not touch either of the electrodes, and caution must be taken that the salt solution does not reach the binding post or wire of the electrodes.

The standard apparatus for this treatment consists of a controller board with lamp and meter, current-supply cord and socket plug, three lead bifurcated cords, six electrodes, six baths (three foot and three hand baths). The baths may be of earthenware or of wood, and the electrodes of pure aluminum. If the current is introduced gradually by a suitable rheostat until the meter shows from 30–50 milliamperes no shock is felt, nor is any unpleasant sensation experienced by the men.

The theory upon which the treatment is based is as follows: When an electrical current is passed through a solution of salt—that is, an acid united with a base—the acid collects at the point where the positive wire enters and the base goes to the negative pole. The two entities in each salt are termed ions, and they can pass through membranes. Since the positive pole is placed in one bath and the negative in the other, the current is assumed to pass through the body of the patient. It is by this reasoning that Sir Thomas Oliver explains the presence of lead on the negative pole; also the disappearance of the blue line from the gums of workmen treated by the double electrical bath.

The duration of the bath may be from 30 minutes to one hour, according to the condition of the patient. For prevention of poisoning and elimination of lead daily absorbed, an average of three baths per week has been found sufficient. In acute cases daily baths are recommended as a cure.

Dr. H. Lewis Jones, of St. Bartholomew's Hospital, about 18–20 years ago treated cases of lead poisoning by means of a single electric bath, and he became enthusiastic over the efficacy of the treatment. The standard form of the Clague-Oliver electrolytic apparatus has been installed in the Mercer Hospital, Trenton, N. J., the East Liverpool City Hospital, East Liverpool, Ohio, and the Wardner Hospital, Kellogg, Idaho.

The tests so far made to determine the efficiency of the Clague-Oliver treatment of plumbism have been few and lack scientific exactness. The only animal experimentation made by Sir Thomas Oliver, who is perhaps the strongest advocate of the electrolytic method, was on a rabbit, which died after having received lead almost daily for three years in the form of a solution of nitrate of lead dropped into the back of its mouth from a pipette. In the course of three years it received 1,095 grains of nitrate of lead, equivalent to 684 grains of metallic lead. Some months after having taken the drug the animal became painlessly paralyzed. It was treated electrolytically by the two-bath system. Under this method of treatment the animal recovered the use of its limbs. In a few days it was quite well again. The administration of lead was resumed, and in the course of nine or ten months the animal again lost the use of its limbs. Treatment by the double electric bath soon restored the rabbit to its former health and vigor. By the end of another year these were again lost, the animal became emaciated and died. In the liver, kidneys, and spleen there was found on microscopical examination a distinct increase of connective tissue, and from the liver and kidneys lead was extracted (1).

This single experiment is not satisfactory, because it takes into account only one factor—that is, the amount of lead given to the rabbit. Other important factors, such as the amounts eliminated by natural means, the amounts absorbed, the amounts eliminated by means of the electric baths, and the behavior of a control rabbit given the same amounts of lead at the same intervals, the electric baths being omitted, have not been taken into account.

On the other hand, experimental work performed by Oxley and Goadby in England in 1914 failed to prove that any lead salt will undergo deionization by electrolysis in the body. On the contrary, at no time did they find lead on the electrodes or in the solution, while the serum of all the animals experimented on contained lead.

In an article published October 3, 1914, in The Lancet, London, W. H. F. Oxley gives the results of his experiments with the electric bath treatment for lead poisoning. A summary of the article follows:

Experiment No. 1.—Eight cases of lead absorption.—Three cases were given 18 baths, 2 were given 14 baths, the others were given 6, 7, and 8 baths. No changes were noted in the lead lines or signs of lead absorption. Languid feeling was noted after the bath.

Experiment No. 2.—One man with lead absorption.—Arms and legs were scrubbed and were put in the baths, with no current passing; no lead was found in the water at the end of 40 minutes. Then a current of 35 M. A. was passed for 40 minutes. The electrodes were removed and the water tested for lead with negative results. The electrodes were tested for lead, and a black (sulphide) precipitate was obtained, which might be mistaken for lead, but positive tests showed this to be iron in the electrodes.

Experiment No. 3.—Same as experiment No. 2, except that platinum sheets were used in place of aluminum electrodes. No lead was found in the water or on the electrodes.

Experiment No. 4.—Six cases of lead absorption were treated with the electric baths, the same water and electrodes being used for all the treatments. No lead was found in the water or on the electrodes.

Experiment No. 5.—Twenty-four hour specimens of urine of two old lead workers were examined for lead, with negative results. The next day treatments were given, with the use of 35 M. A. for 40 minutes; and 24-hour samples of urine were collected. No lead was found in urine, electrodes, or water.

Experiment No. 6.—A rabbit was given large doses of lead during a period of time not specified and was then given the treatment, at first for 2 hours, using 35 to 40 M. A. current, and then for 4 hours. No lead was found in the water of the baths or in the electrodes. The animal died; the body was cut up into a number of pieces, placed in an electric bath through which a current of 90 M. A. was passed for 3 hours. No lead was found in the water or on the electrodes. The liver was emulsified, placed in a dialyzer in an electric bath and a current of 35 M. A. was added for 40 minutes.

No lead was found in the water or on the electrodes. Chemical analysis of the liver showed that 2.2 milligrams of lead were present.

Conclusion.—No good would result from continued treatment with the electric baths. The proportion of lead ions in a body (fatally poisoned) to the tissue ions is not over 1 to 1,600. All the ions use up the current; the available current can not deposit over 0.04 milligram of lead per bath.

Another point which is overlooked by advocates of this treatment is the slow rate of penetration of ions through animal membrane. With this factor and the above factor taken into account, the total possible effect of an electric bath would be to remove from the superficial layers of the skin not over $\frac{1}{7500}$ of a gram of lead.

In the issue of The Lancet in which Oxley's article appears there is also an article by Kenneth Goadby. A summary of Goadby's experiments and conclusions on the electrolytic prevention of lead poisoning is given below.

Iron (as well as some copper) was found on the aluminum electrodes and in the water and salt first used. Platinum electrodes were therefore used instead of aluminum electrodes, and pure water and salt.

Experiment No. 1.—Four cats and two dogs were given lead and were treated with the electric baths. No lead was found in the water or on the electrodes. It was found to be impossible to remove lead from the liver of a lead-poisoned animal by the electrolytic method. Chemical analysis of the liver showed the presence of lead; this lead was probably present as an albuminate. A metal absorbed by albumin is undissociated. Without dissociation, no deposit is likely to occur.

Experiment No. 2.—A 10 per cent solution of lead nitrate was added to a 5 per cent solution of albumin; the substance then gave combined reactions of lead and albumin. Some free lead was also present. Ten grams of lead albuminate were treated with 25 c. c. normal horse serum, the supernatant clear serum was pipetted off and placed in a dialysis tube of parchment paper, suspended in a normal salt solution. A platinum electrode was placed in the tube and another in the surrounding bath. A current of 0.1 ampere at 8 volts was passed for 14 hours. The electrodes were tested for lead, with negative results. The serum was tested and was found to contain lead.

Conclusion.—Lead chloride, or any soluble salt of lead, forms a thick, curdy, white precipitate in the presence of lead, and therefore lead circulating in the blood is unlikely to remain as a simple organic salt; but unless it does so—there is no evidence to show that it does—it will not undergo ionization by small electric currents. Iron is easily deposited by electrolysis; if, therefore, Sir Oliver's contention is correct, that lead is eliminated electrolytically, iron from the hemoglobin of red blood corpuscles should also be removed. Small quantities of lead are no doubt eliminated or washed off the skin.

So far experiments do not establish any grounds for belief in the prevention or the successful treatment of lead absorption or lead poisoning by means of the electric bath.

The experiments described by Oxley and Goadby are more careful and scientific than those described by Oliver. Oxley's and Goadby's findings support each other, and their conclusions agree; but they fail to confirm Oliver's findings in any particular.

As a further test of the efficiency of the treatment, Dr. A. D. McCracken, in a recent communication to this office, proposes the following experiment: "Determine the amount of lead in the urine for three successive days without treatment, then for three days under intensive electrical treatment, and for the three days following. This will not include the lead excreted by the bowel, and as we know that free purgation does relieve the condition, it may be that much the larger part of the lead is eliminated by the bowel, and possibly the experiment should include the bowel discharges also. I suppose that the same method for finding the lead in the urine would be applicable to the feces."

However, present-day opinion among physicians is practically worthless. Careful records have not been kept, and opinions are based largely on statements made by patients rather than on observation of patients for a long period of time. The differences in the opinions offered render them of little value.

Sir Thomas Oliver maintains that persons suffering from lead poisoning show few, if any, signs of plumbism after two or three weeks' treatment with the electrolytic process, while a bath once or twice a week prevents lead from settling in the system; and that rheumatic joints, so-called, improve, and double wrist-drop slowly disappears (2).

While Dr. McCracken, of the Wardner Hospital, believes that there is a rapid clinical improvement with the treatment, Schmitter treated 12 patients without benefit; but he does not state whether the condition of the patient was such that structural alterations of the tissues had advanced too far.

Botterick, while he admits that lead is found in the water of the bath after electrical treatment, thinks that this lead comes possibly from the skin, for lead compounds are known to enter into such close combination with the skin that weeks after men have left off work, and after repeated careful cleansing of the skin, lead can still be detected in the water of the bath.

In attempting to find data in addition to that secured from a physical examination of workers in exposed processes, in order to make a definite statement as to the amount of sickness and death occurring from lead among the pottery workers of New Jersey, Acting Asst. Surg. Eloise Meek states, after a visit to the hospital to inspect the Clague-Oliver machine which the Brotherhood of Operative Potters had placed there:

"It was operated by a nurse in charge; a motor-generator set, 110 volts, connected through a rheostat registering 0.01–0.3, was connected to a positive and negative carbon plate 9 by 4, each of which was placed in a separate fiber tub half filled with a warm solution, to act as an electrolyte. The patient places the affected member, or part, in one of the tubs, and another extremity is put into the alternate tub. The current is then applied, and a gradually increasing current density is used for three-quarters of an hour. Treatments are supposed to be given twice a week, continuing for a minimum of six weeks.

"The nurse stated that most of the cases improved, although, when permission was asked to see records, it was explained that as the patients were sent by the union no records or names were kept, treatments being free and patients coming voluntarily. Her report had merely listed 22 cases as treated, but did not indicate whether all were pottery workers. One case, the most pernicious, was not a pottery worker."

A more recent visit to the Mercer Hospital revealed the fact that the pottery workers were taking fewer treatments, with longer intervals between treatments, although they maintained that they derived some benefits from the treatments.

A survey made by Asst. Surg. Marvin D. Shie (R.), of the East Liverpool City Hospital, indicates that 36 pottery workers received treatment during a period of five months, with a total of 316 treatments. It is interesting to note that only one man took the treatment for the prescribed length of time. He had wrist-drop when he began the treatment, and wrist-drop when he finished. He was somewhat improved, however, but his improvement may well have been due to his absence from work for part of that time. The person who took the next highest number—35—is dead. She died of lead poisoning. The other people who have taken the treatment show no physical improvement; in fact, with some of them the intoxication has slowly progressed in spite of the treatments, although some of their symptoms may be alleviated. While the opinion of many of the potters themselves is that the treatment is of some value, this belief does not seem to have been strong enough to cause them to take it with any regularity. This lack of regularity, shown by the fact that only 316 treatments were taken when 1,500 to 2,000 should have been taken, lessens the value of any conclusion which might be drawn as to the results. The statistics given at East Liverpool Hospital are as follows:

October 1, 1918–February 25, 1919.

Number of persons treated	36 (1 female).
Total number treatments given	316 (30 minutes each).
Average number treatments per case	8.8; per month, 1.8.
Minimum number treatments per case	1 per month.
Maximum number treatments per case	43; per month, 8.6.
Occupations of persons treated	24 dippers, 1 kiln hand, 1 presser, 10 not stated.
Average age of 24 persons treated	46.1 years.
Average length of time (24 persons) in occupation	27.5 years.

The men who had taken the treatments were questioned as to their effects. Most of them made favorable statements, the substance of which is as follows:

1. The patients always feel better immediately after the treatment. This sense of increased well-being often lasts for several days.
2. Appetite is increased.
3. Insomnia is diminished. Sleep is promoted.
4. Those who have wrist-drop and weakness of the muscles of the forearm state that their muscles are stronger immediately after the treatment, and that they are able to grasp things better.
5. Headaches are decreased and diminished in severity.
6. Usually some slight gain in weight is made, probably because of increased appetite and better sleep.

The benefit thus experienced is of no little value, even though it is almost entirely symptomatic. It means much to men who have been suffering from insomnia, headaches, and local and general asthenia to get even temporary relief when they have taken a "treatment." They fallaciously reason from the relief to the elimination of the cause, notwithstanding the fact that in the diagnosis of the examiner plumbism has not decreased, but rather has slowly progressed in some cases. Not enough pottery workers have used the treatment with sufficient regularity to make an evaluation of its worth as a preventive measure possible. One definite result, though, follows the use of the treatment. It does tend to encourage pottery workers to exercise more care in personal hygiene, cleanliness of hands and person, the use of laxatives when they are needed, the keeping of better hours, and like practices, which in themselves help toward prevention and cure. As an adjunct to other treatment, the method is of probable value simply for its symptomatic effects.

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(2) Oliver: Diseases of Occupation, third edition, p. 438.

Appendix B.

CHEMICAL EXAMINATION OF LEAD GLAZES.

The procedure and the technique followed at the Hygienic Laboratory for the determination of the amounts of the soluble and the total lead content in the glaze samples are here given. Although not all the samples were analyzed at this laboratory, the method outlined is similar to that used in the other laboratories.

HANDLING OF SAMPLES.

The preliminary handling of the samples depends entirely on whether the sample is received in the powdered form or suspended in a liquid. The powdered samples are thoroughly ground in a mortar with a pestle until the lumps are broken. The thoroughly mixed sample is then transferred to a stoppered bottle. The samples suspended in liquid are kept stoppered in the original containers, but are thoroughly shaken before analysis is made.

DETERMINATION OF WATER.

In the powdered samples: Weigh 5 grams of the powdered sample into a tarred porcelain dish and dry at 100° C. until there is no further loss in weight. The loss in weight will represent the water present. The resulting dried sample is then transferred to a glass-stoppered bottle and reserved for determination of lead.

In the liquid samples: After thoroughly mixing the sample in the bottle, weigh 10 to 20 grams of the sample into a tarred porcelain dish and dry at 100° C. until residue can be powdered with a spatula. After the dry residue in dish is broken with a spatula, return the dish and sample to oven again and dry at 100° C. until there is no further loss in weight. The loss in weight will represent the water present. The resulting dried sample is then transferred to a glass-stoppered bottle and reserved for determination of lead.

DETERMINATION OF SOLUBLE LEAD.

Weigh in duplicate 0.15 gram of the dried sample into a glass-stoppered bottle and, after adding 150 c. c. of 0.25 per cent hydrochloric acid, shake for one hour in a shaking machine at a rate of 200 excursions per minute. Transfer contents of bottle to a 300 c. c. volumetric flask and dilute to mark with water. After one hour of standing, filter the sample and transfer 100 c. c. aliquot to a 300 c. c. Erlenmeyer flask. Add 2 c. c. of N/5 acetic acid, saturate with hydrogen sulphide, and allow to stand overnight under bell jar. Filter, transferring entire precipitate with aid of first filtrate. Wash the precipitate six times with 10 c. c. portions of a solution of H_2S containing 10 c. c. of saturated aqueous solution of H_2S, 100 c. c. of water, and 5 c. c. of N/5 acetic acid. Return the filter containing the precipitate to the original Erlenmeyer flask and add 20 c. c. of 1-10 HNO_3. Place a funnel in the mouth of the flask and boil moderately for five minutes. Filter, wash residue six times with about 10 c. c. each of hot water, and evaporate filtrate on steam bath to about 10 c. c. Cool, add 5 c. c. of concentrated sulphuric acid, and heat until copious SO_3 fumes are given off. Cool, dilute with 5 c. c. of water, and add 150 c. c. of 50 per cent alcohol. Mix and allow to stand overnight. Filter through a tarred Gooch crucible, and wash six times, filling the crucible each time with 50 per cent alcohol, finally washing with 10 c. c. of 95 per cent alcohol. Dry the crucible and lead sulphate two and one-half hours at 100° C., and weigh. The increased weight of crucible is the lead sulphate. Using the factor 0.6832, calculate the per cent of soluble lead in the sample.

DETERMINATION OF TOTAL LEAD.

Weigh 1 gram of the dried sample into a 100 c. c. casserole, add 30 c. c. of 1-1 nitric acid, and evaporate to dryness on steam bath. Take up residue with hot water and filter, washing the residue on filter paper with hot water. Reserve filtrate for combination with filtrate from fusion of residue. Transfer residue and filter paper to platinum crucible, dry, and ignite cautiously until paper is nearly ashed. Add 4 grams of fusion mixture (5 parts Na_2CO_3 and 7 parts K_2CO_3) to residue in crucible, and fuse until fusion is complete. Remove crucible to casserole and dissolve the fused sample in a weak aqueous solution of HCl until crucible is clean. Filter the resulting solution and wash residue on filter paper until free of solids. Combine the filtrate with above filtrate, evaporate, and transfer the combined filtrate to a 200 c. c. volumetric flask. Dilute to mark and mix thoroughly. Take two 40 c. c. aliquots and evaporate to dryness in 200 c. c. casserole. Add 30 c. c. of 1-1 HNO_3 and evaporate to dryness again. Take up with hot water and transfer to 300 c. c. Erlenmeyer flask, diluting to 100 c. c. mark. Add 5 c. c. of N/5 acetic acid, saturate with H_2S, and allow to stand overnight under bell jar. Filter the lead sulphide, and follow the same procedure as given under the determination of soluble lead, weighing the lead sulphate and calculating the per cent of total in the sample.

APPENDIX C.

STUDIES OF EMANATIONS FROM LEAD GLAZES.

In our efforts to evaluate all the factors which perchance might help to explain the higher incidence of lead poisoning among the dippers, our attention was attracted to J. L. Breton's (1) statement that his experiments, as well as those of M. Trillat, Dr. Heim, and others, proved the emanations and tension of fumes of the carbonate and the oxides of lead. Since these compounds are used in the glaze, it occurred to us that if emanations are given off from the glaze in the open tubs over which the dipper stands he is exposed to an added hazard. This led to the following study and experiments by Assistant Chemist Harry W. Houghton, of this office, who conducted the work at the Hygienic Laboratory:

"In the search for literature pertaining to the hazards of the pottery industry there was found a publication by Breton (1) in which the author described in detail the discovery of emanations from fresh white-lead paint, by the detection with acetic acid solution, of tetramethyl-diamino-dyphenylmethane, Trillat's reagent, which produced a blue color with lead peroxide. The same author cited four other similar investigations, among which were emanation studies on the oxide and carbonate of lead, but in only one of these investigations did the results confirm his experiments. In the majority of the investigations no emanations were found. Although there has been an evident diversity of opinion as to the existence of emanation from lead compound, no further investigation has been undertaken since this publication in 1911.

"Since some of these lead compounds declared by Breton to give off emanations were present in lead glazes used in the pottery industry, it was decided to repeat these experiments in order to determine whether such glazes produce emanations; for if they do so, these emanations undoubtedly present another hazard to workers in pottery.

HISTORICAL REVIEW.

"In 1903 Breton (1) conducted a series of experiments for the determination of emanations from fresh white-lead paint, by detection with tetramethyl-diamino-dyphenylmethane,[1] which when dissolved in acetic acid (Trillat's reagent) gave a distinct blue color with peroxide of lead, resulting in the formation of the corresponding hydrol, $CH.OH(C_6H_4N(CH_3)_2)_2$.

"About the same time the problem was worked on by several other investigators, among whom were Trillat (2), Bezanoon (3), Gautier (4), and Heim and Hébert (5). Most of these investigators, excepting only Breton, and Heim and Hébert, obtained no emanations. The bacteriological studies conducted by Trillat (2) and Marie (6), in which the bacterial cultures were incubated in chambers freshly painted with

[1] This tetramethyl base was prepared as follows: A mixture composed of 30 grams of dimethylaniline, 10 grams of formaldehyde, and 200 c. c. of 5 per cent sulphuric acid solution was heated on a water bath for one hour. After the mixture cooled, an excess of sodium hydroxide was added, and the excess of dimethylaniline and the trace of amine were removed by passing a strong stream of steam through the mixture for 10 minutes. When it had cooled, a mass of crystals settled out, which were removed and recrystallized in alcohol. This procedure gave 15 to 20 grams of the base. The preparation of this base is also given in Farbstoff-Tabellen (1914), by G. Schultz, p. 168.

white-lead paint, showed in the majority of the experiments that there was a retardation of the bacterial growth.

"Trillat reported that he did not obtain any indication of lead emanations, chemically, using the reagent prepared from tetramethyl-diamino-dyphenylmethane; yet Breton conducted similar experiments, spreading the white-lead paint over a large area, and obtained positive evidence of small amounts of lead emanations.

"In his studies Breton arranged a series of freshly-painted boxes under a bell jar in such a manner as to allow a current of air to circulate and be exhausted through a tube connected with an absorption chamber containing 10 per cent sulphuric acid, which held the lead emanations. The sulphuric-acid solution was evaporated to dryness, and lead sulphate was obtained, which was later.reduced to lead peroxide by treatment with alkaline hypochlorite. It is supposed that the remaining lead peroxide was washed free of chlorine and hypochlorite and was then dissolved in acetic acid and tested with Trillat's reagent. The production of a blue color showed the presence of lead emanations.

"Heim and Hébert followed the procedure of Breton to a certain extent, but outlined a method which showed a tension of vapors from carbonate and oxide of lead. The technique of these authors was as follows: The air was first drawn through absorption tubes containing sulphuric acid and caustic potash, to free it of all acid or basic vapors which might be present in the atmosphere: then through a long tube (1–2 cm. in diameter) in which was placed the lead compound, held at the proper temperature; if the compound was in the pulverized form, the two extremities of the tube were closed with cotton plugs to prevent the passage of any dust; the air was then let through a U-tube filled with cotton, which also served to retain any dust; and then into a Gautier absorption tube, in which was placed 10 c. c. of sulphuric acid, which held the emanation of lead; the air was finally passed through a gas meter in order to measure the rate of flow of air that passed through the apparatus. From 3 to 4 liters of air were allowed to pass through per hour. As soon as 100 liters had passed through the apparatus the absorption tube containing the sulphuric acid was removed, and the sulphuric acid was thoroughly washed from the absorption tube. This acid solution containing the lead emanations was evaporated to dryness, leaving the lead in the form of lead sulphate. The dry residue was treated with a solution of sodium hypochlorite, which reduced the lead sulphate to lead peroxide. The chlorine was removed by calcination or washing. On adding the Trillat reagent directly to the residue of lead peroxide there was obtained a characteristic blue color, which was determined colorimetrically by comparison of intensity of color with similar color produced by known amount of lead peroxide likewise treated. Traces of manganese and copper gave similar color reaction, but these were removed from the lead sulphate by washing.

"Through this procedure, Heim and Hébert studied first the emanations given off from 10 grams of metallic lead filings mixed with 150 grams of emery, and they obtained 0.5 and 1 milligram of lead as emanations per 100 liters of air, at temperatures of 18° and 100°, respectively. The same quantity of pure lead and solder or type alloy in fusion showed, respectively, 0.4 and 0.3 milligram of lead emanation per 100 liters of air. The results of these experiments showed that lead filings heated to 18° and 100° gave off more emanations than the molten pure lead, solder, and type alloy.

"In other experiments in which they used 100 grams of ground emery and a quantity of white lead corresponding to 10 grams of metallic lead, Heim and Hébert obtained the following results, at a temperature of 15° to 20°—namely, 0.15, 0.20, and 0.12 milligram of lead per 100 liters of air. These investigators concluded that their experiments verified those of Breton.

"PRELIMINARY EXPERIMENTS.

"As a preliminary to the determination of emanations from the lead glazes, it was necessary, since neither of the procedures described by Breton and by Heim and Hébert, was sufficient in detail to permit exact repetition of these experiments, to conduct a few experiments in order to ascertain the exact conditions which must exist in order to reduce the lead su.phate completely to lead peroxide, and also to remove all traces of oxidizing agents, such as chlorine, ozone, etc., derived from the sodium hypochlorite solution, after acidifying.

"In the first experiment portions of prepared lead sulphate were treated with sodium hypochlorite, first without heating, and secondly by boiling; but neither of these processes reduced the lead sulphate to peroxide. In subsequent experiments the sodium hypochlorite solution which was added to the lead sulphate was heated nearly to boiling. This procedure brought about the proper reduction of lead sulphate to peroxide.

"The experiments next conducted were to determine the treatment that must be followed in order to remove all oxidizing agents given off from sodium hypochlorite when acidified, since these gases also produced a blue color with Trillat's reagent. When the lead sulphate had been reduced to lead peroxide, after the procedure just described, the remaining sodium-hypochlorite solution was acidified with nitric acid. This acid solution was then filtered and the residue was washed until the filtrate was free from chlorides and acid. Considerable washing was required in order to remove all compounds which gave a blue color with the Trillat reagent, except the lead peroxide. The residue on the filter paper was then dissolved in acetic acid and tested with the Trillat reagent.

"Having finally worked out a procedure which would give somewhat dependable results, the following method of analysis was adopted:

"*Apparatus.*—The apparatus consisted of a series of absorption tubes, one Erlenmeyer flask, and a gas meter, connected with glass tubing in such a manner as to permit a known amount of air to be drawn through the apparatus.

"The air was first passed through two absorption tubes—one of which contained sulphuric acid, while the other contained caustic potash—thus removing any acid or basic vapor that might be present in the atmosphere; from these absorption tubes the air was led into a stoppered Erlenmeyer flask (1,000 c. c. capacity) to within 1 inch of the bottom, so as not to come in contact with the lead glaze which was in this flask; the air was then drawn from the Erlenmeyer flask through a U-tube filled with cotton batting, which served to prevent the escape of any dust from the sample of lead glaze; the air was then passed through a Geissler absorption bulb containing 10 c. c. of concentrated sulphuric acid, which dissolved the emanation of lead glazes; finally the air passed through a gas meter, which enabled the measurement of the flow of air through the apparatus.

"*Method.*—An amount of the lead glaze equivalent to 10 grams of metallic lead was weighed out and placed in the Erlenmeyer flask. Before the apparatus which has been just described was put in connection, the Erlenmeyer flask was rotated so as to spread the glaze over the entire interior surface of the flask. After a tight connection on the apparatus had been made the air was permitted to flow over the lead glaze at a rate of 6 liters an hour for a period of 24 hours. At the end of this time the Geissler bulb containing the sulphuric acid was disconnected, and the acid was thoroughly removed from the bulb to an evaporating dish, with water. The acid solution, which was evaporated to dryness, was treated with 20 c. c. of sodium-hypochlorite solution heated nearly to boiling point. This solution was then acidfied with nitric acid and filtrated. The residue on the filter paper was thoroughly washed until filtrate was free of chlorides and acid. The lead peroxide on the filter paper was dissolved in a small amount of acetic acid and tested with Trillat's reagent. The productions of a blue color indicated lead peroxide.

EXPERIMENTAL DATA.

Experiment No. 1 (lead glaze No. 16).

Per cent of water present	43.31
Per cent of total lead present	7.88
Per cent of soluble lead present	6.09
Weight of sample taken ... grams	12.69
Volume of air aspirated per 24 hours ... liters	144.00
Temperature of air during period of experiment ... degrees	18–22
Amount of lead emanations obtained	None.

Experiment No. 2 (lead glaze No. 19).

Per cent of water present	35.34
Percent of total lead present	14.40
Per cent of soluble lead present	13.01
Weight of sample taken ... grams	69.50
Volume of air aspirated per 24 hours ... liters	144.00
Temperature of air during period of experiment ... degrees	18–22
Amount of lead emanations obtained	None.

Experiment No. 3 (lead glaze No. 39).

Per cent of water present	0.62
Per cent of total lead present	17.85
Per cent of soluble lead present	9.77
Weight of sample taken ... grams	56.02
Volume of air aspirated per 24 hours ... liters	144.00
Temperature of air during period of experiment ... degrees	18–23
Amount of lead emanations obtained	None.

Experiment No. 4 (lead glaze No. 41–a).

Per cent of water present	30.17
Per cent of total lead present	26.67
Per cent of soluble lead present	None.
Weight of sample taken ... grams	37.50
Volume of air aspirated during 24 hours ... liters	144.00
Temperature of air during period of experiment ... degrees	20–22
Amount of lead emanations obtained	None.

Experiment No. 5 (lead glaze No. 41–b).

Per cent of water present	43.68
Per cent of total lead present	25.49
Per cent of soluble lead present	23.47
Weight of sample taken ... grams	39.20
Volume of air aspirated during 24 hours ... liters	144.00
Temperature of air during period of experiment ... degrees	20–23
Amount of lead emanations obtained	None.

"DISCUSSION.

"The oxidizing agents, such as chlorine and ozone, which were liberated from the sodium hypochlorite and lead peroxide by the addition of nitric acid, were entirely separated from the remaining lead peroxide by filtration, followed by a thorough washing until the filtration was free of chlorine and acid. As a check on the complete removal of these oxidizing agents, there were run each time control experiments, using 20 c. c. of sodium hypochlorite with and without 0.2 milligram of lead sulphate, which is the compound of lead obtained by evaporating the sulphuric acid, if there were any emanations given off from lead glazes. In each of the five experiments conducted to determine the emanations from lead glazes the final test with the Trillat reagent was negative, agreeing exactly each time with the test made of the blank experiments. But in the experiments where 0.2 milligram of lead sulphate was treated with the sodium hypochlorite solution and the resulting lead peroxide was filtered and washed free of oxidizing agents, such as chlorine and ozone, there was obtained each time a positive test for lead peroxide, indicated by the distinct blue color produced with the Trillat reagent.

"The absence of emanations from lead glazes might be accounted for by the fact that some glazes were mixed with 30 to 43 per cent of water, which would tend to prevent any emanations. Yet this is hardly true, for in most of the experiments the water evaporated during the aeration period. Even in the cases where the water evaporated, there were present no indications of emanations. The results of these experiments agreed with those obtained by Experiment No. 3, in which was used a glaze containing 0.62 per cent of water.

"Furthermore, the absence of emanations in these experiments, as shown by chemical detection with Trillat's reagent—i. e., 5 per cent acetic acid solution of tetramethyldiamino—dyphenylmethane—agreed with the results of Trillat, Bezancon, and Gautier (loc. cit.), although it disagreed with the results obtained by Breton and Heim and Hébert (loc. cit.), in spite of the fact that the technique followed was nearly identical with that stated to have been used by the latter investigators. In the method followed by Heim and Hébert it was stated that the chlorine was removed from the lead peroxide and the sodium hypochlorite solution by calcination or by washing with water. Both these procedures were found to be impracticable. Calcination and boiling, if sufficient to remove the chlorine, destroyed the lead peroxide, while the removal of the chlorine by washing was found to be practically impossible, since in the effort to remove the last traces of chlorine from such small amounts of lead peroxide as 0.1 to 0.2 milligram and also to free the interior of the beaker of adhering hypochlorite and free chlorine, the lead compound was lost by suspension in the wash water. Unless all the chlorine and hypochlorite were removed from the beaker, the Trillat reagent would turn blue in the absence of lead peroxide because of the chlorine gas set free from the hypochlorite by its acidifying with acetic acid contained in the Trillat reagent. In addition to the chlorine gas, which produced a blue color with the Trillat reagent, traces of ozone would also be present, which would likewise produce a blue color, according to the results stated by Arnold and Mentzel (7), and Fischer and Marx (8). The ability of Trillat's reagent to detect oxidizing agents as well as lead peroxide rather offsets its use as a reliable test for lead, especially where such small amounts of lead peroxide and gases were present.

"CONCLUSIONS.

"1. There were no emanations given off from the five lead glazes that were studied.

"2. The Trillat reagent, which was used for the detection of lead peroxide, was found to be extremely sensitive likewise to such oxidizing agents as chlorine and ozone.

"3. Unquestionable detection of lead emanations as lead peroxide from lead compounds must absolutely be determined in the absence of chlorine and ozone, if Trillat's reagent is used for the detection."

The above conclusions by Harry W. Houghton indicate that no lead hazard exists from emanations arising from tubs filled with glaze.

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Appendix D.

In this table the 92 potteries are arrayed in order of the rate of positive and presumptive plumbism, that having the highest rate being at the top. In the first column is given the approximate number of employees, in the second the average number of years of exposure of those employed in the glaze department, and in the third the average per cent of lead used in the glaze samples collected from the plant.

In the remaining columns there are enumerated certain undesirable plant conditions. The conditions found in the several plants are indicated by a star in the appropriate column. The total number of these conditions found in any plant is given in the last column.

This array is divided into three groups of about an equal number of plants, and column totals or averages are given for each group.

Thus, the average number employed in the upper group is 221, in the middle group it is 180, and in the lower group it is 138. The upper group has an average of 15.1 of these undesirable conditions: the middle group, of 11.8, and the lower group, of 9.6.

Undesirable plant conditions for 92 potteries, arranged in the order of rate of positive and presumptive plumbism.

Approximate number of employees.	Average number of years of exposure.	Per cent of soluble lead used in glaze.	Bad toilets.	Common drinking cup.	Open water pail.	Dirty ware board.	Expectorations on the floor.	Dust 200,000 particles.	Poor illumination.	Piecework.	Eat in workroom.	No bathing facilities.	Poor wash facilities.	Poor ventilation.	Splash about tubs.	Dry sweeping.	Sweep during work hours.	Use soft coal.	Open glaze containers.	No respirators.	No special clothing.	No instruction.	No lockers.	No soap and towels.	Pronounced. Cold hazard.	Pronounced. Heat hazard.	Pronounced. Wet hazard.	Pronounced. Fatigue hazard.	Total.
130	13.0	12.8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	25
100	14.0	13.3	*	*	*	*		*	*	*	*	*	*		*	*				*		*	*	*			*		17
150	13.7	15.6		*		*	*	*	*	*	*	*	*				*			*	*		*	*				*	15
100	15.0	13.9	*	*			*		*	*	*	*	*	*	*		*			*	*		*	*	*		*	*	18
130	11.9	13.7		*	*		*	*	*	*	*	*	*		*		*			*	*		*	*			*	*	17
25	5.0	45.7	*	*		*			*	*	*	*	*	*		*	*			*		*	*						14
365	12.4	13.1	*	*	*	*	*	*	*	*	*	*	*			*			*	*		*	*	*					17
825	12.2	13.3	*	*	*	*		*	*	*	*	*	*	*			*			*		*	*	*				*	17
200	12.4	14.2	*	*			*		*	*	*	*	*		*	*				*	*		*	*				*	15
225	13.3	13.0	*	*		*	*	*	*	*		*	*		*		*				*	*	*	*					15
90	13.8	12.6	*	*		*	*	*	*	*	*	*	*	*	*		*			*	*		*	*				*	18
200	8.8	13.4	*	*		*		*	*	*	*	*	*	*	*	*					*	*	*	*					16
300	12.8	12.3	*	*	*		*			*	*	*					*			*	*		*	*				*	13
125	6.0	13.8	*	*			*		*	*	*	*	*	*	*	*	*			*	*		*	*				*	17
125	10.0	12.6	*	*	*		*		*	*	*	*	*		*		*		*	*			*	*				*	16
275	6.8	12.4		*			*	*	*			*		*	*					*	*	*		*					11
400	7.9	12.3		*	*	*	*		*	*	*	*			*						*		*	*				*	13
800	12.0	12.3	*	*	*	*	*		*	*	*	*			*		*			*	*		*	*				*	16
230	16.6	19.2	*	*			*		*		*	*			*		*			*	*		*	*				*	13
70	13.3	16.0	*	*					*	*	*	*	*		*	*			*			*	*	*				*	14
80	5.9	16.3	*	*	*		*	*			*	*		*	*	*	*						*	*					13
110	9.8	10.8		*			*	*	*	*	*	*			*						*	*		*					11
75	12.4	11.6	*			*	*	*	*	*	*	*			*	*					*		*	*	*	*		*	16
410	8.5	12.0	*	*		*	*	*			*	*	*		*	*			*	*		*	*	*					15
375	10.9	3.1		*		*	*	*		*	*	*			*		*			*		*			*	*			13
700	10.6	13.7			*		*	*	*	*	*	*		*	*		*							*				*	12
90	3.1	14.7	*	*			*	*	*	*	*	*	*		*		*			*			*	*					14
200	8.1	15.5	*	*	*		*	*		*	*	*	*		*		*				*		*	*				*	15
230	11.3	14.5	*	*	*		*			*	*			*	*		*			*	*		*	*				*	14
275	7.2	14.4		*	*		*			*	*	*	*		*		*			*	*		*	*				*	14
100	10.6	10.2	*			*	*		*	*	*	*	*		*		*	*				*	*	*					14
[1] 221	12.4[1]	14.3	23	28	14	16	26	18	24	27	29	30	20	11	26	11	21	2	5	21	19	13	27	29	4	2	4	19	[1] 15

[1] Average for group.

Undesirable plant conditions for 92 potteries, arranged in the order of rate of positive and presumptive plumbism—Continued.

Approximate number of employees.	Average number of years of exposure.	Per cent of soluble lead used in glaze.	Bad toilets.	Common drinking cup.	Open water pail.	Dirty ware board.	Expectorations on the floor.	Dust 200,000 particles.	Poor illumination.	Piecework.	Eat in workroom.	No bathing facilities.	Poor wash facilities.	Poor ventilation.	Splash about tubs.	Dry sweeping.	Sweep during work hours.	Use soft coal.	Open glaze containers.	No respirators.	No special clothing.	No instruction.	No lockers.	No soap and towels.	Pronounced.				Total.
																									Cold hazard.	Heat hazard.	Wet hazard.	Fatigue hazard.	
140	16.8	14.6	...	*	...	*	...	*	*	*	*	*	...	*	...	*	...	...	*	...	...	*	*	*	...	...	...	...	13
135	10.8	12.8	*	*	...	*	*	...	*	*	...	*	...	...	*	*	...	...	...	...	*	*	*	*	...	...	...	...	13
150	11.4	12.3	*	*	*	...	*	...	*	*	*	*	*	...	...	...	*	...	...	*	*	...	*	*	...	...	...	*	13
60	15.3	No.	...	...	...	...	...	*	...	*	*	*	...	...	...	...	...	...	...	...	*	...	*	*	...	...	...	...	7
120	15.4	9.2	...	*	*	...	*	*	*	*	...	*	...	...	*	...	*	...	*	...	*	*	*	*	...	...	...	*	15
220	10.8	9.2	*	*	*	...	*	*	*	*	*	...	...	...	*	...	*	...	...	*	...	*	*	*	...	...	...	...	14
185	10.6	13.3	...	*	*	*	*	*	*	*	*	*	*	...	...	*	*	...	...	...	...	*	*	*	...	...	...	...	15
65	11.5	13.9	*	*	...	...	*	*	*	...	*	*	*	...	*	...	*	...	...	*	*	...	*	*	...	...	...	*	15
65	10.2	27.9	...	*	...	...	*	*	*	*	...	*	*	...	...	...	*	...	...	*	*	...	*	*	...	...	...	...	12
110	15.2	10.6	*	*	...	*	...	*	*	*	*	...	...	...	*	...	*	...	...	...	*	...	*	*	...	...	...	...	12
225	7.6	14.2	...	*	...	*	*	*	...	*	...	*	*	...	...	...	...	...	...	*	*	...	*	*	...	...	...	...	11
185	7.4	10.3	*	*	*	...	*	*	*	*	*	*	...	...	*	...	...	...	...	...	...	*	*	*	...	...	...	...	13
275	12.0	10.6	...	*	*	...	*	*	...	...	*	*	*	...	*	...	*	...	...	*	*	...	*	*	...	...	...	*	15
200	9.3	8.3	...	...	...	...	*	*	...	...	...	...	...	...	*	...	*	...	...	...	*	...	...	...	*	...	...	...	6
50	7.9	21.8	...	*	...	...	...	*	*	*	...	*	...	...	...	*	...	...	...	...	...	...	...	*	...	...	...	...	7
230	3.0	13.9	...	*	...	...	...	*	...	...	...	*	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	4
205	5.1	28.7	...	*	...	...	*	*	*	...	*	*	*	...	...	*	...	...	...	*	*	...	*	*	*	...	...	...	13
155	6.0	27.9	...	*	...	...	...	...	...	...	...	*	...	...	*	...	...	...	...	...	...	*	...	...	...	...	...	...	4
350	2.7	12.3	...	*	*	*	*	*	...	*	...	*	...	...	...	*	...	*	...	...	...	*	*	*	...	...	...	...	12
125	2.4	8.7	...	*	...	...	...	*	...	*	*	*	*	...	...	*	...	...	*	...	...	*	*	*	...	...	...	...	11
200	9.1	9.8	...	*	*	...	*	*	*	*	*	*	*	...	*	...	*	...	...	*	*	...	*	*	...	...	...	*	16
150	9.4	13.9	*	*	*	*	...	*	...	...	*	*	*	...	*	*	...	...	...	*	...	*	*	*	...	...	...	...	14
120	16.5	No.	...	...	...	*	*	*	*	...	...	*	...	...	*	...	...	...	...	...	...	*	...	*	...	...	...	...	8
150	9.9	12.4	...	*	*	...	*	...	*	*	*	*	*	...	*	...	*	...	...	*	*	...	*	*	...	...	...	*	15
155	6.0	10.4	*	*	...	...	*	*	...	*	*	...	*	...	*	*	...	...	...	*	...	*	*	*	...	...	...	...	13
300	11.6	14.0	...	*	*	...	*	*	...	*	*	*	*	*	*	...	*	...	...	...	*	...	*	*	...	...	...	*	15
325	11.7	12.3	...	*	*	...	*	...	...	*	*	*	...	...	...	...	*	...	...	*	*	...	*	*	...	...	...	...	11
190	11.7	11.1	*	*	*	*	...	*	*	...	*	*	*	...	...	...	...	...	...	...	...	*	*	*	...	...	...	...	12
200	5.0	9.4	...	*	*	...	*	*	...	*	*	*	...	...	*	...	*	...	...	...	*	...	*	*	...	...	...	...	12
350	11.4	9.8	...	*	...	...	*	*	...	...	*	*	...	...	...	*	*	...	...	...	...	*	*	*	...	...	...	...	10
[1] 180	[1] 11.0	[1] 13.7	9	27	14	9	21	25	16	21	20	26	14	2	16	10	15	1	3	12	17	14	25	27	2	...	...	7	[1] 11.8
115	11.4	14.7	...	*	...	...	*	*	*	*	...	*	...	...	...	...	*	...	...	...	*	...	...	*	...	...	...	*	10
75	13.4	12.4	...	*	*	...	*	*	...	*	*	...	*	...	*	...	...	...	...	...	...	*	...	*	...	...	...	...	10
40	15.0	No.	*	*	...	*	*	*	*	...	*	*	*	...	...	...	...	...	...	...	*	...	*	*	...	...	...	...	12
70	10.0	No.	*	*	*	...	*	...	...	*	*	*	*	...	*	...	*	...	...	...	...	...	*	*	...	...	...	...	12
125	16.9	12.3	*	*	*	...	*	...	*	*	*	*	*	*	*	...	*	...	...	*	*	...	*	*	...	...	...	*	17
125	14.8	13.3	*	*	*	...	*	*	...	*	*	*	*	...	*	*	*	...	...	*	...	...	*	*	...	...	...	*	16
110	10.8	10.6	...	*	...	...	*	...	...	*	*	...	...	...	...	*	*	...	...	...	...	...	...	...	...	...	...	...	6
120	12.6	15.4	...	*	...	*	*	...	...	...	...	*	*	...	*	*	*	...	...	...	...	...	...	*	...	...	...	*	10
120	12.9	20.4	...	*	...	*	*	...	...	*	*	*	*	...	*	...	...	...	...	...	...	...	*	*	...	...	...	...	10
135	5.4	9.8	*	*	...	...	*	...	*	...	...	*	*	...	*	...	...	...	...	*	*	...	*	*	...	...	...	*	12
120	10.2	9.2	...	*	...	...	...	...	*	*	...	...	...	...	...	...	...	...	...	*	...	...	...	*	...	...	...	...	5
65	14.8	15.7	...	...	...	...	*	*	...	*	...	*	...	...	*	...	...	...	...	...	*	*	...	*	...	...	...	...	8
175	6.9	12.0	*	*	*	*	...	...	...	*	*	*	*	...	...	...	...	...	...	...	...	*	*	*	...	...	...	...	11
125	7.7	5.6	...	...	...	...	...	*	...	...	...	*	...	...	...	...	...	...	...	*	*	...	*	*	...	...	...	...	6
115	10.3	11.0	...	*	...	...	*	...	*	...	*	*	*	...	...	...	...	...	...	*	*	...	*	*	...	...	...	*	11
175	9.3	14.0	*	...	...	...	*	...	...	*	*	...	...	...	*	...	*	...	...	*	*	...	*	*	...	...	...	...	10
150	8.8	18.9	...	*	*	...	*	*	...	*	...	*	...	...	...	...	*	...	...	*	*	...	*	*	...	...	...	*	12
225	7.3	11.7	...	*	...	...	*	*	...	*	...	*	...	...	*	...	...	...	...	*	*	...	*	*	...	...	...	...	10
135	5.7	11.4	...	...	...	...	*	*	...	...	*	...	...	...	*	...	*	*	...	...	...	...	*	*	...	...	...	...	8
450	7.2	4.8	...	...	...	...	...	...	...	...	*	*	...	...	...	...	*	...	...	*	*	...	...	*	...	...	...	...	6
25	9.2	20.1	...	*	...	*	*	...	...	*	...	...	*	...	*	*	*	...	...	...	...	...	*	*	...	...	...	...	10
80	11.7	18.5	...	*	...	...	*	...	...	*	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	4
105	11.9	No.	*	*	...	...	...	*	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
30	12.4	10.6	*	*	...	...	*	*	*	*	...	...	*	...	*	...	...	...	...	...	*	...	*	...	...	...	...	...	10
95	11.4	13.6	...	*	...	...	*	*	*	*	...	...	...	...	*	...	...	...	...	...	*	*	...	*	...	...	...	...	9
120	8.8	16.7	...	*	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
125	10.3	13.1	...	*	*	...	*	...	*	*	*	...	...	...	...	...	...	...	...	...	*	...	*	*	...	...	...	...	9
140	9.3	14.8	...	*	*	...	...	...	...	...	*	*	*	...	*	...	...	...	...	...	...	*	*	*	...	...	...	...	9
260	3.7	7.4	...	*	...	...	...	*	*	*	...	*	...	...	...	...	...	...	...	...	*	...	*	*	...	...	...	...	8
225	8.4	12.9	*	*	*	...	...	...	...	*	*	*	*	...	*	...	...	...	...	...	...	*	*	...	...	...	...	...	11
200	10.1	.3	*	*	*	...	...	*	...	*	*	*	...	...	*	...	...	...	...	...	...	*	*	...	...	...	...	...	10
[1] 134	[1] 9.3	[1] 12.5	11	26	10	5	21	14	10	23	16	19	14	1	17	4	11	1	...	10	15	8	20	25	...	...	...	7	[1] 9.6

[1] Average for group.

Appendix E.

DUST.

The dust samples are given according to the dipping, glaze-mixing, and glost-kiln rooms of the pottery plants.

The tables show the number of particles of each class, the weight of all solids in the sample, and the divisions of this solid material. The last two columns in the tables show the total amounts inhaled daily, based on the accepted fact that 135 cubic feet of air is the average amount of inhaled air per accepted workday for each adult exposed to these dusts.

METHODS OF COLLECTING DUST SAMPLES.

All dust counts in the survey were based on the number of dust particles per cubic foot. The technique used closely followed that worked out by Palmer, Coleman, and Ward. (Report of Committee on Standard Methods of the Examination of Air, American Public Health Journal, Vol. VII, 1917.) Our methods have already been described in Part I of the report.

The following tables were made on the basis outlined:

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday.

DIPPING ROOM.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
SANITARY WARE.												
1			22,000	693,300	715,300	0.258	0.0252	0.0227	9	8.8	96,565,500	3.0645
2			25,000	1,695,000	1,720,000	.090	.0103	.0103	11.4	11.4	232,200,000	1.39
3			6,800	351,100	357,900	.0904	.0128	.0128	14.2	14.2	48,316,500	1.728
4			5,300	596,700	602,000	.116	.0144	.0144	12.4	12.4	81,270,000	1.944
5				152,000	152,000						20,520	
6			4,400	118,200	122,600	.0133	.001	.001	7.8	7.8	16,551,000	.135
7			16,500	1,651,200	1,667,700	.104	.0092	.0092	8.8	8.8	225,139,500	1.242
8			440,000	98,300,000	98,740,000	.142	.0071	.0071	5	5	13,329,900,000	.9585
9			600	176,000	176,600	.078	.01	.0099	12.9	12.8	23,841,000	1.3365
10				61,000	61,000	.08	.005	.005	6.2	6.2	8,235,000	.675
11			1,000	286,000	287,000	.036	.022	.022	60.5	60.5	38,745,000	.297
12			7,000	248,000	255,000	.034	.022	.022	64.7	64.7	34,425,000	.297
13		1,200	23,600	1,140,000	1,164,800	.114	.0036		3.15		157,248,000	
14			12,000	2,126,000	2,138,000	.114	.0012		1.05		288,630,000	
15			8,400	1,916,000	1,924,400	.110	.0075		6.82		259,794,000	
16			16,000	307,000	323,000	.092	.015	.015	16.3	16.3	43,605,000	2.025
17			12,000	320,000	332,000	.126	.01	.01	7.93	7.93	44,820,000	1.35
18			6,000	156,000	162,000	.069	.008	.008	11.5	11.5	21,870,000	1.08
19			5,000	539,000	544,000	.088	.024	.024	27.2	27.2	73,440,000	3.24
20			16,000	256,000	272,000	.131	.015	.015	11.45	11.4	36,720,000	2.025
21			2,000	268,000	270,000	.068	.044	.044	64.8	64.8	36,450,000	5.94
22			3,000	213,000	216,000	.048	.022	.022	45.3	45.3	29,160,000	2.97
23			2,030,000	99,600,000	101,630,000	.082	.0010		1.2		13,720,050,000	
24			600,000	61,200,000	61,800,000	.078	.0012		1.6		834,300,000	
25			6,000	256,000	262,000	.053	.015	.015	28.1	28.1	35,420,000	2.025

26				6,000	230,000	236,000	.131	.015	.015	11.46	11.46	31,860,000	2.025
27				10,000	230,000	240,000	.155	.015	.015	9.66	9.6	32,400,000	2.025
28				7,000	187,000	194,000	.116	.01	.01	8.59	8.59	36,190,000	1.35
29				8,000	207,000	215,000	.061	.013	.013	21.45	21.3	29,160,000	1.755
30				10,000	346,000	356,000	.208	.015	.015	7.2	7.2	46,925,000	2.025
31				41,000	517,000	559,000	.156	.011	.011	7.1	7	75,465,000	1.485
GENERAL WARE.													
32				140,000	15,960,000	16,100,000	.707	.0009	.0009	.1	.1	2,173,500,000	.1215
33				6,300	192,000	198.800	.025	.0011	.0011	4.4	4.4	26,838,000	.1485
34				112,000	18,875,000	18,987,000	.639	.116	.116	18.2	18.2	2,863,245,000	15.66
35				1,100	36,200	37,300	.0044	.0006	.0006	12.5	12.5	6,527,500	.810
36				32,000	1,677,300	1,709,300	.0887	.0041	.0041	4.6	4.6	230,745,500	.5535
37				7,200	237,100,000	244,300	.0222	.0009	.0009	4	4	32,980,500	.1215
38				58,600	1,076,800	1,135,400	.109	.0053	.0053	4.9	4.9	153,279,000	.7155
39							.0228	.0069	.0069	30.2	30.2		.9315
40							.074	.0035	.0035	5	5		.4725
41				8,900	1,109,000	1,117,900	.040					150,916,500	
42				91,000	8,225,000	8,316,000	.37	.034	.034	9.2	9.2	1,122,660,000	4.59
43				6,000	202,000	208,000	.107	.0024	.0024	2.2	2.2	28,080,000	.3240
44				7,500	89,500	97,000	.0378	.0022	.0018	5.9	4.9	13,095,000	.243
45				2,000	48,100	50,100	.0283	.0036	.0025	12.7	8.8	6,763,500	.3375
46				28,000	2,415,500	2,443,500	.095	.0069	.0069	7.3	7.3	329,872,500	.9315
47				48,000	1,872,000	1,920,000	.155	.0082	.0082	5.3	5.3	259,200,000	1.107
48				5,800	237,400	243,200	.0827	.0103	.0103	12.4	12.4	32,832,000	1.3905
49				69,300	1,597,000	1,666,300	.0713	.0068	.0068	9.5	9.5	224,950,500	.918
50				22,000	1,553,000	1,575,000	.132	.0057	.0057	4.3	4.3	212,625,000	.7695
51				8,800	1,138,000	1,146,800	.138	.0089	.0089	6.5	6.5	154,718,000	1.2015
52				2,800	294,400	297,200	.276	.0122	.0122	4.4	4.4	40,122,000	1.647
53							.0322	.0083	.0083	25.7	25.7		1.1205
54							.0317	.0028	.0028	8.9	6.1		.378
55				11,600	1,126,000	1,137,600	.075	.0188	.0186	25.1	24.8	153,576,000	2.511
56				15,600	291,100	306,700	.025	.0004	.0004	1.8	1.8	41,504,500	.054
57				2,400	68,800	71,200	.023	.0013	.0013	5.7	5.7	9,612,000	.1755
58				1,700	67,500	69,200	.0075	.0008	.0008	10	10	9,342,000	.108
59				6,400	686,600	693,000	.0716	.0054	.005	7.5	7	93,555,000	.675
60				5,600	520,800	526,400	.0541	.0064	.0057	11.9	10.5	71,064,000	.7695
61				95,200	3,485,700	3,580,900	.562	.0362	.0329	6.4	5.8	473,421,500	4.44
62				10,400	1,380,000	1,390,400	.138	.009	.009	6.5	6.5	187,704,000	1.215
63				35,500	1,324,400	1,359,900	.316	.0253	.0253	8	8	183,586,500	3.4155
64				17,100	243,200	260,300	.0467	.003	.003	6.5	6.5	35,140,500	.405
65				18,700	159,000	177,700	.0707	.0021	.0021	3	3	23,989,500	.2835
66				5,700	871,700	877,400	.0563	.0065	.0061	11.5	10.9	118,449,000	.8235

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday—Continued.

DIPPING ROOM—Continued.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
GENERAL WARE—contd.												
67			4,900	856,400	861,300	0.0667	0.0041	0.0041	6.2	6.2	116,275,500	0.5535
68			77,700	4,155,500	4,233,200	.8861	.0794	.0794	9.2	9.2	571,482,000	10.719
69			210,000	10,090,000	10,300,000	.0756	.0067	.0067	8.8	8.8	1,390,500,000	.9045
70			107,000	5,340,000	5,447,000	.0281	.0012	.0012	4.2	4.2	735,345,000	.162
71			32,000	2,616,000	2,648,000	.412	.0096	.0096	2.3	2.3	357,480,000	1.296
72			6,800	520,000	526,800	.124	.0046	.0046	3.7	3.7	131,118,000	.6210
73			3,800	731,400	735,200	.138	.0133	.0133	9.7	9.7	99,252,000	1.7955
74			3,200	21,600	24,800	.0407	.0012	.0012	2.9	2.9	3,348,000	.162
75			79,200	165,000	194,200	.0541	.0048	.0048	8.9	8.9	26,216,000	.648
76			36,000	312,800	348,800	.252	.0188	.0188	7.4	7.4	47,088,000	2.538
77			6,500	342,500	349,000	.0296	.0008	.0008	2.8	2.8	47,115,000	.108
78			6,200	261,900	268,100	.0437	.0012	.0008	2.7	1.9	36,193,500	.108
79			6,600	396,000	402,600	.0409	.0031	.0027	7.5	6.5	54,351,000	.3645
80			12,200	1,940,000	1,952,200	.114	.0095	.0083	8.3	7.3	263,547,000	1.12
81			7,200	1,132,000	1,139,000	.102	.0026		2.5		153,765,000	
82			680,000	206,000,000	206,680,000	.152	.0075				27,901,800,000	
83			8,000	28,000	36,000	.0625	.00205	.00206	3.307	3.3	44,860,000	.278
84				5,050	5,050	.060		.0061		9	681,750	.8235
85			29,560	14,780	44,340	.132		.0094		7.1	5,985,900	1.269
86			2,640	2,640	5,280	.111		.012		10.8	712,800	1.62
87						.08		.056		5.6		7.56
88			12,460	28,050	40,510	.108		.0046		4.3	4,468,850	.621
89						.093		.0015		1.6		.2025
90						.126		.0043		3.4		.5805
91			720,000	116,000,000	116,720,000	.089	.0011		1.2		15,757,200,000	

92			450,000	67,500	517,500	.701		.0175		2.3	69,862,500	2.30
93						.186		.0041		2.2		.5535
94						.152		.0026		1.7		.351
95						.312		.0066		2.2		.891
96						.156		.0031		2		.4185
97						.133		.0025		1.9		.3375
98			6,894	389,583	386,477	.02	.0007	.00056		3.89	53,524,395	.0756
99			14,222	363,666	377,100		.0032	.0008			50,908,500	.108
100						.0156	.0007	.0005	4.53	3.73		.0675
101							.0022					
102						.0233	.0010	.0008	4.28	3.39		.108
103			18,364	126,090	144,454	.0288	.0002	.0001	0.78	0.47	19,501,290	.0135
104						.0307	.0008	.0003	2.65	1.08		.0405
105						.0086		.0004		5.26		.054
106			7,000	126,000	133,000	.093	.015	.015	16.2	16.1	17,955,000	2.025
107		500	6,000	320,000	326,000	.164	.053	.053	32.2	32.2	44,010,000	7.155
108			10,000	288,000	298,000	.19	.067	.067	35.5	35.5	40,230,000	9.045
109			15,000	257,000	272,000	.156	.028	.028	8.05	18	36,720,000	3.78
110			9,000	173,000	182,000	.082	.031	.031	37.8	37.8	24,570,000	4.185
111						.133	.038	.038	28.6	28.6		5.13
112			13,000	144,000	157,000	.102	.034	.034	33.2	33.2	21,195,000	4.59
113						.0022		.0003		14.29		.0405
114						.0250	.0007	.0006	2.83	2.33		.081
115			4,000	78,000	82,000	.086	.025	.025	29.1	29.1	11,070,000	3.375
116			11,000	227,000	238,000	.108	.011	.011	10.25	10.2	32,130,000	1.485
117			23,000	256,000	279,000	.111	.010	.00999	9.0	9	37,665,000	1.3486
118			26,000	428,000	454,000	.138	.044	4.4	32	31.9	61,290,000	5.94
119			10,000	309,000	319,000	.062	.008	.008	12.8	12.8	43,065,000	1.08
120			28,000	178,000	206,000	.106	.028	.028	26.4	26	27,810,000	3.78
121			7,000	56,000	63,000	.074	.027	.027	36.5	36	8,505,000	3,645
122			6,500	30,000	36,500	.057	.019	.019	33.25	33.2	4,927,500	2.565
123			19,000	382,000	401,000	.067	.081	.031	20.67	20.6	54,135,000	4.185
124			13,560	32,530	46,090	.084		.0033	3.9	3.9	6,222,150	.4455
125			230,620	435,620	666,240	.154		.006	3.9	3.9	89,942,400	.81
126			30,500	23,720	54,220	.175		.0037	2.1	2.1	7,319,700	.4995
127			20,330	20,330	40,660						5,489,100	
128			17,780	142,220	160,000						21,600,000	
129			410,000	86,400,000	86,810,000	.073	.0004		.5		89,848,350,000	
130			510,000	222,900,000	223,470,000	.088	.0005		.5		30,168,450,000	
131			1,040,000	176,000,000	177,040,000	.104	.0007		.7		23,900,400,000	
132			440,000	200,000,000	200,440,000	.077	.0006		.8		27,059,400	
133			1,600,000	369,000,000	370,600,000	.484	.0067		1.4		50,031,000,000	
134			440,000	108,000,000	108,440,000	.064	.001		1.6		14,639,400	
135			50,000	227,000	277,000	.229	.028	.0229	10	10	34,695,000	3.0915
136			26,000	137,000	163,000	.117	.013	.0129	11	41	22,006,000	1.7415

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday—Continued.

DIPPING ROOM—Continued.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
GENERAL WARE—contd.												
137	...	...	47,000	377,000	424,000	0.113	0.016	0.0129	14.1	14.1	57,240,000	1.7415
138	...	...	1,100,000	14,300,000	...	...	.012	...	...	...	...	...
139	...	...	...	...	...	.0425	...	.0025	...	5.88	...	.3375
140	...	...	...	...	...	.003	.0003	.00015	10	5	...	.02025
141	...	...	...	...	...	.0104	.0008	.0008	8	8	...	.108
142	...	...	...	...	...	.019	.0025	.0025	13.2	13.2	...	.3375
143	...	...	...	...	...	.0525	.0012	.0012	2.38	.2	...	.162
144	...	...	...	...	...	.0175	...	.0011	...	.17	...	.1485
145	...	...	...	...	...	.0558	.0038	.0038	6.94	6.94	...	.513
146	...	...	...	...	...	.0208	...	.00054	...	2.65	...	.0729
OTHER WARE.												
147	...	...	57,700	1,622,200	1,679,900	.164	.0129	.0123	7.8	7.5	226,786,500	1.66
148	...	...	6,400	336,000	342,400	.072	.0024	.0024	3.3	3.3	46,224,000	.324
149	...	...	11,000	422,000	433,000	.15	.042	.042	28	28	58,455,000	5.67
150	...	...	47,000	592,000	639,000	.289	.019	.019	6.57	6.5	87,265,000	2.565
151	...	...	35,000	523,000	558,000	.227	.014	.014	6.16	6.1	75,330,000	1.89
152	...	...	4,000	73,000	77,000	.042	.0083	.0083	19.9	19.8	10,395,000	1.12
153	...	...	22,000	352,000	374,000	.111	.015	.0149	13.5	13.5	50,490,000	2.01
154	...	...	9,000	200,000	209,000	.065	.01	.01	15.5	15.4	28,215,000	1.35
155	...	...	5,000	190,000	195,000	.06	...	...	...	...	26,325,000	...
156	...	...	34,000	277,000	311,000	.113	.013	.013	11.47	11.4	41,985,000	1.755
157	...	...	22,000	133,000	155,000	.09	.008	.00792	9	8.8	20,925,000	1.0692
158	...	...	11,000	385,000	396,000	.112	.01	.01	8.92	.09	53,460,000	1.35
159	...	...	17,000	147,000	164,000	.109	.009	.009	8.31	8.2	22,140,000	1.215
160	...	...	25,000	390,000	415,000	...	...	...	...	.173	56,025,000	1.08
161	...	...	20,000	203,000	223,000	.14	.019	.019	13.5	13.5	30,105,000	2.565
162	...	...	88,000	228,000	316,000	.128	.008	.008	6.25	6.3	42,660,000	1.08
163	...	...	5,000	51,000	56,000	.033	.003	.003	9	9	7,560,000	.405

GLAZE-MIXING ROOM.

SANITARY WARE.												
164			14,500	177,900	192,400	0.0452	0.0005	0.0005	1.1	1.1	25,974,000	0.0675
165			59,000	2,331,000	2,390,000	.476	.242	.242	50.8	50.8	322,650,000	3.267
166			41,000	1,973,000	2,014,000	.318	.043	.043	12.51	13.5	27,189,000	5.805
167			168,000	2,887,000	3,055,000	1.164	.037	.037	3.4	3.2	412,425,000	4.995
168			24,000	2,652,000	2,676,000	.378	.06	.06	15.8	15.6	361,260,000	8.1
169			9,000	602,000	611,000	.16	.01	.01	6.25	6.2	82,485,000	1.35
GENERAL WARE.												
170			6,600	515,500	522,100	.0228	.0007	.0007	2.9	2.9	70,483,500	.0945
171			341,300	4,805,300	5,146,600	.549	.0005	.0005	.1	.1	180,131,000	.0675
172			8,900	969,000	977,900	.0311					130,801,500	
173			20,000	433,200	4,752,000	.206	.0228	.0228	11.1	11.1	641,520,000	3.078
174			5,800	666,000	671,800	.0844	.0007	.0007	.8	.8	90,693,000	.0945
175			400	140,400	140,800	.0968	.0262	.0262	27	27	19,008,000	3.537
176			22,400	4,416,800	4,439,200	.204	.0228	.0228	12.3	12.3	599,292,000	3.078
177			7,600	1,464,100	1,471,700	.125	.0108	.0097	8.6	7.7	198,679,500	1.3095
178			41,700	1,648,700	1,690,400	.291	.0710	.0710	24.6	24.4	228,204	9.585
179			18,800	321,200	340,000	.057	.0040	.0040	7	7	45,900,000	.54
180			42,500	931,500	974,000	.4704	.0211	.0207	4.5	4.4	131,490,000	2.7945
181			17,500	987,500	1,005,000	.209	.01	.01	4.8	4.8	135,675,000	1.35
182			66,600	8,022,200	8,088,800	1.026					1,091,988,000	.108
183			416,000	24,064,000	24,480,000	5.208	2.07	2.07	39.7	39.7	3,304,800,000	2.7945
184				59,090	59,090	.62		.0099		1.6	7,977,150	1.3365
185			31,430	51,070	82,500	.63		.0435		6.9	11,137,500	5.8725
186			3,270	58,800	62,070	.27		.0459		17	8,379,450	6.196
187			56,000	229,600	285,600	1.31		.0039		.3	38,556,000	.5265
188			26,670	240,000	266,670	1.397		.5937		42.5	36,000,450	8.0149
189			214,220	489,640	703,860	5.446		.0653		1.2	95,021,100	8.8155
190			127,910	22,240	150,150	.444		.0178		4	20,270,250	2.403
191			50,000	227,000	277,000	.229	.028	.0229	10	10	34,695,000	3.0915
192			26,000	137,000	163,000	.117	.013	.0129	11.1	11.1	22,005,000	1.7415
193			47,000	337,000	424,000	.113	.016	.0159	14.1	14.1	57,240,000	2.1465
194			1,100,000	14,300,000			.012					
195						.0062	.0012	.0012	4.76	4.76		.162
196						.0396	.0042	.0040	10.63	10.11		.54
197						.0191	.00075	.0005	3.91	2.61		.0675
198			6,000	1,222,000	1,228,000	.338	.044	.044	13	13	165,780,000	5.94
199			4,000	110,000	114,000	.064	.028	.021	31.2	33.3	15,390,000	2.835

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday—Continued.

GLAZE-MIXING ROOM—Continued.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
GENERAL WARE—contd.												
200	....	....	18,000	633,000	651,000	0.207	0.071	0.071	34.2	34.2	87,885,000	9.585
201	....	....	13,000	144,000	157,000	.15	.034	.032	22	22	21,195,000	4.32
202	....	....	12,500	1,975,000	1,987,500	.625	.0875	.0875	14	14	268,312,500	11.8125
203	....	....	17,000	122,000	139,000	.119	.006	.006	5	5	18,765,000	.81
204	....	....	35,000	577,000	612,000	.196	.004	.004	2.04	2	82,620,000	.54
205	....	....	47,000	1,000,000	1,047,000	.648	.028	....	....	4.3	141,345,000	....
206	....	....	11,200	124,400	135,600	.0170	.0010	.0010	5.9	5.9	18,306,000	.135
207	....	....	5,000	190,000	195,000	.06	....	....	....	....	26,325,000	....
208	....	....	9,000	300,000	309,000	.198	.103	.103	52	52	41,715,000	13.9

KILN ROOM.

Sample No.	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.	Per cent of lead.	Per cent of soluble lead.	Number of particles.	Amount of soluble lead (milligrams).
SANITARY WARE.												
209	....	....	4,100	26,600	30,700	0.017	0.0004	0.0004	2.2	2.2	4,144,500	0.054
210	....	....	7,700	697,100	704,800	.0717	.0043	.0043	6	6	95,148,000	.5805
211	....	....	540,000	72,900,000	73,440,000	.1	.0007	.0007	.7	.7	9,914,400,000	.0945
212	....	....	54,000	775,000	829,000	.336	.013	.013	3.86	3.8	111,915,000	1.755
213	....	....	67,000	951,000	1,018,000	.51	.011	.011	2.16	2.1	137,430,000	1.485
214	....	....	21,000	1,122,000	1,143,000	.172	.11	.11	.64	.64	154,305,000	1.485
215	....	....	12,000	490,000	502,000	.073	.024	.024	33	32.9	67,770,000	3.24
216	....	....	14,900	2,007,600	2,021,800	.13	.0014	....	1.06	....	270,943,000	....
217	....	....	41,000	1,675,000	1,716,000	.544	.021	.021	4.22	3.8	231,660,000	2.835
218	....	....	7,000	248,000	255,000	.59	.011	.011	1.86	1.8	34,425,000	1.485

219			3,820,000	162,000,000	165,820,000	.227	.0036		1.5		22,345,200,000	
220			21,000	367,000	388,000	.192	.01	.0090	5.22	5.2	52,380,000	1.33
221			4,000	353,000	357,000	.126	.0077	.007	5.55	5.5	48,105,000	.945
222			23,000	746,000	769,000	.170	.021	.021	11.9	11.9	103,815,000	2.835
223			19,000	546,000	565,000	.096	.008	.008	8.3	8.3	76,275,000	.108
224			4,000	144,000	148,000	.053	.005	.005	9.37	9.4	19,980,000	.675
225			13,000	590,000	603,000	.158	.015	.015	9.52	9.5	81,405,000	2.025
226			31,000	1,295,000	1,326,000	.638	.015	.0146	2.3	2.3	179,010,000	1.971
227			8,500	543,000	551,500	.245	.01	.01	4.08	4.1	74,452,500	1.35
228			16,000	471,000	487,000	.283	.013	.013	.046	.046	65,745,000	1.755
GENERAL WARE.												
229			75,930	49,130	125,000	.78		.0158		2	16,883,100	2.133
230		53,400	17,800	89,000	160,200	.1473		.0221		1.5	21,627,000	2.9835
231			192,000	384,000	576,000	.35		.0248		3.3	77,760,000	3.348
232			2,240,000	109,000,000	191,240,000	.096	.0006		.6		25,817,400,000	
233			1,120,000	195,000,000	196,120,000	.089	.0006		.6		26,476,200,000	
234		500	28,000	641,000	669,000	.171	.021	.021	13.50	12.3	90,315,000	2.835
235			23,000	409,000	432,000	.528	.019	.019	3.6	3.6	58,320,000	2.565
236			22,000	531,000	553,000	.12	.026	.026	21.7	21.7	74,655,000	3.51
237			22,000	1,298,000	1,320,000	.196	.018	.018	9	9	178,200,000	2.43
238			23,000	555,000	578,000	.114	.016	.016	14.3	14	78,030,000	2.16
239			58,000	3,440,000	3,498,000	.533	.009	.009	1.7	1.7	472,230,000	1.215
240						.0025	.00085	.0006	34	24		.081
241						.007	.0006	.00045	8.57	5.71		.06075
242						.0262	.0012	.0012	4.76	4.76		.162
243						.0396	.0042	.0040	10.63	10.11		.54
244						.0215			.00	.00		
245							.0009					
246						.0712	.0031	.0031	4.38	4.38		.4185
247						.0014	.0006	.0006	4.34	4.34		.081
248						.1	.0022	.0020	2.21	2		.27
249						.0176	.0014	.0013	8.3	7.55		.1755
250						.0887	.0029	.0026	3.22	2.93		.351
251							.0005					
252							.0021	.0014				.189
253			11,800	853,300	865,100	.0711	.0024	.0024	3.3	3.3	116,788,500	.3240
254			15,500	1,440,000	1,455,500	.0594	.0023	.0023	3.8	3.8	196,492,500	.3105
255			10,600	3,760,000	3,770,600	.205	.0133	.0133	6.5	6.5	659,855,000	1.7955
256			20,000	398,300	418,300	.050	.0002	.0002	.3	.3	56,470,500	.027
257			22,400	583,100	605,500	.0539	.0007	.0007	1.2	1.2	81,742,500	.0945
258			72,000	2,432,000	2,504,000	.222	.0072	.0072	3.2	3.2	338,040,000	.972

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday—Continued.

KILN ROOM—Continued.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
GENERAL WARE—contd.												
259	....	....	....	....	....	0.0322	0.0033	0.0031	10.2	9.8	....	0.4185
260	....	....	....	....	....	.0172	.0009	.0009	5.5	5.5	....	.1215
261	....	....	....	....	....	.101	.0069	.0069	6.6	6.8	....	.9315
262	....	....	3,000	128,400	131,400	.0239	.0034	.0034	14.2	14.2	17,739,000	.4590
263	....	....	3,000	124,000	127,000	.0328	.0041	.0041	12.5	12.5	17,145,000	.5535
264	....	....	156,000	12,148,000	12,304,000	.1206	.0013	.0013	.1	.1	1,661,040	.1755
265	....	....	4,600	62,200	66,800	.0183	.0023	.0011	12.7	6.1	9,018,000	.1485
266	....	....	4,800	202,100	206,900	.0547	.0027	.0027	4.9	4.9	28,031,500	.3645
267	....	....	1,000	153,800	154,800	.098	.0055	.0055	5.6	5.6	20,898,000	.7425
268	....	....	2,600	1,592,000	1,594,600	.0813	.0055	.0055	6.7	6.7	215,271,000	.7425
269	....	....	36,000	4,760,000	4,796,000	.326	.0106	.0106	32.5	32.5	647,460,000	1.431
270	....	....	4,400	927,600	932,000	.101	.0008	.0008	.8	.8	125,820,000	.108
271	....	....	12,000	793,600	805,600	.0722	.0004	.0004	.6	.6	108,756,000	.054
272	....	....	16,000	609,000	625,000	.09	.0004	.0004	.5	.5	84,375,000	.054
273	....	....	6,600	713,500	719,900	.105	.0204	.0204	19.4	19.4	97,186,500	2.754
274	....	....	22,200	613,300	635,500	.0689	.0038	.0038	5.6	5.6	85,792,500	.513
275	....	....	12,000	1,656,000	1,668,000	.149	.0082	.0082	5.5	5.5	225,180,000	1.107
276	....	....	7,400	626,000	633,400	.0633	.0064	.0052	10.2	8.2	85,509,000	.7021
277	....	....	1,500	104,000	105,300	.0156	.0014	.0014	9.3	9.3	14,215,500	.189
278	....	....	9,800	306,000	315,800	.045	.0012	.0011	2.6	2.3	42,633,000	.1485
279	....	....	2,500	183,900	186,400	.0145	.0002	.0002	1.5	1.5	25,164,000	.027
280	....	....	26,300	1,936,800	1,963,100	.193	.0064	.0049	3.3	3.3	265,018,500	.6615
281	....	....	150,000	4,200,000	4,350,000	.613	.0317	.0288	5.2	4.7	587,250,000	3.888
282	....	....	14,400	1,352,800	1,367,200	.08	.0084	.0074	10.5	9.3	184,572,000	.999
283	....	....	56,000	1,549,300	1,605,300	.408	.0241	.0241	5.9	5.9	216,715,500	3.2535

284	....		....	31,300	648,500	679,800	.0733	.0009	.0009	1.2	1.2	90,123,000	.1215
285	....		....	11,200	48,400	59,600	.006	.0004	.0004	.6	.6	8,040,000	.054
286	....		....	7,600	553,200	560,800	.0410	.0031	.0031	6.6	6.6	75,708,000	.4185
287	....		....	25,400	3,542,800	3,568,200	.0190	.0059	.0059	30.8	30.8	481,707,000	.7965
288	....		....	29,600	1,059,200	1,088,800	.21	.0074	.0074	3.5	3.5	1,489,880	.909
289	....		....	10,000	24,800	234,800	.0393	.0015	.0015	3.8	3.8	31,698,000	.2025
290	....		....	17,700	734,800	752,500	.0926	.0039	.0039	4.2	4.2	101,587,500	.5265
291	....		....	76,300	1,440,000	1,516,300	.0664	.0040	.0040	6.	6.	204,700,500	.54
292	....		....	152,700	6,341,800	6,494,500	1.465	.0453	.0444	3.1	3.	876,757,500	5.994
293	....		....	2,900	25,400	28,300	.0192	.0002	.0002	1.2	1.2	3,820,500	.027
294	....		....	31,200	420,000	451,200	.182	.0048	.0048	2.6	2.6	60,012,000	.648
295	....		....	13,900	133,000	146,900	.0437	.0008	.0008	1.9	1.9	19,751,500	.108
296	....		....	5,600	436,700	442,300	.0541	.0016	.0013	3.	2.3	59,710,500	.1755
297	....		....	6,300	323,300	329,600	.0325	.0003	.0003	1.	1.	44,496,000	.0405
298	....		....	23,200	1,341,600	1,364,800	.222	.0018	.0018	.8	.8	184,248,000	.243
299	....		....	5,900	507,800	513,700	.039	.0008	.0008	1.9	1.	69,349,500	.108
300	....		....	30,000	172,000	1,202,000	.167	.0076	....	4.71	....	162,270,000	....
301	....		....	11,000	580,000	591,000	.105	.0028	....	2.65	....	79,785,000	....
302	....		....	1,440,000	249,000,000	250,440,000	.152	.0075	....	....	....	11,269,800,000	....
303	....		....	760,000	6,800,000	61,560,000	.096	.0026	....	....	....	8,310,600,000	....
304	....		....	12,340	24,680	37,020	.113	.0015	.00149	1.32	1.3	4,997,700	.201
305	....		....	12,340	24,680	37,020	.082	.008	.0008	.97	.9	4,997,700	1.08
306	....		....	6,880	36,120	43,000	.182	....	.0066	....	3.6	5,805,000	.891
307	....		....	58,750	117,500	176,250	.685	....	.0247	....	3.6	23,793,750	3.3245
308	....		....	1,640,000	260,000,000	261,640,000	.124	.0013	....	1.5	....	35,321,400,000	....
309	....	145,710	....	36,430	255,000	437,140	1.357	....	.0163	....	1.2	59,013,900	2.2
310	....	33,090	....	50,800	23,060	96,980	.171	....	.0067	....	3.9	13,092,300	.9045
311	....	....	....	7,550	11,330	18,880	.101	....	.0027	....	2.7	2,548,850	.3645
312	....	....	....	79,200	158,400	237,600	.355	....	.0067	....	1.2	32,076,000	.9045
313	....	....	....	....	....	....	.349	....	.0185	....	5.3	....	2.4975
314	....	....	....	....	....	....	.30	....	.0156	....	5.2		2.106
315	....	....	....	....	....	....	1.80	....	.0504	....	2.8	....	6.804
316	....	....	....	31,290	39,110	70,400	.078	....	.00437	....	5.6	9,504,000	.5899
317	....	....	....	33,600	48,550	85,860	.422	....	.0051	....	1.2	11,591,100	.6885
318	....	....	....	30,100	97,280	127,680	.18	....	.0059	....	3.3	17,236,800	.7965
319	....	....	....	3,550	53,250	56,800	.70	....	.0091	....	1.3	7,668,000	1.228
320	....	....	....	....	....	....	.0951	.0039	.0018	3.13	1.84	T.	.243
321	....	....	....	....	....	....	.0084	.0008	.0004	10.0	5.0	....	.054
322	....	....	....	23,000	409,000	432,000	.20	.025	.025	12.5	12.5	58,320,000	3.375
323	....	....	....	....	....	....	.0067	....	....	....	....	....	....
324	....	....	....	14,000	291,000	305,000	.177	.014	.014	7.9	7.8	41,175,000	1.89
325	....	....	....	63,000	170,000	233,000	.107	.027	.027	15.3	25.2	31,455,000	3.645
326	....	....	....	9,000	173,000	182,000	.08	.023	.023	28.75	28.7	24,570,000	3.105
327	....	....	....	14,000	329,000	343,000	.075	.023	.023	30.67	30.6	46,305,000	3.1
328	....	....	....	10,000	345,000	355,000	.21	.018	.018	8.73	8.7	47,925,000	2.43

Number of dust particles in each class, weight of solids, and number of dust particles and amount of soluble lead inhaled per workday—Continued.

KILN ROOM—Continued.

Sample No.	Number of particles per cubic foot.					Weight per cubic foot of air (milligrams).			Per cent of lead.	Per cent of soluble lead.	135 cubic feet of air breathed per day.	
	Class 1.	Class 2.	Class 3.	Class 4.	Total.	Total.	Lead.	Soluble lead.			Number of particles.	Amount of soluble lead (milligrams).
GENERAL WARE—contd.												
329	....	....	....	....	....	0.0185	0.0007	0.0005	3.59	2.90	....	0.0675
330	....	....	....	....	....	.0179	.0022	.0020	12.66	11.25	....	.27
331	....	....	7,000	551,000	558,000	.166	.012	.012	7.2	7.5	75,330,000	1.620
332	....	6,000	15,000	206,000	221,000	.198	.015	.015	7.57	7.3	29,916,000	2.025
333	....	....	20,000	443,050	463,000	.128	.005	.005	3.9	5.9	16,205,000	.6750
334	....	....	28,000	1,204,000	1,130,000	.325	.013	.013	4	4	152,550,000	1.755
335	....	....	26,000	443,000	469,000	.11	.01	.0099	9.09	9	63,315,000	1.3365
336	....	1,500	15,000	527,000	544,500	.222	.039	3.9	17.55	17.5	73,507,500	5.265
337	....	....	15,000	216,000	231,000	.128	.039	.039	30.5	30.5	31,185,000	5.265
OTHER WARE.												
338	....	....	66,600	760,000	826,600	.124	.0021	.0021	1.7	1.7	111,591,000	.2825
339	....	....	8,000	335,000	343,000	.167	.027	.027	16.2	16	46,305,000	3.645
340	....	....	6,000	217,000	223,000	.067	.044	.044	66	65.7	30,105,000	5.94
341	....	....	5,000	190,000	195,000	.058	.007	.007	12.1	12.1	26,325,000	.945
342 [1]	....	....	8,000	210,000	218,000	.0544	.00067	.00067	1.2	1.2	28,430,000	.09045
343	....	....	44,000	2,308,000	3,424,000	.16	.0139	.0139	8.7	8.7	462,240,000	1.8765
344	....	....	64,000	1,825,000	1,889,000	.205	.012	.012	5.8	5.8	255,015,000	1.62
345 [2]	....	....	21,100	89,100	110,200	.074	.0011	.0011	1.6	1.6	14,877,000	.1485
346	....	....	16,830	24,040	37,870	.11	.0018	.00176	1.63	1.6	5,112,450	.2376

[1] General dipping wareroom.

[2] Bisque wareroom.

INDEX.

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