FILE COPY

JOHNS-MANVILLE RESEARCH
AND ENGINEERING CENTER

Memorandum M404-66

Date February 4, 1969

VISIT TO THE U. S. BUREAU OF MINES - T. J. Weeks and A. F. Burns
January 13 through 15, 1969

U. S. Bureau of Mines personnel attending: Robert H. Schutz and A. J. Beckert.

SILICA DUST TEST

The silica dust test chamber is 8 ft x 6 ft x 6 ft and averages 12 air changes an hour. The silica is obtained from the Pennsylvania Sand Glass Corporation. It is fed by vacuum through a cyclone with a 1.43 cm orifice and thence into the chamber. This reduces the particle size from an average 1.3 μ to 0.6 μ. (See Appendix I for diagrams of the apparatus. These were provided by the Bureau of Mines.) The mask is cemented onto a brass frame which is then placed in the dust chamber and air is drawn through at 32 liters a minute. There are three ports in the silica chamber: one for the monitor, one for the mask being tested, and one for an American Optical mask which was used as a standard to determine if the silica chamber was acting right. Note that this also tests the filter container as well as the filter.

Behind the mask is a glass fiber filter obtained from MSA (# 1106B). This is weighed before and after the test. During the 90 minute test, the silica concentration is monitored every 20 minutes. For this, the glass filter mat is placed in the chamber and air drawn through for 10 minutes. The Bureau of Mines specifications require the silica concentration be between 50 and 60 mg/m^3 during the test. This requirement seems to be more strict than their test facilities achieve. While there, it was noticed the concentration ranged from as low as 43 mg/m^3 to as high as 75 mg/m^3. (However, the average during the 90 minute test was between 50 and 60.) Inhalation and exhalation resistances were tested at 85 liters a minute before and after the silica test. The following table gives silica penetration, exhalation resistance, and inhalation resistance data for the J-M mask, the American Optical mask, and the 3M mask.

PRODUCED
JM - 83

Table 1. Silica Dust Test

	J-M			A-O	3M
	1	2	3	1	1
Initial inhalation resistance (mm)	9.0	7.0	7.5	16.0	1.0
Final inhalation resistance	14.0	11.0	11.0	38.0	45.0
Initial exhalation resistance	8.0	7.5	8.5	25.0	--
Final exhalation resistance	11.0	11.0	10.5	25.0	--
Silica breakthrough (mg)	1.5	3.0	2.6	1.9	31.2
Challenge concentration (mg/m^3)	64.7	58.9	55.7	64.7	62.9
Per cent efficiency	0.80	1.77	1.65	1.02	17.2

JM CONFIDENTIAL. Not for general distribution or republication.

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/1

In two out of three cases the silica breakthrough on the J-M mask exceeded Bureau of Mines specifications (the 3M element did also, but this is not an approved mask). At the Research Center, the silica breakthrough averaged less than 0.5 per cent for filter elements prepared. The discrepancy between our data and Bureau of Mines results is due to the fact that we did not run the silica dust through a cyclone, thereby having a larger particle size. Also, concentrations in this laboratory were run two-three times greater than those at the Bureau of Mines and the test period was 40 minutes, thereby resulting in faster loading. This was necessary to achieve rapid screening of filter elements which were prepared. Also, the Bureau's resistances were lower than ours because they used a more accurate differential manometer.

The exhalation data is interesting. If all the air were going out the exhalation valve, there should be no increase in exhalation resistance after loading. However, this was not the case. In fact, the American Optical mask had the identical expiratory valve as the J-M mask and its resistance was three times that of the J-M mask. Therefore, it appears obvious that the exhalation valve can be eliminated. This will decrease the cost by eliminating an operation and part. Without the valve, our exhalation resistance will still be well within the Bureau's specifications. Bob is attending a meeting of the AIHA committee on dust masks and respiratory devices to discuss the feasibility of an approved valveless respirator. It would appear that our mask would meet any requirements they might devise.

The efficiency of our filter can be increased by merely increasing the concentration of Code 106 MICRO-FIBERS in the mix. The breathing resistance is so low now that a small rise will not be noticeable. The filter now is a double element with the backup being pure rayon and binder while the filtering media is composed of glass, rayon, and little binder. The hinge action of the mask would work better if the filter element were more flexible. This can be achieved by having a thinner backup filter or finding a more flexible binder.

COAL DUST TEST

The coal dust test is run in a room similar to that of the silica chamber. Coal dust of approximately 1.2 μ was blown into the chamber. A monitor samples the air inside the mask and in the room at a flow rate of 2 liters a minute. During this half hour test, the subject talks, frowns, smiles, nods head, etc. B. Schutz wore a mask without the silicone gum and the leakage was 5.1 per cent. Using Millipore membranes, 0.12 mg coal dust was collected from the face piece and 2.31 mg was collected outside. The concentration in the chamber was 39 mg/m^3 which was lower than usual (75 $\pm$25 mg/m^3 in the Bureau of Mines requirement). This again indicates that a great amount of art is involved in the Bureau's testing schedules.

In two other tests considerable silicone gum was included in the face piece; one test subject was T. J. Weeks. Both Weeks and Beckert gave leakages of 5.5 per cent (Weeks - face piece concentration 0.10 mg, chamber 1.81 mg; Beckert - face piece concentration 0.14 mg, chamber 2.53 mg). Interestingly enough, both were in the chamber at the same time. Inasmuch as the filter frames are made by Weeks and pressed around his face for initial forming, it should be assumed that 5 per cent is the lowest leakage rate obtainable. Beckert leaked around the nose and one cheek; Schutz leaked under the chin; but no obvious leakage was detected with Weeks.

JM CONFIDENTIAL. Not for general distribution or republication.

PRODUCED
JM - 83

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/2

From these tests, it appears that the silicone gum offers no advantage and should be eliminated. This would decrease the cost of the mask considerably since 8 cents worth of gum is used in the mask. If one includes the cost of compounding with Cab-O-Sil, placing the gum in the groove, and then covering the gum with waxed paper, the total cost reduction would probably be from 15 - 20 cents.

ASBESTOS DUST TEST

Eight different dust masks were tested with asbestos dust. This dust was Plasti-best 20 which was air-jet milled and micropulverized two times. See Appendix II for micrographs of the processed fiber taken by D. Bailey. Passage through the cyclone eliminates the larger bundles. Testing procedure was identical to that of the silica dust test. The asbestos fed into the chamber generally very nicely although upon occasion it would clump in the feeding tube. This was remedied by just tapping the tube. The two pictures in Appendix III show the feeding tube. The film was too slow to catch the true swirling of the asbestos in the tube. On a previous visit, samples were taken from the chamber on Gellman filters. One electron micrograph of these is included here (Picture 3, Appendix II). A Formvar coated grid was simply placed against the membrane and the picture taken. The method is crude but does show the fiber was dispersed. More samples were taken on this trip and will be studied under a scanning electron microscope.

As the data shows, the asbestos concentration remained quite constant.

Table 2. Asbestos Fiber Concentrations

[1] mg/m^3	[2] mg/m^3	[3] mg/m^3	[4] mg/m^3
19.6	17.8	28.3	16.3
15.6	30.9	31.9	25.0
10.9	29.1	32.5	34.1
15.3	30.3	27.5	24.1

1. A 2 3/4-in. pulley was used giving a lift rate of 13 cm/hr.
2. Using 5 1/4-in. pulley (only 1/2 hr allowed for equilibration) 25 cm/hr.
3. Using 6 7/8-in. pulley, using 33 cm/hr.
4. Using 6 7/8-in. pulley, using 33 cm/hr.

The diameter of the feed tube was 25 mm. During the last visit at the Bureau, a 12 mm tube was used which did not feed well. Also, a 50 mm tube was tried and was satisfactory. The rate of feed was changed from test to test as indicated on the data sheet.

The masks tested were chosen to cover as wide a variety of filter elements as possible. Five of the masks did not have Bureau of Mines approval (Schutz was extremely cooperative in allowing these to be tested since technically [illegible] not allowed).

JM CONFIDENTIAL. Not for general distribution or republication.

PRODUCED
JM - 83

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/3

Table 3. Asbestos Fiber Penetration

	J-M[c]	A-O	3M[c]	Flex-a-Foam[c]	Acme[c]	MSA "77"	Wilson	Baxter[c]
Initial inhalation resistance (mm)	6.0	16.0	1.0	4.0	44.0	22.0	13.0	18.0
Final inhalation resistance	8.0	50.0	--[a]	23.0	83.0	29.0	36.0	38.0
Fiber breakthrough (mg)	-0.1	0.0	0.4	2.0	0.1	-0.1	0.3	0.0
Challenge concentration (mg/m^3)	30.5	15.4	15.4	28.0	25.0	30.5	28.0	25.0
Per cent efficiency	--[b]	--[b]	0.75	2.48	--[b]	--[b]	0.37	--[b]

[a]Not determined, however, in the silica dust test this mask gave a final resistance of 45 mm.
[b](0.11 per cent) is the experimental limit.
[c]Not approved.

A crude generalization on the filter elements follows:

3M	-	cellulose glass fiber
MSA	-	rayon-glass mixture
J-M	-	rayon-glass mixture
Baxter	-	rosin wool
Wilson	-	rosin wool felt
Acme	-	glass fiber in a canister or MICRO-QUARTZ type material
American Optical	-	crocidolite, glass, and nylon
Flex-a-Foam	-	open cell foam.

Surprisingly, only the Flex-a-Foam mask allowed an asbestos breakthrough of greater than 1 per cent. Notice that the 3M mask, while giving 17 per cent silica breakthrough, gave only 0.75 per cent asbestos breakthrough. This is further indication of the efficiency of the crudest media against asbestos dust. The J-M mask had considerably better loading characteristics than the other masks in regard to the inhalation resistance increase.

In one case, a 0.8 Millipore membrane was used in a backup of the MSA filter element. This showed no weight increase but the electron micrograph may pick up some fibers. Other samples were taken at various time intervals in the chamber on a 5 Millipore membranes. In several cases, the 5 μ membrane was backed up by a 0.8 μ filter to check fiber penetration through the Millipore.

There is a considerable lack of information in the field of filter efficiencies against fiber and a considerable amount of excitement engendered by Leroy Balzer's statements that he found significant amosite fiber breakthrough through filters. We should write this up as a note immediately and submit it to the AIHA Journal. Discussions with Schutz indicated that because of the governmental red tape necessary for publication and the fact that we tested some non-approved filters that his name not be included on the paper. We will, of course, give him a glowing

PRODUCED
JM - 83

acknowledgement and a preprint to insure that we are not compromising the Bureau. Further, I mentioned that he was welcome to use our data from the fiber tests. He said the inasmuch as we may become a dust mask manufacturer, he would not discuss any of the results of our visit with anyone.

MISCELLANEOUS INFORMATION OBTAINED

While at the Bureau some information was obtained on the Lepestock 200 mask which was mentioned by Bill Burgess at the Mt. Sinai meeting. Coal dust leakage tests indicate a leakage rate of 8 per cent. However, the breathing resistance increases very quickly and becomes uncomfortably high. Silica dust tests indicate the mask is very efficient, i.e. less than 1 per cent breakthrough. However, it loads very quickly. A sample of the filter element was obtained from B. Schutz and has been given to the Chem Lab for analysis. It is assumed this filter element is PVC.

I mentioned to Bob that Duncan Holiday was working for Selikoff. He was quite impressed and said Holiday has an excellent reputation.

T. J. Weeks

T. J. Weeks

A. F. Burns

A. F. Burns

/mac

cc: F. L. Pundsack
S. Speil
E. M. Fenner
J. P. Leineweber
T. J. Weeks
A. F. Burns
Library (2)
G. Kwasniewski 4/13/72
R.M. Halvorsen 6-5-69 Ret'd 4/10/72

JM CONFIDENTIAL. Not for general distribution or republication.

PRODUCED JM - 83

APPENDIX I

CHAMBER 8' x 6' x 6' --high

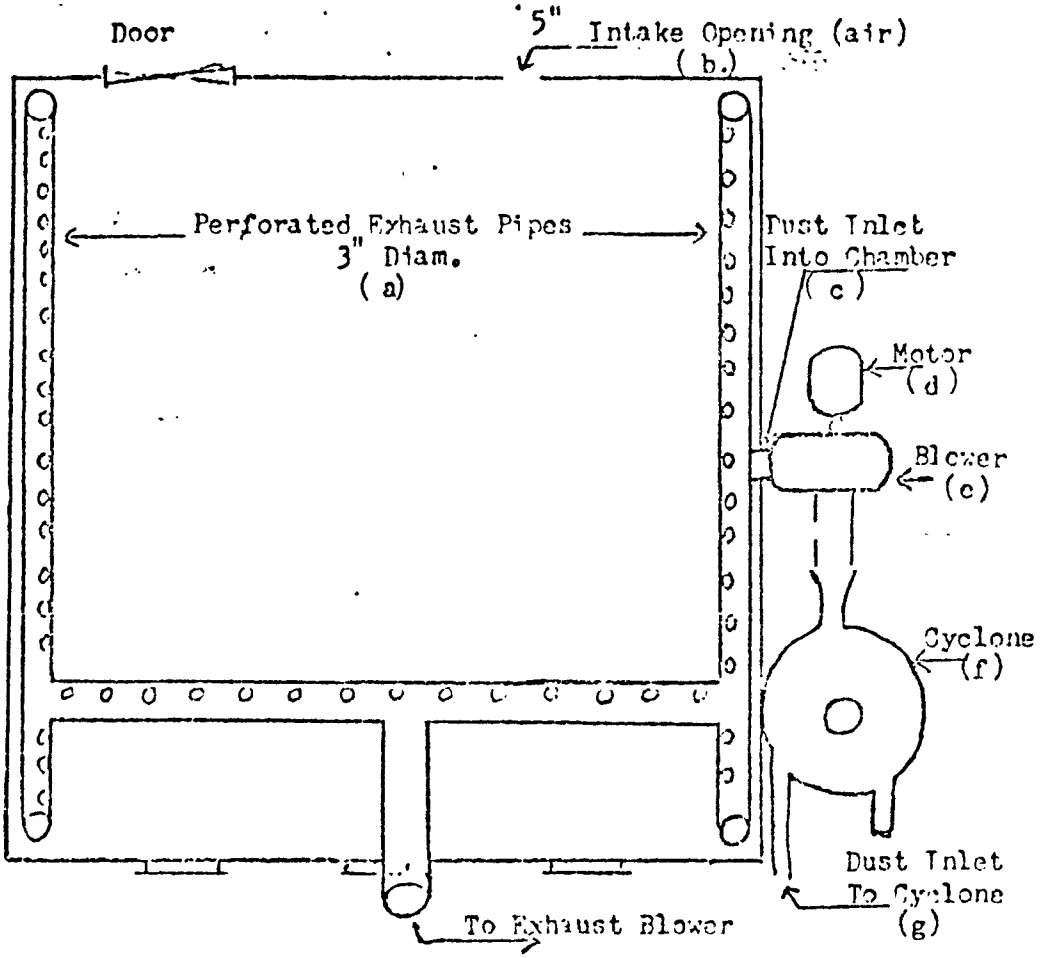


Figure 1. Silica Dust Chamber
Schematic Diagram
(Top View)

PRODUCED
JM - 83

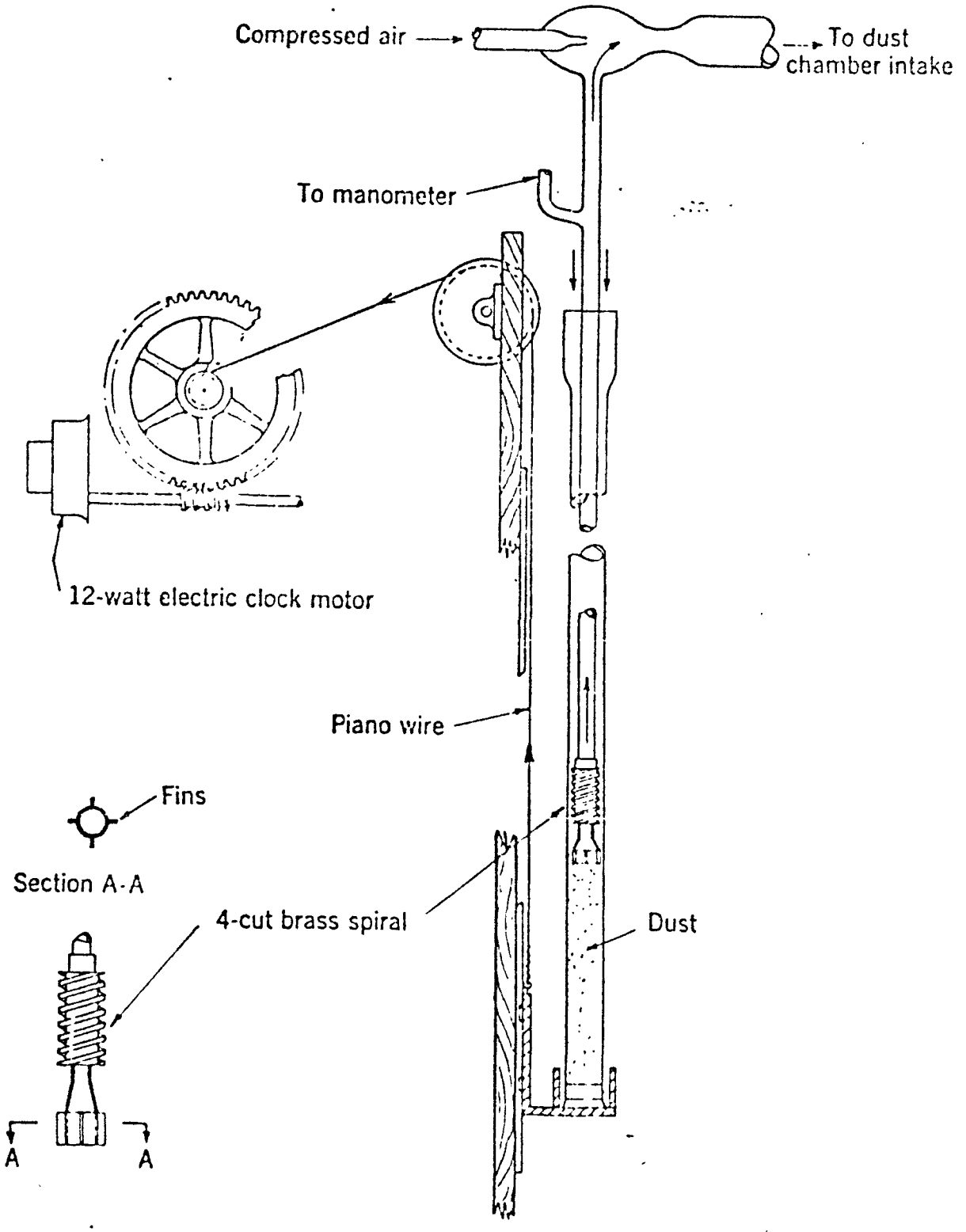


Figure 2.- Dust feed apparatus.

PRODUCED JM - 83

APPENDIX I

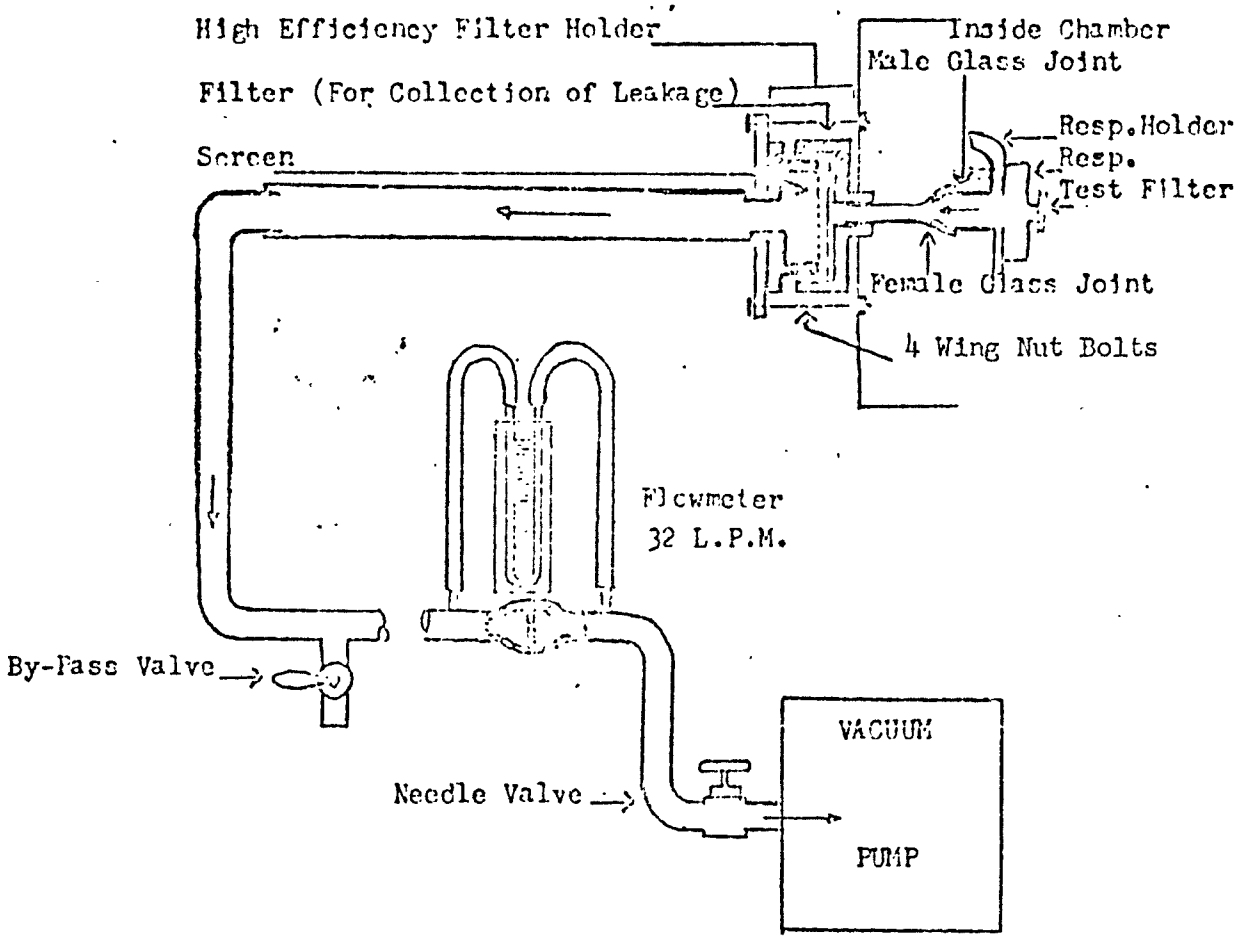


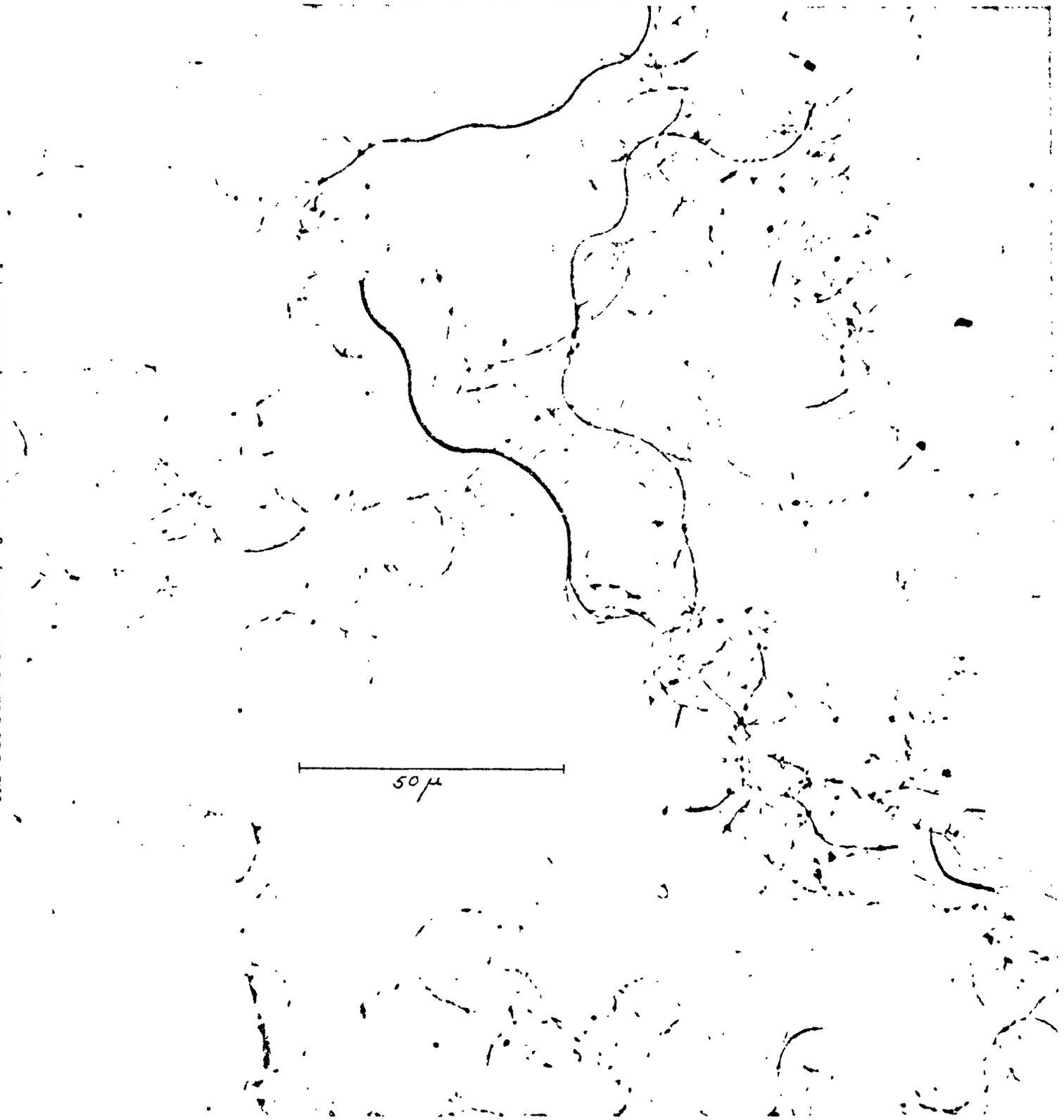
FIGURE 3 DUST-SAMPLING APPARATUS
SCHEMATIC DIAGRAM

PRODUCED
JM - 83

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/8

APPENDIX II

Picture 1. Before Chamber.



Plastibest 20 1000X E-3833B

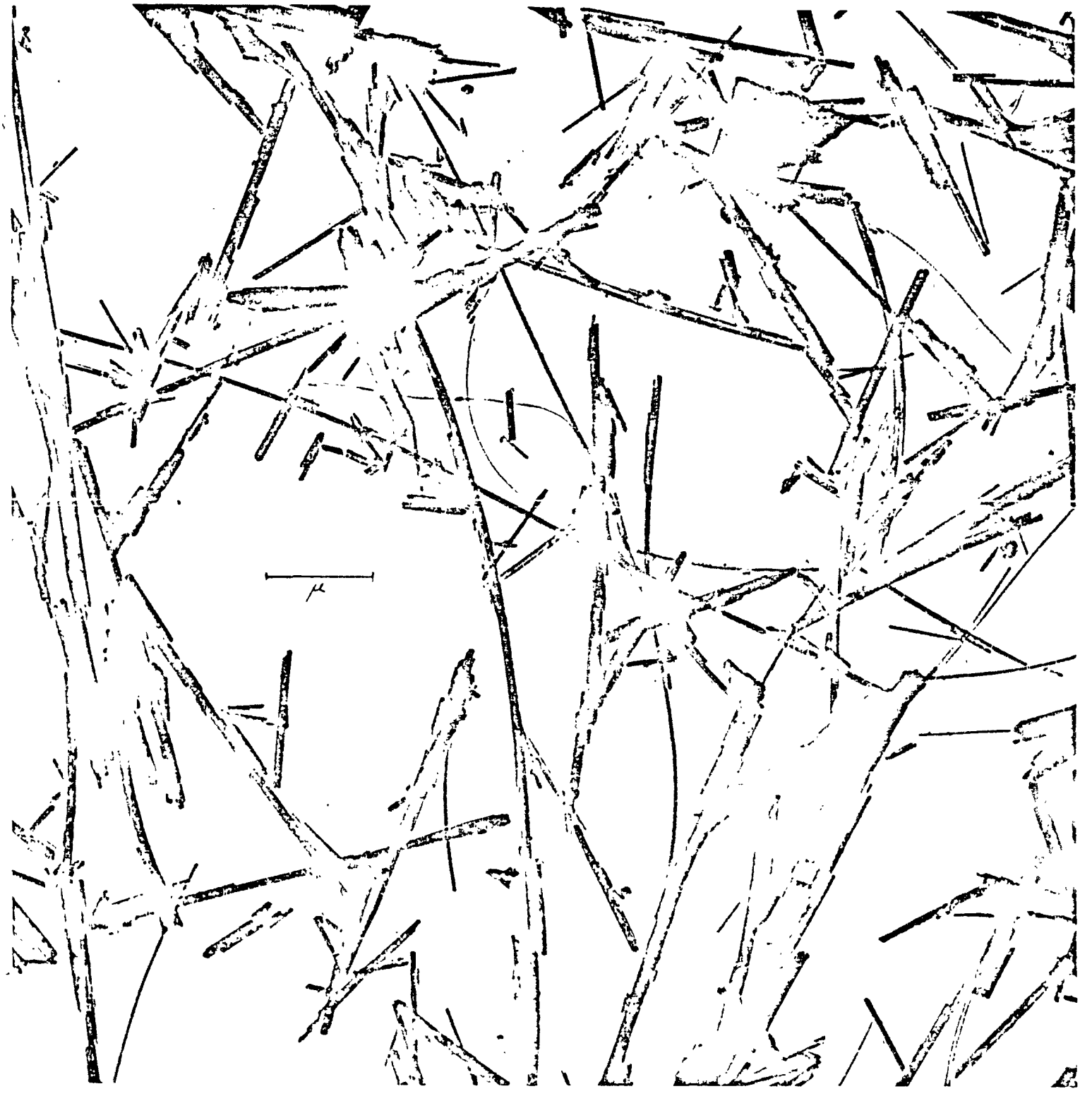
JM CONFIDENTIAL. Not for general distribution or republication.

PRODUCED
JM - 83

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/9

APPENDIX II

Picture 2. Before Chamber.



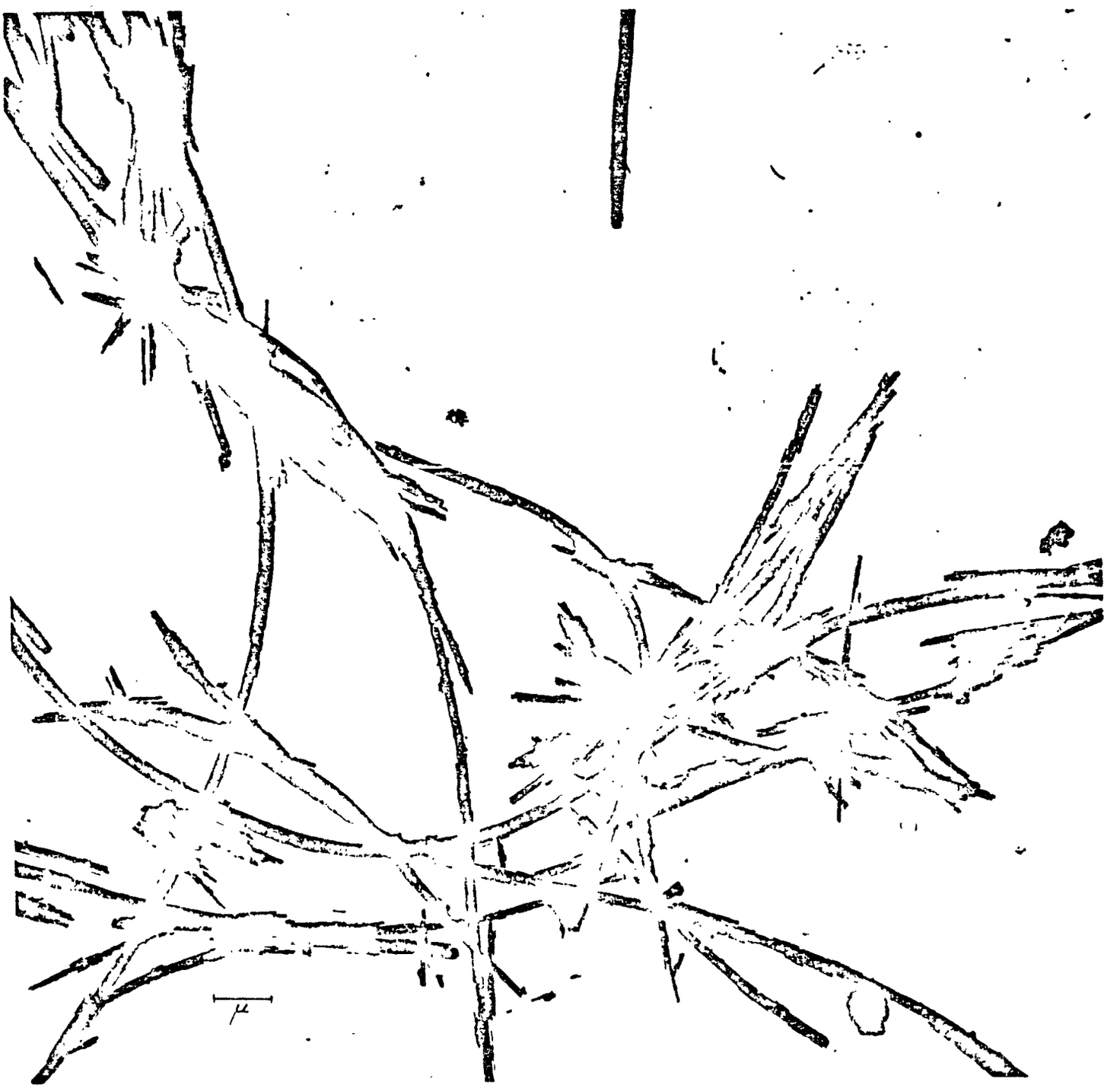
Plastibest 20 20,000X 858C

PRODUCED
JM - 83

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/10

APPENDIX II

Picture 3. Collected from Chamber on Membrane.

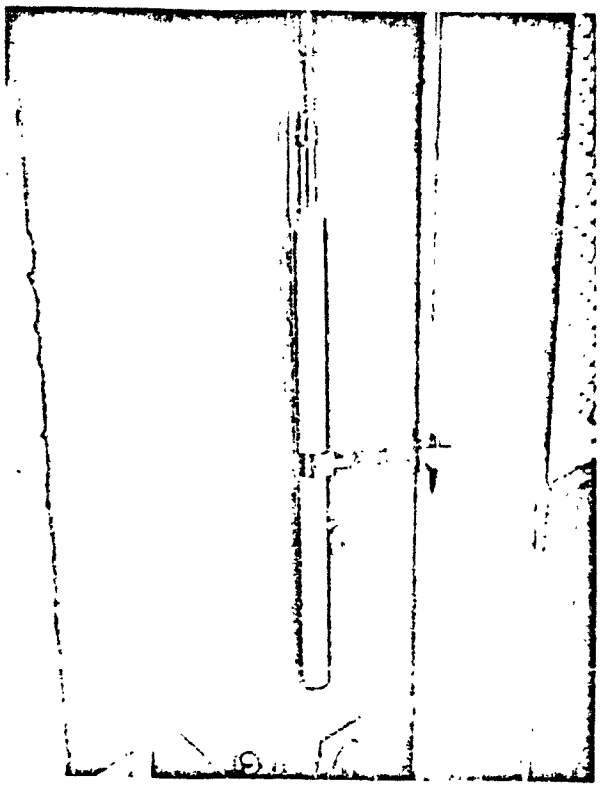


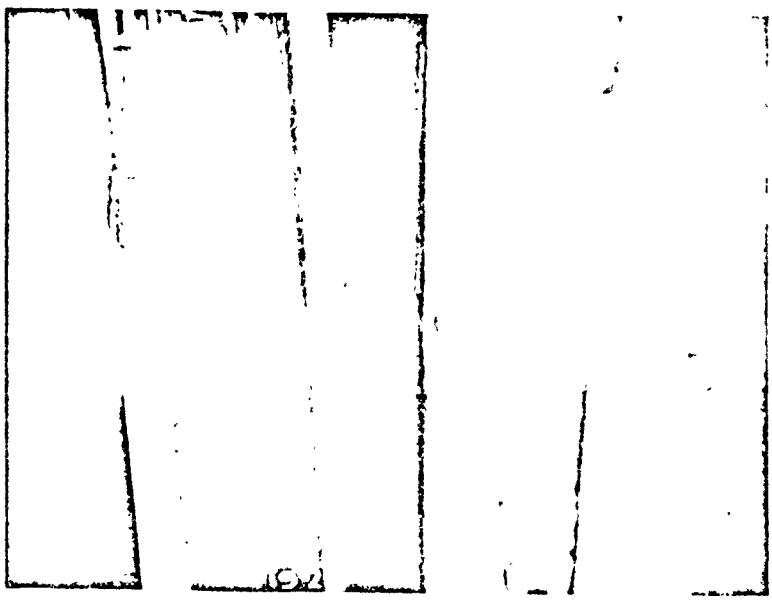
10,000X

PRODUCED
JM - 83 829B

Published by AsbestosClaims.Law
asbestosclaims.law/library/24587/11

APPENDIX III





PRODUCED
JM - 83