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A STUDY OF DUST CONDITIONS

in the Manheim Plant

of the

UNITED STATES ASBESTOS & RUBBER DIVISION OF THE RAYBESTOS-MANHATTAN, INC.

* * * *

1930

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The following report is a study of dust conditions in the Manheim plant of the United States Asbestos & Rubber Division of the Raybestos-Manhattan, Inc. This study was carried on during February, 1930, by the Industrial Health Service of the Metropolitan Life Insurance Company.

It is the third unit in a series of studies of the asbestos industry in the United States and Canada for the purpose of determining the extent and nature of atmospheric pollution to which asbestos workers are exposed and whether there can be demonstrated any harmful effect to such workers.

This study differs from the two preceding ones in that there were included physical examinations of employees, hence it is more complete and informative.

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APPARATUS AND METHODS OF SAMPLING:

The impinger method[1] was used for collecting samples of dust in the air. This is accomplished by aspirating the air to be sampled, and impinging it upon a flat surface under a liquid of either distilled water or alcohol. In general whenever the dust collected is of a siliceous nature an alcohol-water mixture is used to prevent any silica going into solution. Pyrex flasks are used as containers to collect the samples, as experience has shown that this glass is, for all purposes, practically insoluble. The volume of air is measured by means of a flow meter or else a vacuum gauge and the air sample is aspirated by suction supplied either by an electrically driven pump or else by an ejector actuated by compressed air. Each dust sample collected represented a volume of air of from 50 to 80 cubic feet.

Due to the high concentrations of dust in the departments of this plant this size sample was found to be representative and of sufficient size for analysis. The impinger was placed in close proximity to and at the breathing level of the workmen.

Air samples were also taken with the electric precipitator[2] for dust particle measurements. This instrument is designed upon the principle of the Cottrell precipitator. Air is drawn through an electrostatic field, where the dust particles are deposited upon a celluloid foil, by means of a small electrically driven pump. The volume of air sampled is measured by means

(1)"Comparative Tests of Instruments for Determining Atmospheric Dusts", - Public Health Bulletin, No. 144, Treasury Dept., Washington, D.C.
(2)"Determination of Suspensoids by Alternating Current Precipitators", - Philip Drinker and Robert W. Thomson, Journal of Industrial Hygiene, Vol. VII, No. 8, June, 1925.

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of a flow meter. From 10 to 50 cubic feet of air were taken for a sample.

The collected dust samples were transported to the laboratory where total dust counts were made, and particle size measurements were taken. The results are tabulated and appear in graphs attached. The percentages of the various sized particles may be interpolated from these graphs.

Microphotographs of these dust particles were taken under high power and were further enlarged by being projected upon a screen by means of a lantern slide projector. The enlarged particles were then measured with a ruler. Knowing the entire enlargement (by actual measurement) it was possible to calculate the original particle size.(3) By the use of Hazen's(4) logarithmic probability paper, the logarithms of the function to be measured - in this case microns - are plotted as ordinates against the probability of occurrence as abscissae. Since the line is straight, exterpolation and interpolation of any desired region is facilitated.

It will be noted from these curves that from 86 to 99% of the particles are less than 10 microns in their greatest diameter.

The analyses are reported in total particles per cubic foot, and also in the corresponding weight of the dust in milligrams. There is no indicated relationship between the dust counts and the corresponding weights.

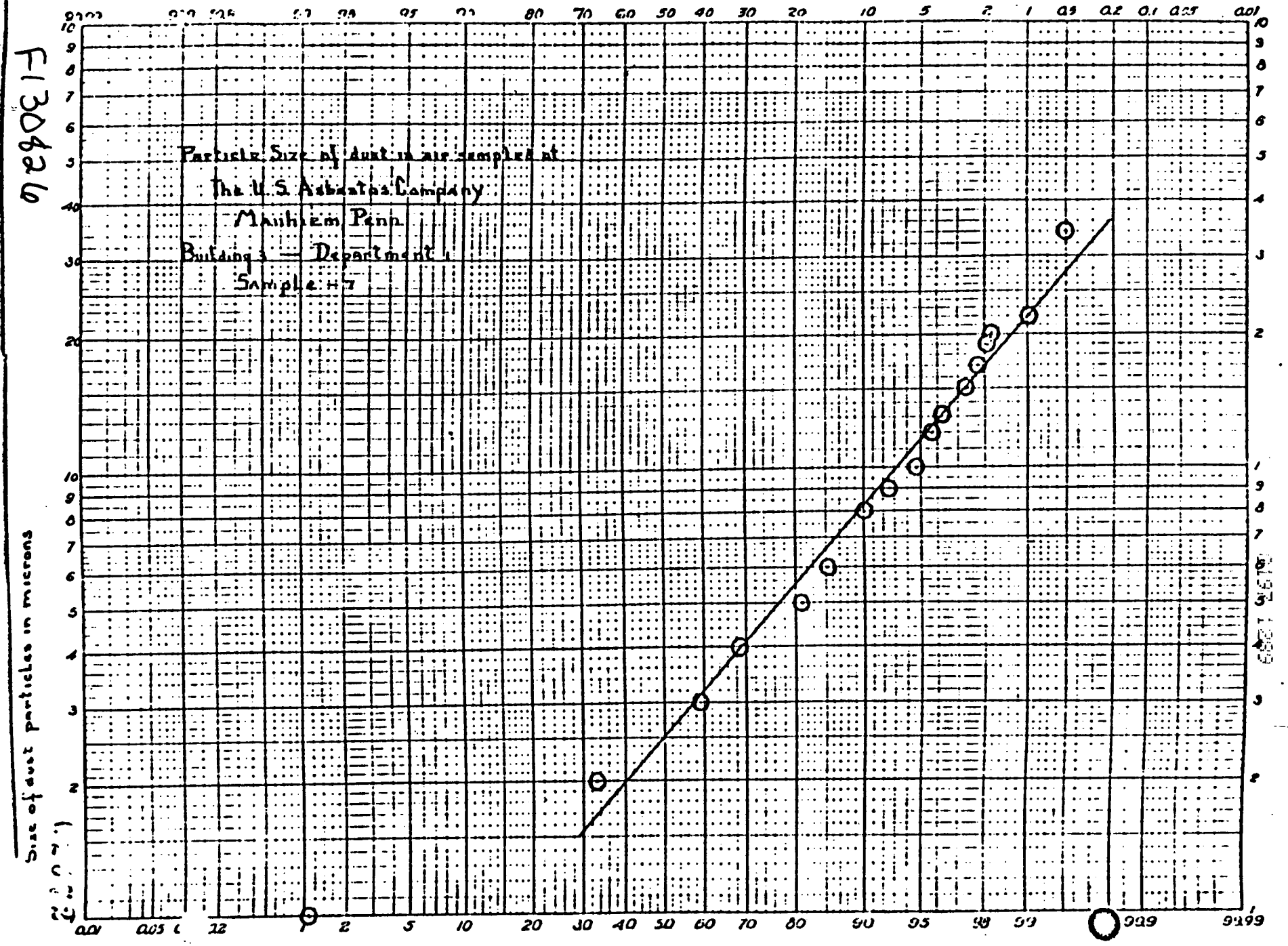
DESCRIPTION OF PLANT:

The plant at Manheim consists of a number of one-story and two two-story buildings. One of the two-story buildings houses the offices, laboratories, dispensary and store room, while the other is devoted to the preparation

(3) Green, H. "A Photomicrographic Method for the Determination of Particle Size of Paint and Rubber Pigments", Journal Franklin Institute, 1921, 192, 657.
(4) Whipple, G.C. Vital Statistics, N.Y. John Wiley & Sons, Inc. 1925, p. 451

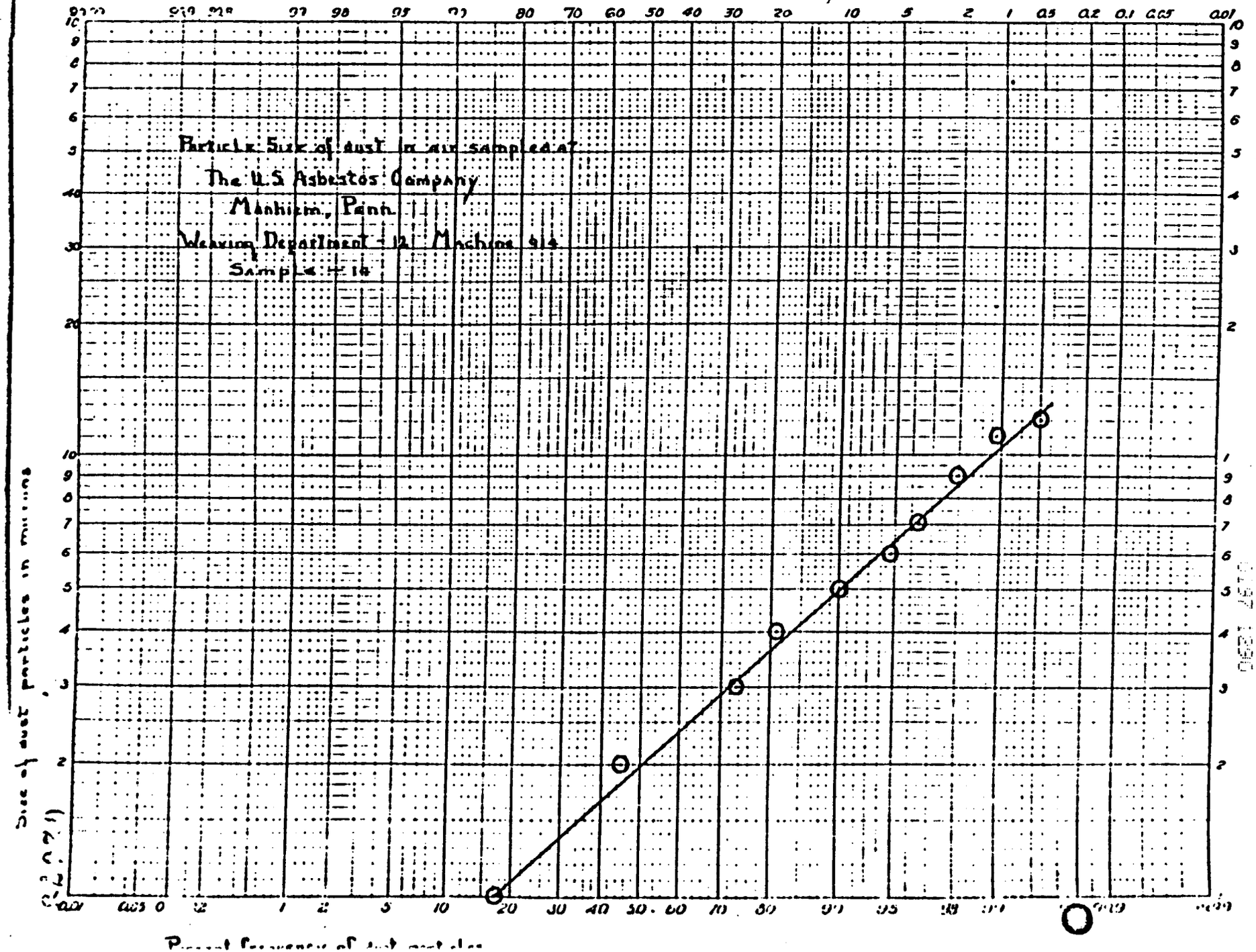
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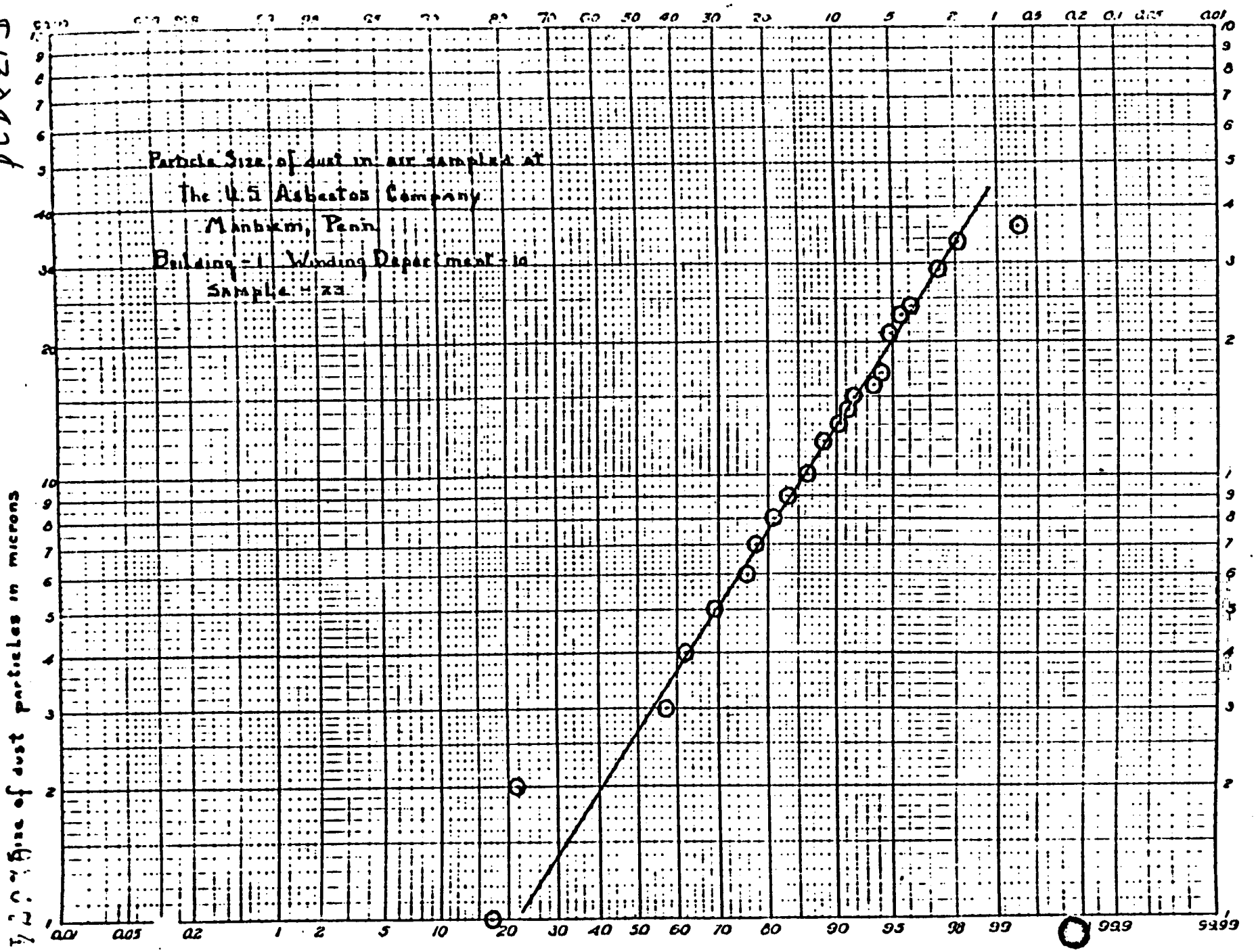


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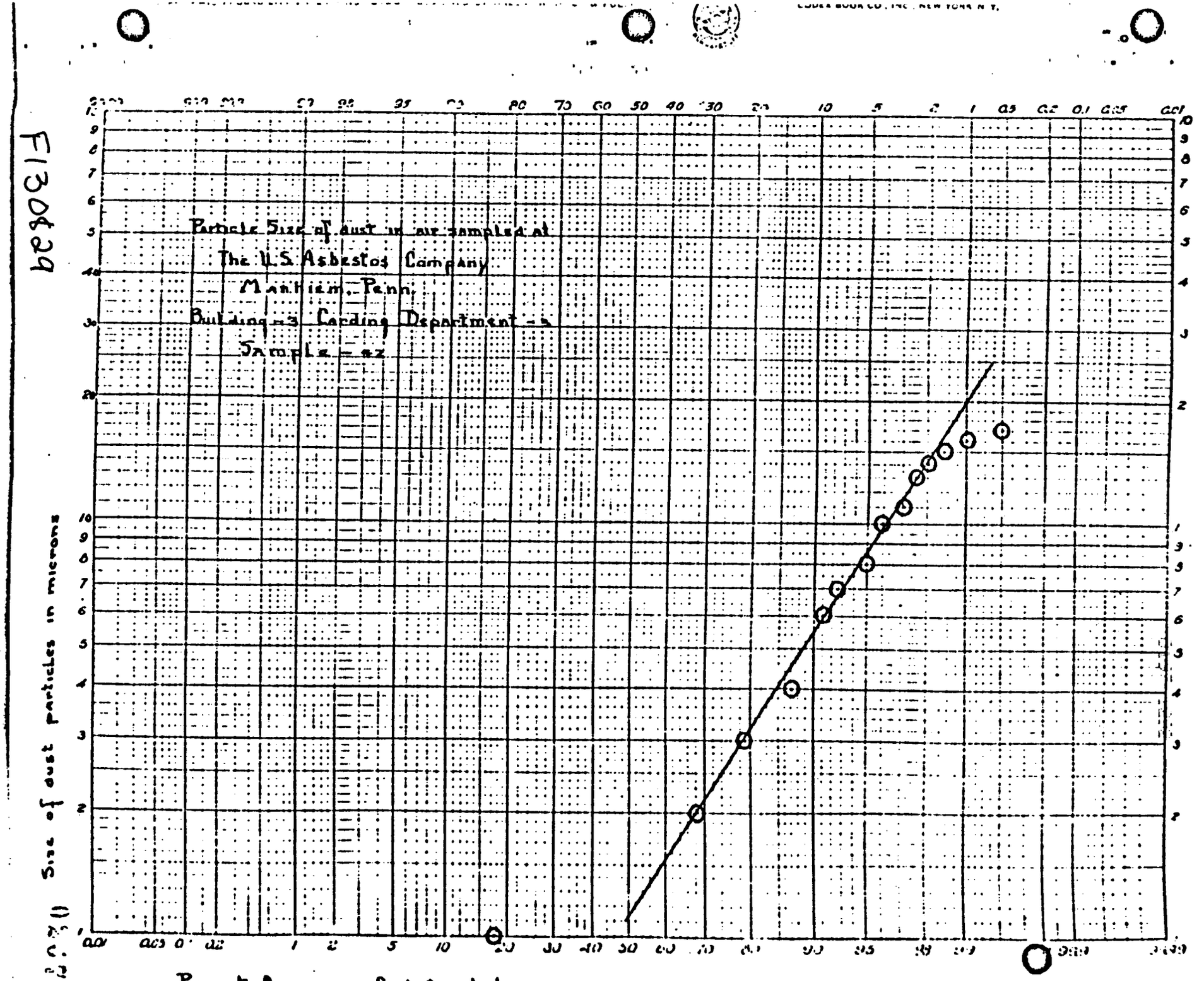
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room and brake-band weave room on the first floor and the carding, spinning and spooling operations are performed on the second floor.

The other one-story buildings are occupied by spooling, twisting and broad loom operations, brake-band treating and packing manufacturing, shops and shipping department.

PREPARATION DEPARTMENT:

The asbestos is received in bags and emptied upon the floor. It is then shoveled into pug mills or chasers from which it is passed into an opener and on a shaker sieve. Here it is piled on the floor to made up into mixtures with proportionate amounts of cotton which has already been passed through an opener. The batches of mixed cotton and asbestos are passed through a mixer picker and carried by suction through a pipe to bins in the card room on the second floor. In this suction pipe oil is applied to the mixture of cotton and asbestos by means of sprayers. Judging from the high dust counts found in the card room, as compared with those found at similar locations in the plant at Charleston, the method of applying the oil does not appear to be as effective.

Two card machines working on waste material are making wicking in this department. One loom is operating on brake-bands.

The exhaust systems at the various machines were only in partial operation due to relocation of machines. No humidifying system was in operation. The temperature of this department at the time of visit was 67° F. with a relative humidity of 37%, as compared with outdoor temperature of 39° F. and a relative humidity of 67%. The high incidence of dust in this department is partly due to the alterations being made.

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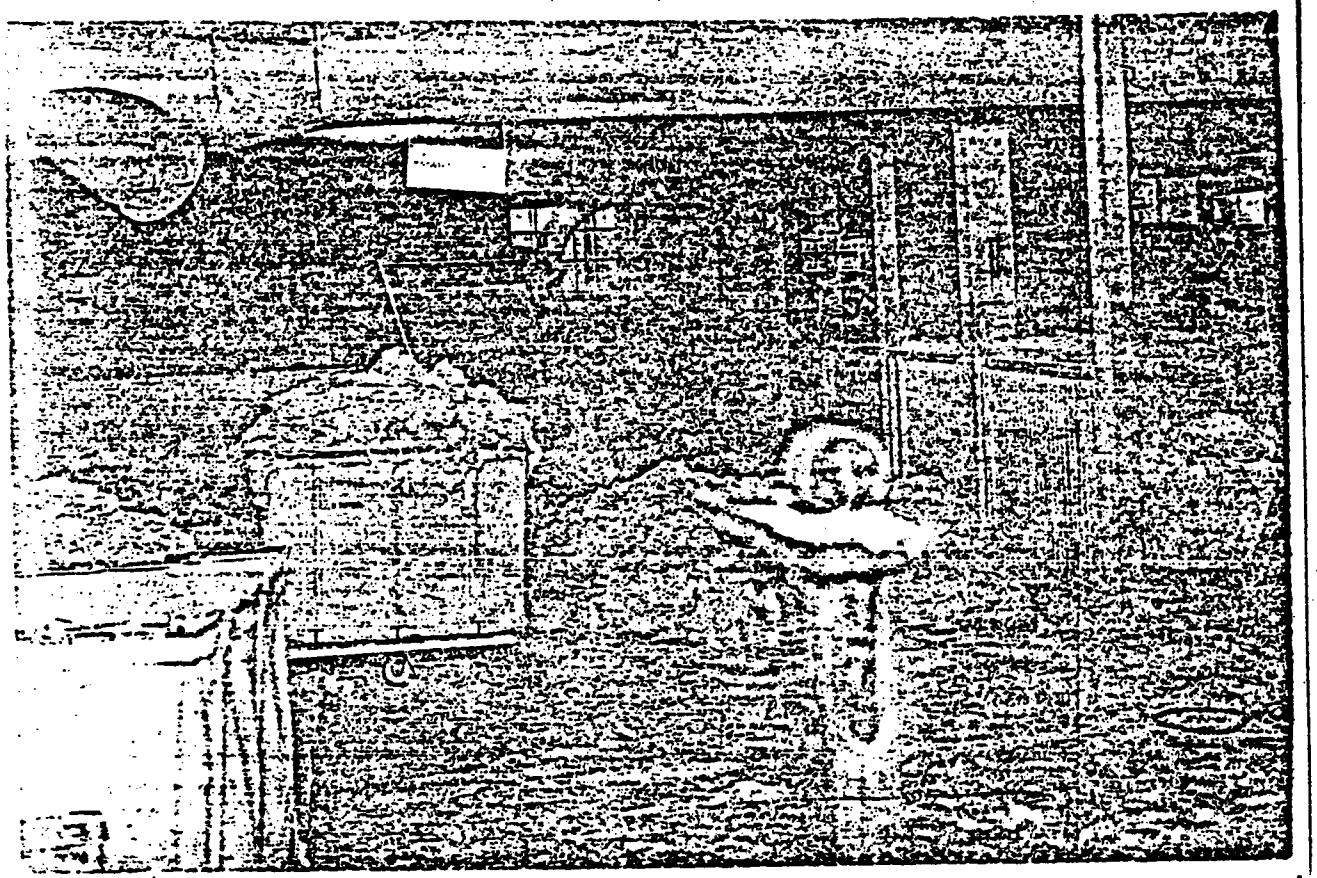
TABLE NO. 1

PREPARATION ROOM

Sample No.	Building No.	Dept. No.	Location of Sampling	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
1	5	1	Alongside exhaust pipe from vertical opener discharging on to shaker sieve	43,259,154	2.5
3	5	1	Alongside loom 946. Only one loom in preparation room	2,201,597	.46
4	5	1	Alongside chasers #1 and 2	3,135,214	.47
5	5	1	At the side of shaker sieve	23,809,525	1.37
6	5	1	Floor mixing center of room	3,457,689	.45
8	5	1	Alongside feeder end of wick card working waste material, machine 136	3,067,129	.40
9	5	1	Machine #18, feeder hopper of breaker card	29,219,143	3.4
11	5	1	At the take off end of wick card machine #136	4,904,515	.65

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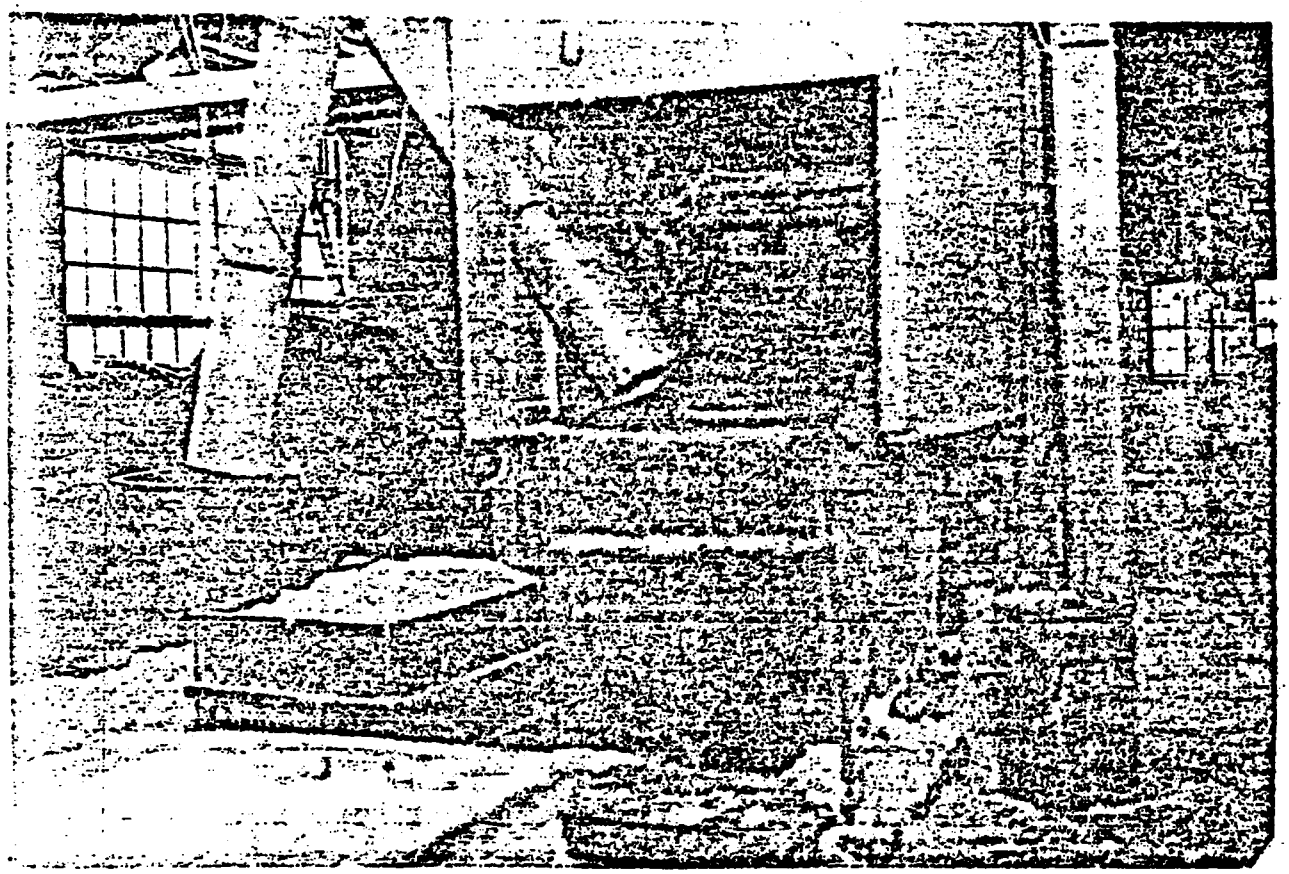


Storage and Batch Mixing Bins
in
Preparation Room

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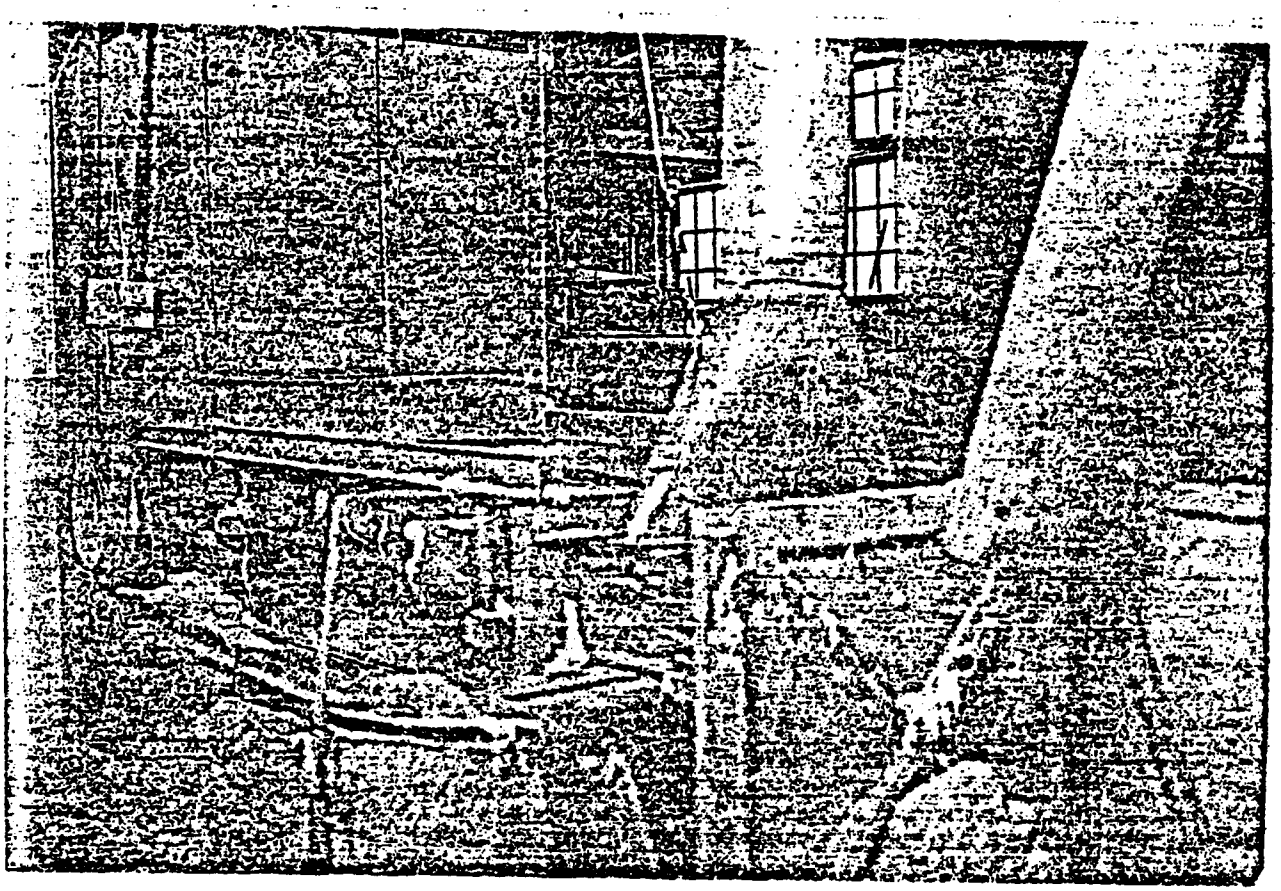


Feeder End of Shaker Sieve
in
Preparation Room

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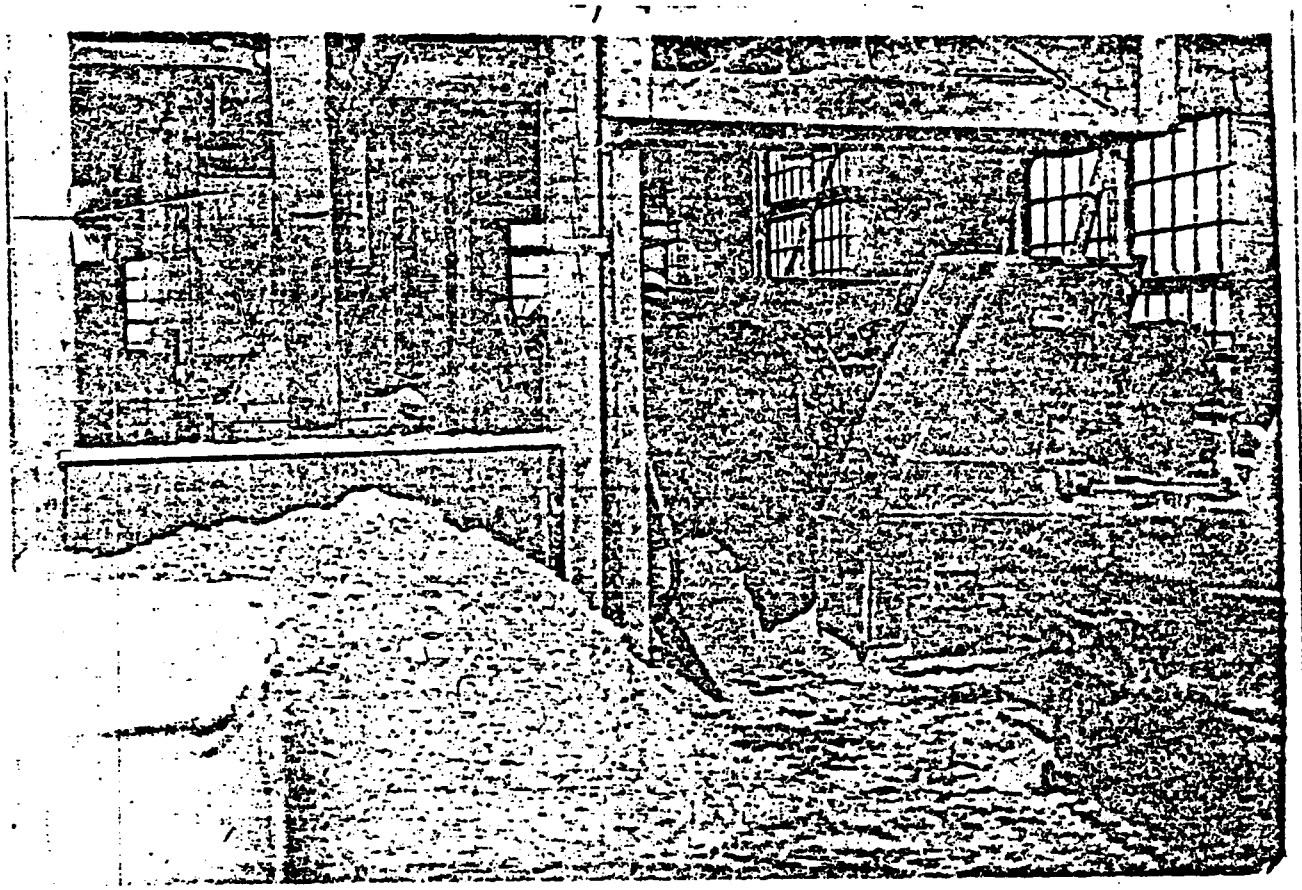


Take-off End of Shaker Sieve
Preparation Room

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Floor Mixing in Preparation Room
Chaser or Pug Mill Visible at the Right

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It will be noticed that the dust count is high in places and exceeds 10,000,000 particles, the standard adopted by the U.S. Public Health Service in their study of the granite industry.(5)

BRAKE-BAND WEAVING DEPARTMENT:

This process is conducted in a room adjacent to the preparation department. This room is equipped with hand controlled water sprays for humidifying. The temperature in this department was found to be 69° F. and the relative humidity was 76%.

Artificial illumination is furnished by Cooper Hewitt lamps.

Dust counts were collected in close proximity to the workers and are as follows:

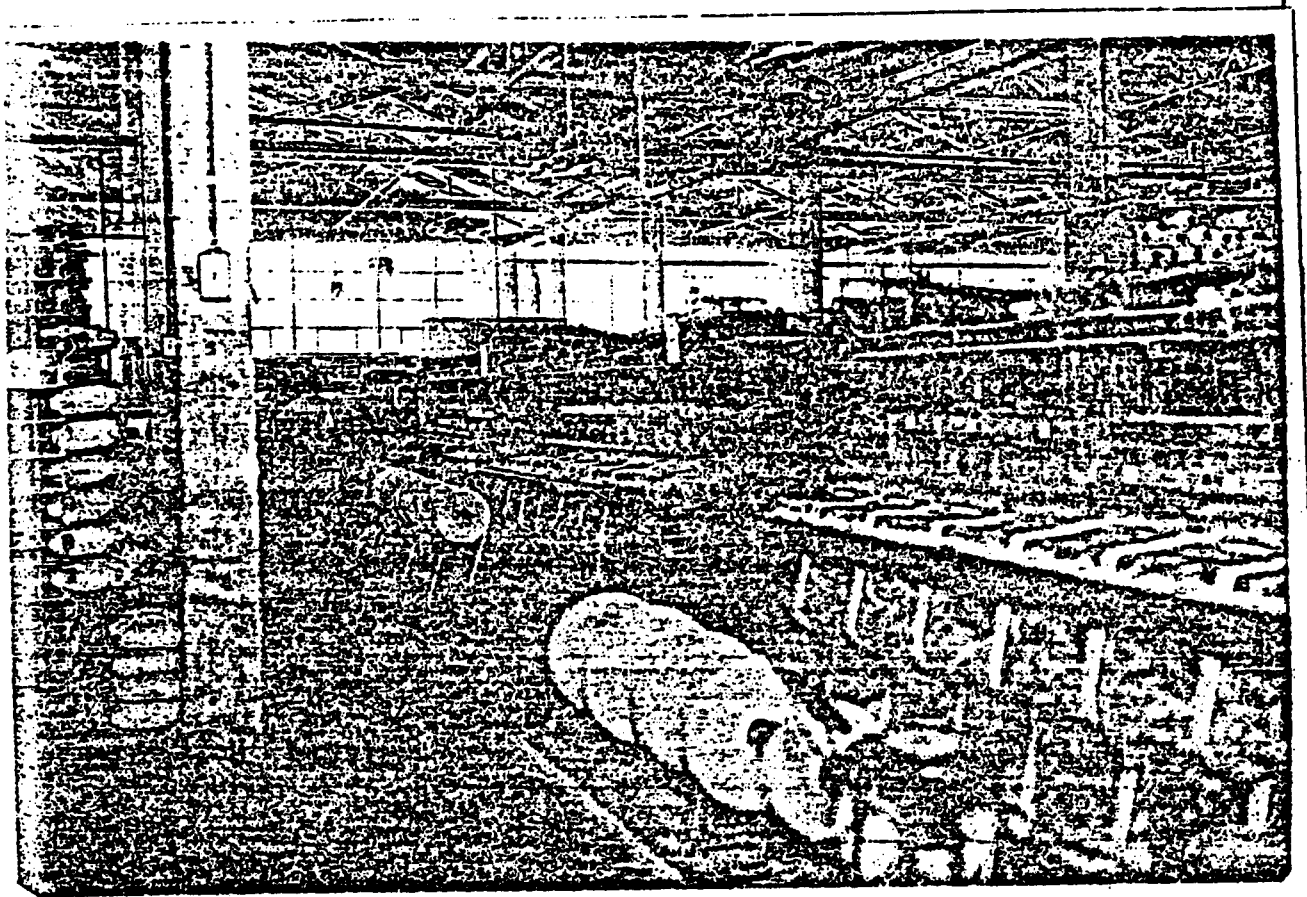
(5) Public Health Bulletin No. 187 "The Health of Workers in Dusty Trades II. Exposure to Siliceous Dust (Granite Industry)" - U.S.P.H.S., Treasury Dept., Washington, D.C. 1929.

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Brake-Band Weaving

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TABLE No. 2

WEAVE ROOM (BRAKE BAND)

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
12	1	12	Alongside loom 9 space 8. Machine #918	8,101,852	.80
13	1	12	Alongside loom 6 space 8. Machine #913	6,074,858	1.1
15	1	12	Alongside loom 3 space 12. Machine #923	4,824,606	.60
17	1	12	Front of loom 20 space 8. Machine #926	3,703,703	—
18	1	12	Front of loom 37 space 4. Machine #944	9,982,638	1.1
19	1	12	Front of loom 19 space 2. Machine #925	9,076,765	1.5

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The number of particles per cubic foot of air in this room are considerably less than in the preparation room, and slightly under the standard quoted above.

SPOOLING, TWISTING AND BROAD LOOM WEAVING:

These processes are likewise carried out on the first floor of building number one. This department is equipped with the Carrier Air Conditioners which furnish ample humidification. The temperature was found to be 74° F. and the relative humidity was 50%.

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TABLE No. 5

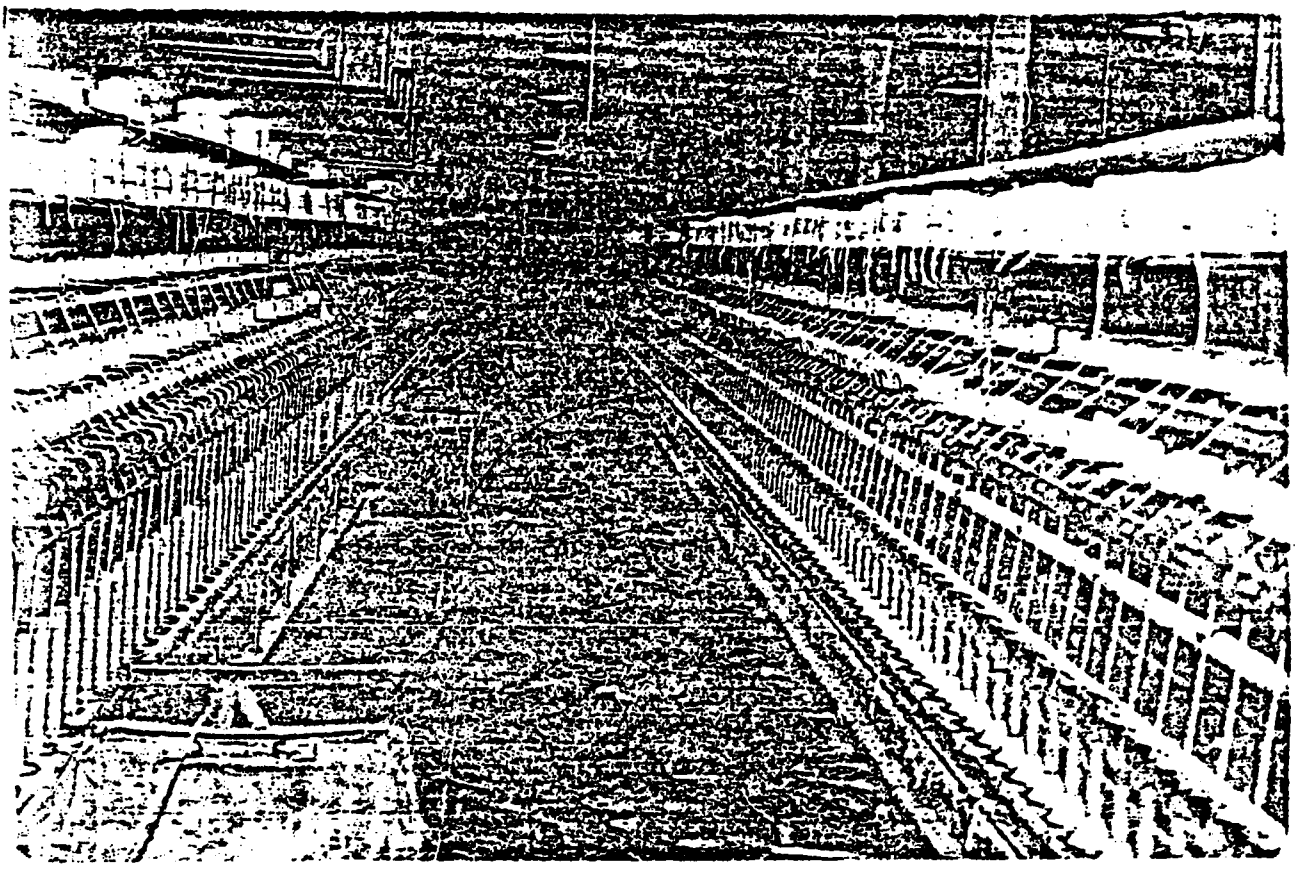
SPOOLING, TWISTING AND WEAVING

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
20	1 N.E. corner	6	Between spoolers 603 and 602	2,979,991	.65
21	1	6	Front of spooler #605	1,150,173	.25
22	1	10	Between universal winders 701 and 706	1,322,751	.30
24	1	7	Between twisters 660 and 661	3,732,638	.60
25	1	10	Alongside loom #1016 weaving broad cloth	2,270,469	.26
26	1	5	Alongside machine #451. Ring spinning	1,489,320	.35
28	1	10	Alongside loom #1017. (dry weaving)	3,182,870	.30
30	1	10	Between looms 5, 21 and 20 dry weaving on wide material	2,704,291	.50

First floor of building #1 equipped with the Carrier system.

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Twisting Machines

The dust counts as shown in the table indicate a relatively small number of particles.

SPINNING DEPARTMENT:

This department is located on the second floor of building No. 1 at one end of the main card room.

Mule spinning and some spooling operations are carried on here. The department is provided with the Carrier System. No ring frame spinning is done.

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TABLE No. 4

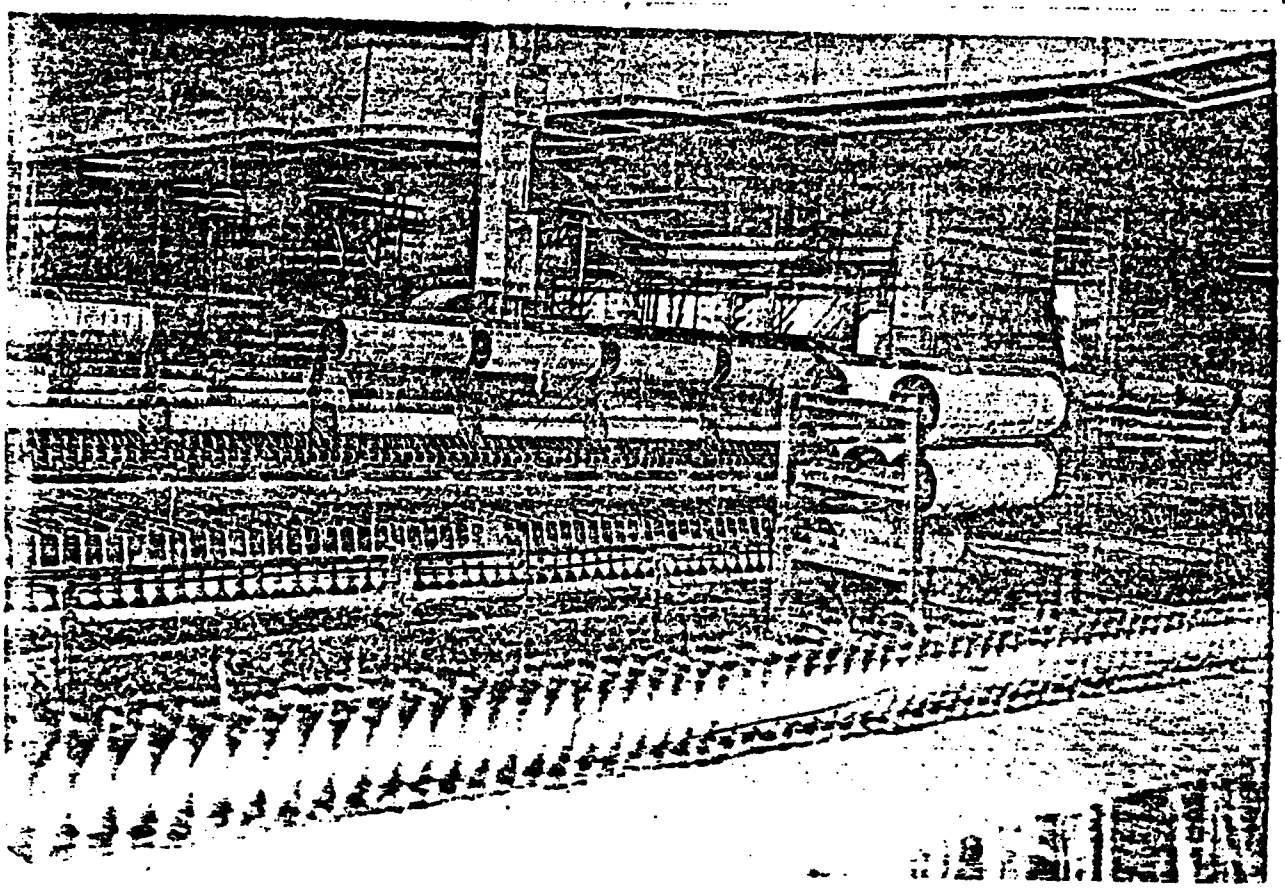
SPINNING

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
32	1 2nd floor	4	Between mules 405 and 406 at S.E. corner of room	2,514,814	.49
33	1 2nd floor	4	Between mules 405 and 406 at the N.E. corner of room	4,576,610	.40
34	1 2nd floor	4	At the end of spooler 457	1,254,164	—

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These counts are comparatively low and indicate effective control.



Mule Spinning

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CARDING ROOM:

This room consists of two connecting departments occupying the second floors of building No. 1 and No. 3, except for a portion in building No. 1 devoted to spinning.

The section located in building No. 1 is equipped with the Carrier System. No form of humidification is used in building No. 3.

The carding machines in building No. 1 are totally enclosed by canvas covered wooden frames and each enclosure is equipped with an exhaust to remove the dust. That section located in building No. 3 is not totally enclosed. The exhaust on these machines is connected with the hood covering the comb of the card.

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TABLE No. 5

CARD ROOM

Sample No.	Building No.	Dept. No.	Location of Sample	Total Counts of Dust Particles per cubic foot	Weight of Dust in milligrams per cubic foot
36	1 2nd floor	2	Between cards #101 and 102	10,127,514	1.58
37	1 2nd floor	2	Alongside of card #201	3,519,228	.70
38	1 2nd floor	2	On spooler #459	3,625,518	.99
39	3 2nd floor	3	Alongside card #184	7,520,930	1.28
40	3 2nd floor	3	Alongside card #172	15,677,052	1.35
41	3 2nd floor	3	Between carders #162 and 193	6,221,064	.57

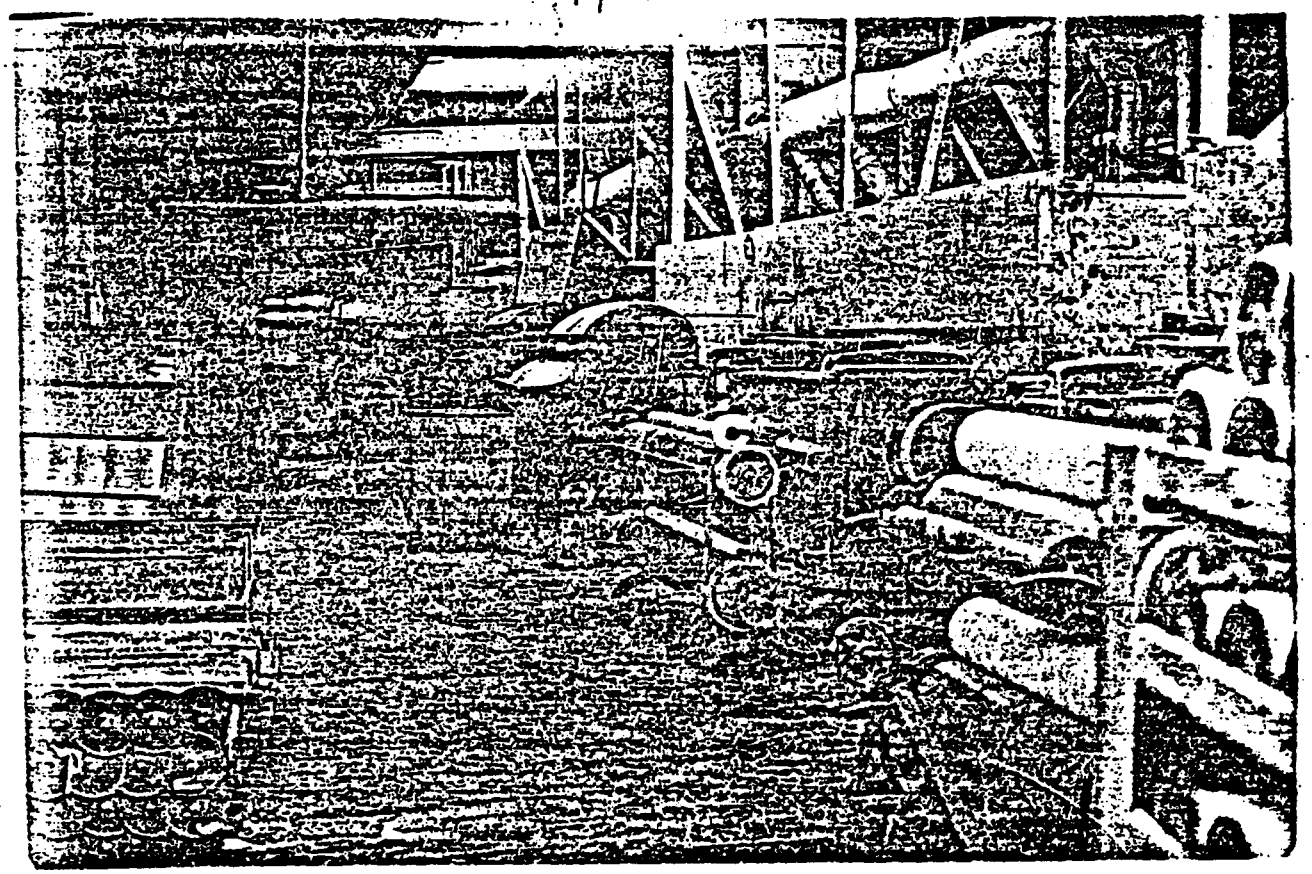
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It will be noticed that the counts vary considerably and in two instances are quite high. No marked difference is noticed where the machines are totally enclosed and only partially enclosed.

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Main Card Room, Second Floor
Bldg. #1
Showing totally enclosed card machine

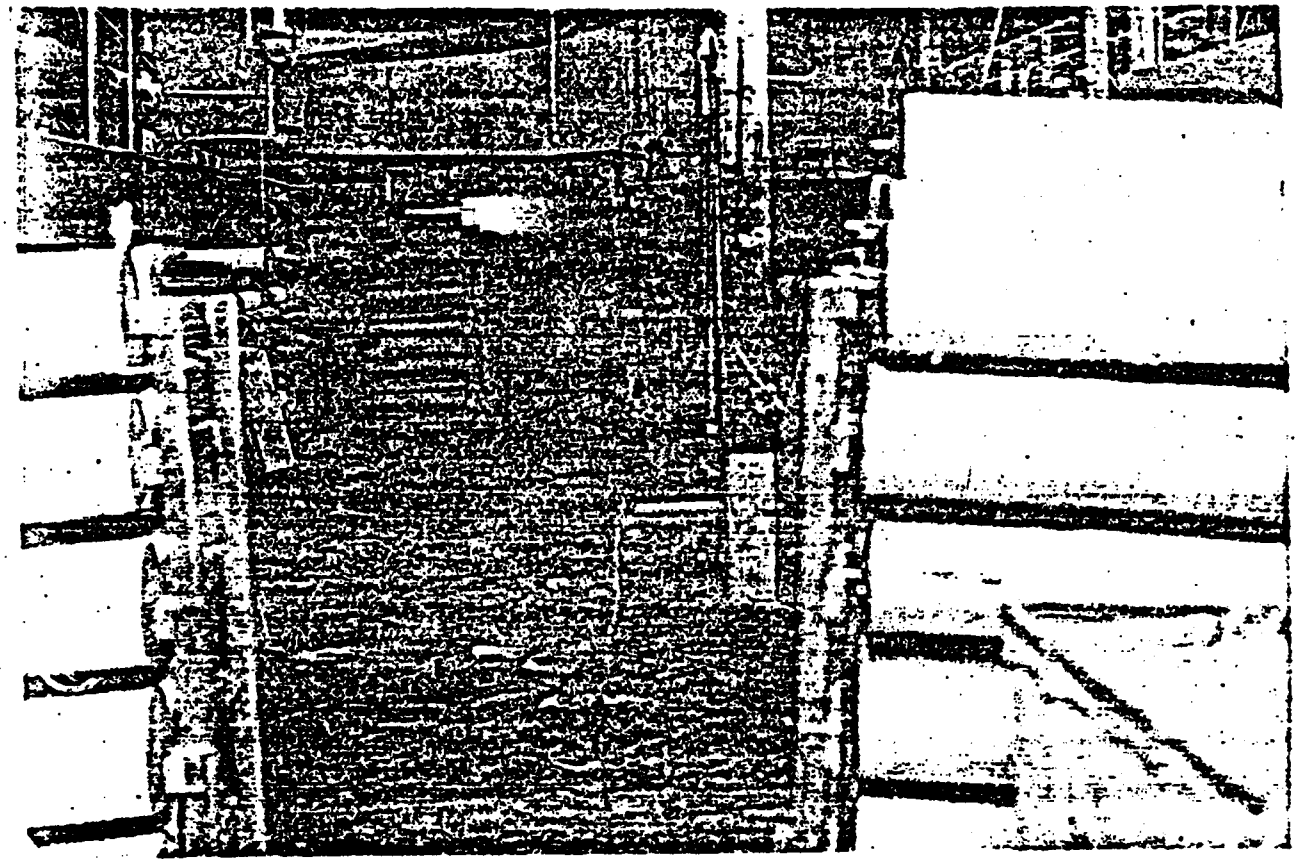
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Card Room, Second Floor
Bldg. #1

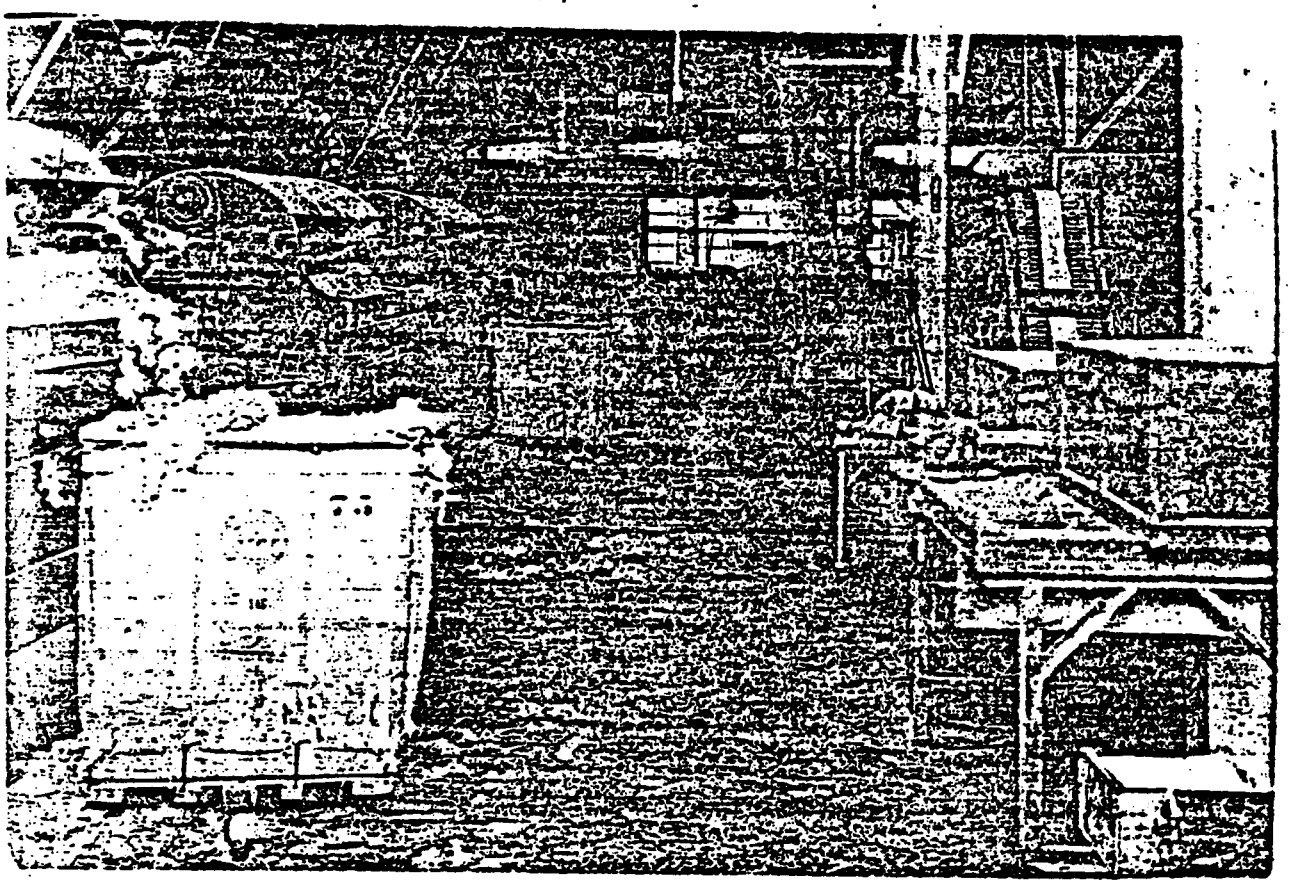
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Card Room, Second Floor
Building #3

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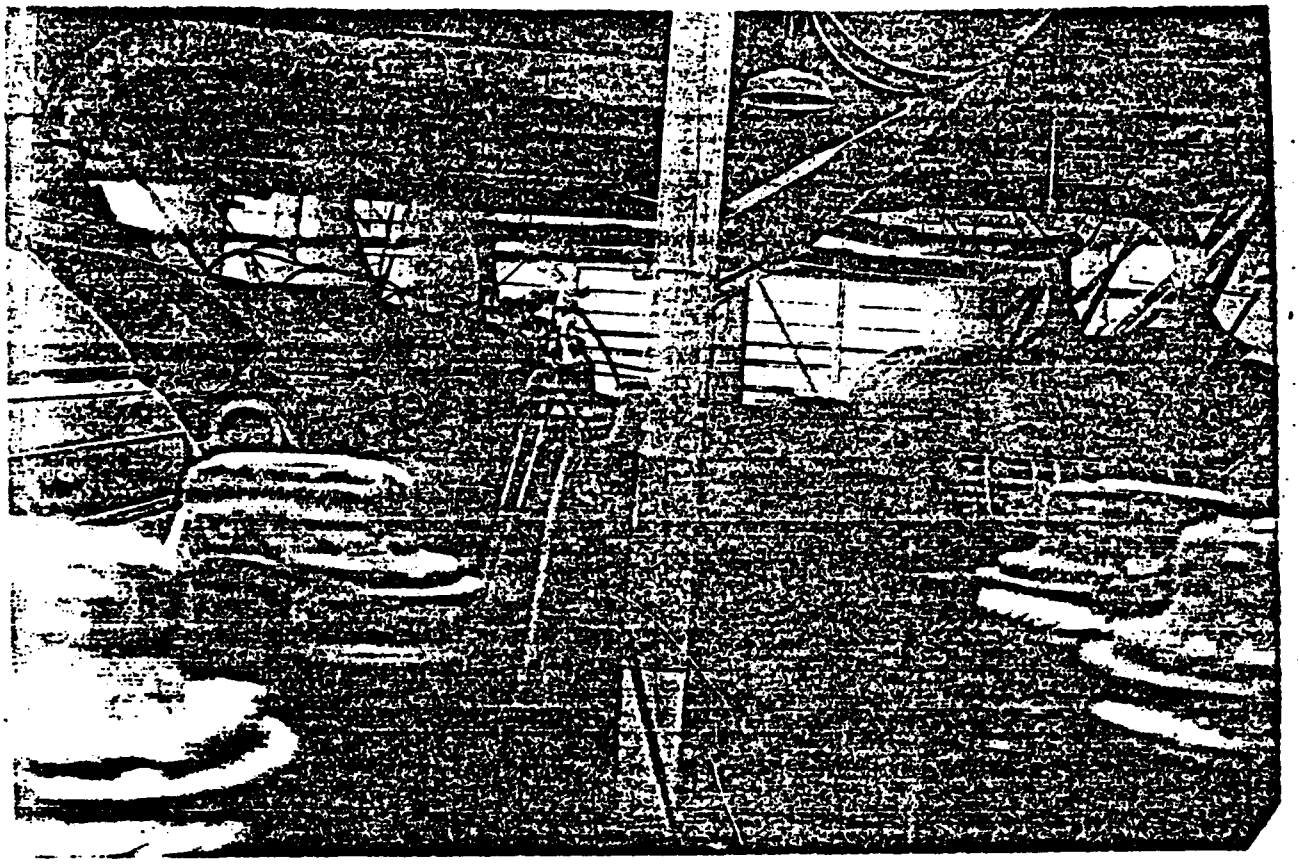
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Card Room, Second Floor
Building #3

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PLANT HOUSEKEEPING:

The floors are dry swept almost continuously throughout the working period. Each Friday the dust is removed from the ceilings, walls, and machines by means of an air hose during the working period. The dust counts during this period of cleaning would be increased considerably. It is recommended that cleaning be accomplished by means of a vacuum system. There are portable units on the market designed for this kind of work.

PHYSICAL EXAMINATIONS:

Physical examinations were made on fifty-four employees. All who worked in an asbestos industry three years or longer were included in this group. These employees were examined for symptoms usually associated with what English authorities term "asbestosis". These include anorexia, leaden hued complexion, emaciation, dyspnoea, cyanosis, cough, expectoration, "asbestos corns", decrease in chest expansion, clubbing of fingers, swelling of skin at the nails, and history of chest trouble. The chests of these employees were then examined for friction rubs, rales, dullness, diminished breath sounds, increased voice sounds, and where the symptoms and findings suggested further examination, X-ray pictures of the lungs were taken.

X-ray examinations were made of 20 employees; of these 10 showed definite evidence of asbestos dust injury to the lungs; one showed tuberculosis without dust injury, and nine were negative.

The action of inorganic dust upon the lung tissue is such as to cause the development of fibrous tissue - fibrosis. Such dust fibroses are classified under the general term pneumoconiosis. The various types of pneumo-

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coniosis are further differentiated by more specific titles which define themselves, such as silicosis, anthracosis, and asbestosis.

On page 2 of the first unit report of this series of studies it was stated, in relation to the action of asbestos dust on the lungs, "We are confronted with three alternatives:

(1) Asbestos dust does not cause pulmonary damage.

(2) Asbestos dust does cause pulmonary damage akin to silicosis, but of a milder nature.

(3) Asbestos dust itself does cause pulmonary damage, but in a manner and of a type entirely distinct from silicosis."

The X-ray films of this study definitely inform us that individuals exposed to the inhalation of asbestos will in time show structural changes in their lungs - pneumoconiosis. Our studies have not progressed sufficiently for us to construe this type of pneumoconiosis in term of disability or of increased susceptibility to tuberculosis. This type of pneumoconiosis, to which the term asbestosis may properly be applied, is quite distinct in its X-ray film appearance from true silicosis and an experienced technician would have no difficulty in distinguishing the two conditions. The evidence so far would indicate that the action of asbestos dust is in accord with the second alternative quoted above.

Four films showing definite asbestosis also showed old tuberculous lesions, apparently inactive, 3 of the films negative for asbestosis also showed such lesions; this would lend support to the contention that asbestosis does not tend to activate quiescent tuberculous lesions which is in accord with the meagre evidence so far available from animal experimentation and with the limited clinical experience.

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The following table summarizes the X-ray examinations.

No.	Sex	Age	Occupational History	Diagnosis
1	F	36	Weaving 21 yrs. off & on, 4 yrs. U.S. Asbestos Co.	Negative
2	F	37	Twisting 15 years	Late first degree asbestosis
3	M	32	Weaving 12 years	Early first degree asb. old tubercu-lous lesion
4	M	53	Spooling 6 years	Negative.
5	M	47	Spooling 3 yrs. U.S.As.Co. 14 yrs. elsewhere	Negative
6	M	68	Warping 12 years	Negative; old tuberculous lesion
7	M	50	Weaving 10 years	Early first degree asbestosis
8	M	44	Carding 5 years	Early first degree asbestosis; heart lesion
9	M	58	Spooling 5 years	Beginning asbes-tosis
10	M	37	Weaving 6 years	Negative
11	M	32	Weaving 9 years	Negative. Old tuberculous lesion
12	M	36	Weaving 22 years	First degree as-bestosis. Old tuberculous lesion
13	M	45	Weaving 7 years U.S. As. Co. 11 yrs. elsewhere off & on	Negative
14	M	64	Warping 12 years	Negative

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No.	Sex	Age	Occupational History	Diagnosis
15	M	39	Weaving 3 years	Negative. Old tuberculous lesion active(?)
16	M.	52	Weaving 18 years	Early asbestosis
17	F	41	Spinning 3 years	Negative
18	M	33	Carding 7 years	First degree asbestosis
19	M	48	Foreman 22 years	Early second degree asbestosis
20	M		Worked in asbestos 20 years, out of plant 10 years	Late second degree asbestosis. Old tuberculous lesion

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In the foregoing cases the length of exposure with the resultant degree of pneumoconiosis and the general appearance of the films all support the second alternative mentioned above.

Sputum analysis was made of ten of the individuals X-rayed, and "asbestos bodies" were found in one case.

SUMMARY:

Dust counts in the preparation room and carding room were high, several counts higher than ten million.

Individuals exposed to this dust showed definite pneumoconiosis. Their occupation and length of exposure were as follows (omitting 19 and 20 whose histories were not clear):

Twisting	Spooling	Carding	Weaving
15 years	5 years	5 years	10 years
		7 "	12 "
			18 "
			22 "

The number of these cases is too small to draw any final conclusions. They indicate a possible variation of hazard in the four processes listed, but further study will be needed to establish the facts.

RECOMMENDATIONS:

1. The method of application of the oil used in the preparation room at the Charleston plant is more effective than that used at Manheim. Therefore, the Charleston method is preferred.

2. That the humidification and air conditioning system be continued

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and extended wherever possible.

3. The dust counts indicate little difference between the two systems of exhausting dust arising from the carding machines. The canvas covers have no advantage in exhausting the dust, and have the disadvantage of making it more difficult to clean the machines. They also offer a larger surface for dust to settle. The exhaust system connected with the metal hood covering the comb of the card is recommended.

4. That the exhaust system attached to the machines in the preparation room be repaired and maintained, especially those connected with the shaker sieve and the wick carding machines.

5. That cleaning be done by means of a vacuum system instead of the present method of blowing with compressed air.

6. That all employees be given an initial physical examination and periodically thereafter. X-ray examinations should be made when indicated.

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