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HIGH EFFICIENCY FILTER BURNING HUMIDITY TESTS FOR PROJECT CGI-791 IPD CONFINEMENT PROGRAM

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J. H. PALMER, Supervisor

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POWER AND GENERAL MAINTENANCE
CHEMICAL PROCESSING DEPARTMENT

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HIGH EFFICIENCY FILTER BURNING HUMIDITY TESTS FOR PROJECT CGI - 791 IPD CONFINEMENT PROGRAM

BY J. H. PALMER, SUPERVISOR

POWER AND GENERAL MAINTENANCE
CHEMICAL PROCESSING DEPARTMENT
GENERAL ELECTRIC COMPANY
HANFORD, WASHINGTON

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HIGH EFFICIENCY FILTER BURNING, HUMIDITY, AND DOP TESTING

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HIGH EFFICIENCY FILTER-BURNING TESTS

SEPTEMBER 30 & OCTOBER 1, 1959

Introduction

Burning tests were conducted on the three principal manufacturers' filters on the above dates. These tests were run chiefly to determine the fire resistive qualities of new adhesives used in binding the internals to the filter frames, and to test innovations adopted by two of the manufacturers. Moisture saturation tests are also being conducted, but as they are incomplete, will be covered by a separate report. These tests are being conducted in connection with the IPD confinement program and also at the request of AEC Safety and Fire Protection Engineers at Washington, D.C., and at Hanford.

The manufacturers, with our cooperation, are continuously endeavoring to improve the fire resistant qualities of their products. The change in adhesives and the innovations were made as a result of this endeavor.

The tests were observed by representatives of AEC Fire and Safety Engineers from Washington, D.C., the Idaho Operations Office and the Hanford Operation. Members of IPD, HLO, CPD and other HAPO Operations, and a representative of the Purchasing Command, Army Chemical Corps, from Edgewood, Maryland, also witnessed the tests.

Summary of Tests

Of the filters tested in this series, the wood frame and sloped separators, using adhesive, suffered the least damage to separators and adhesive. The sloped separators are an innovation designed to strengthen the internals.

The "honeycomb" filter, a new filter designed to meet competitive prices, suffered the most serious damage. This filter is assembled without separators. As a consequence, damage by fire is more apparent. A fire screen is supplied with this filter and designed to protect the filter from flames. In our test it failed to do so before the media was destroyed. The screen is apparently treated with intumescent paint or simular material, which swells with heat application, completely cutting off air passage to the filter. The use of this screen would be hazardous in our processing plants because of the danger of pressurizing contaminated exhaust systems, hoods, etc.

The methods used in testing were the same as described in previous reports, and were deliberately designed to be destructive. Photographs taken during and after the tests graphically portray results.

It is again emphasized that once exposed to fire, this type filter has lost efficiency and should be replaced immediately.

Tests

Test 1 - Filter, with adhesive. asbestos separators; fire-resistant plywood frame.

Remarks: Highest temperature recorded in this test, 1,000°C, was at a point approximately 1" above the adhesive at the bottom of the filter and about 6"

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from the front. The next highest, 883°C, at the center and approximately 8" from the bottom of the front face of the filter.

The adhesive was charred, but still held edges of the separators and media. The separators warped and opened up, permitting flames to travel beyond the filter unit. The media broke through as soon as the flame touched it.

Test 2 - Filter, with adhesive. asbestos separators; fire-resistant plywood frame.

Remarks: Highest temperature recorded in this test was recorded 8" up from the bottom center of the front face, 1,000°C+. The next highest was approximately 1" above the bottom center, halfway through the filter, 1,000°C.

Adhesive was charred to approximately the same extent and with the same results as in Test 1. The separators warped and opened up with the same effect as in Test 1.

Test 3 - Stock special, sloped asbestos separators, ~~ceramic~~ frame. アスベスト仕上げ

Remarks: Highest temperature recorded was at a point 1" above the adhesive at bottom center and halfway through the filter, 825°C. Next highest was 8" above the bottom center and at front face, 470°C.

The adhesive was still pliable and had a strong hold on separators and media. In this test the separators held their shape--did not warp or open up.

Note: In this test, temperature was not as high as in Tests 1 and 2, although excelsior used in burning was carefully weighed. Hindsight indicates that placing of burning material is responsible. Photographs show that in this test the excelsior was evenly spread over the entire face of the filter, while in Tests 1 and 2, the excelsior was concentrated, or bulked, at the bottom of the filter.

Test 4 - with adhesive. Stock special sloped asbestos separators; fire-resistant plywood frame.

Remarks: Highest temperature recorded was at a point 8" above bottom center on front face, 823°C. Next highest was 1" above adhesive at the bottom of the filter, 567°C.

The adhesive was in excellent condition, still pliable and firmly holding the separators and media. The separators held conformation and showed little or no effect of the fire exposure. This may or may not reflect the advantages to be gained from sloped separators. As in Test 3, the heat developed was lower than in Tests 1 and 2.

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Test 5 - with adhesive. Stock special sloped asbestos separators; ~~ceramic~~ frame. ASBESTOLUX

Remarks: Highest temperature was at 8" above bottom center on front face, 845°C; next highest was 1" above adhesive at the bottom of the filter, 625°C.

The adhesive, although slightly charred on the surface, was still tacky and held firmly to the filter frame. The separators showed little effect from the fire exposure.

Test 6 (numbered 45 in photographs) - , with adhesive. sloped asbestos separators; fire-resistant plywood frame.

Remarks: Highest temperature recorded, 667°C, was at a point 8" down from top center. The next highest was at a point 1" above the adhesive at bottom center and halfway through the filter.

The adhesive was still pliable and tacky under a thin charred crust. The separator ends were still held firmly by the adhesive. The separators held shape and did not open up.

Test 7 (numbered 55 in photographs) "Honeycomb" Ultra-efficient Filter. Adhesive not specified; no separators; fire-resistant plywood frame, with optional treated woven glass fire screen.

Remarks: Highest temperatures recorded in this test were 530°C and 455°C, in the same locations as in previous tests. However, the temperatures have very little significance, as within 30 seconds the flow through the filters was considerably reduced by swelling of the intumescent paint with which the fire screen was treated. The media broke through before the screen action could take effect.

Test 8 - adhesive not specified. Wood frame painted with fire-resistant paint; ceramic separators.

Remarks: Testing of this filter was overlooked until after the temperature instrumentation was removed. Consequently, temperatures were not recorded. Every effort, however, was made to subject this filter to the same conditions as in the previous tests.

The adhesive at point of greatest fire contact was charred to a crisp, otherwise, the adhesive was not greatly damaged. The separators opened up at the filter face, but show little damage at the rear face. The media, as is always the case, disintegrated in the area exposed to direct fire.

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PICTURE NO. 1 TEST 1

wood frame. Start of typical filter-burning test. Burning material is held 6" away from face of filter by means of a wide mesh screen. A carefully weighed amount ($4\frac{1}{2}$ lbs.) of excelsior is used in firing.

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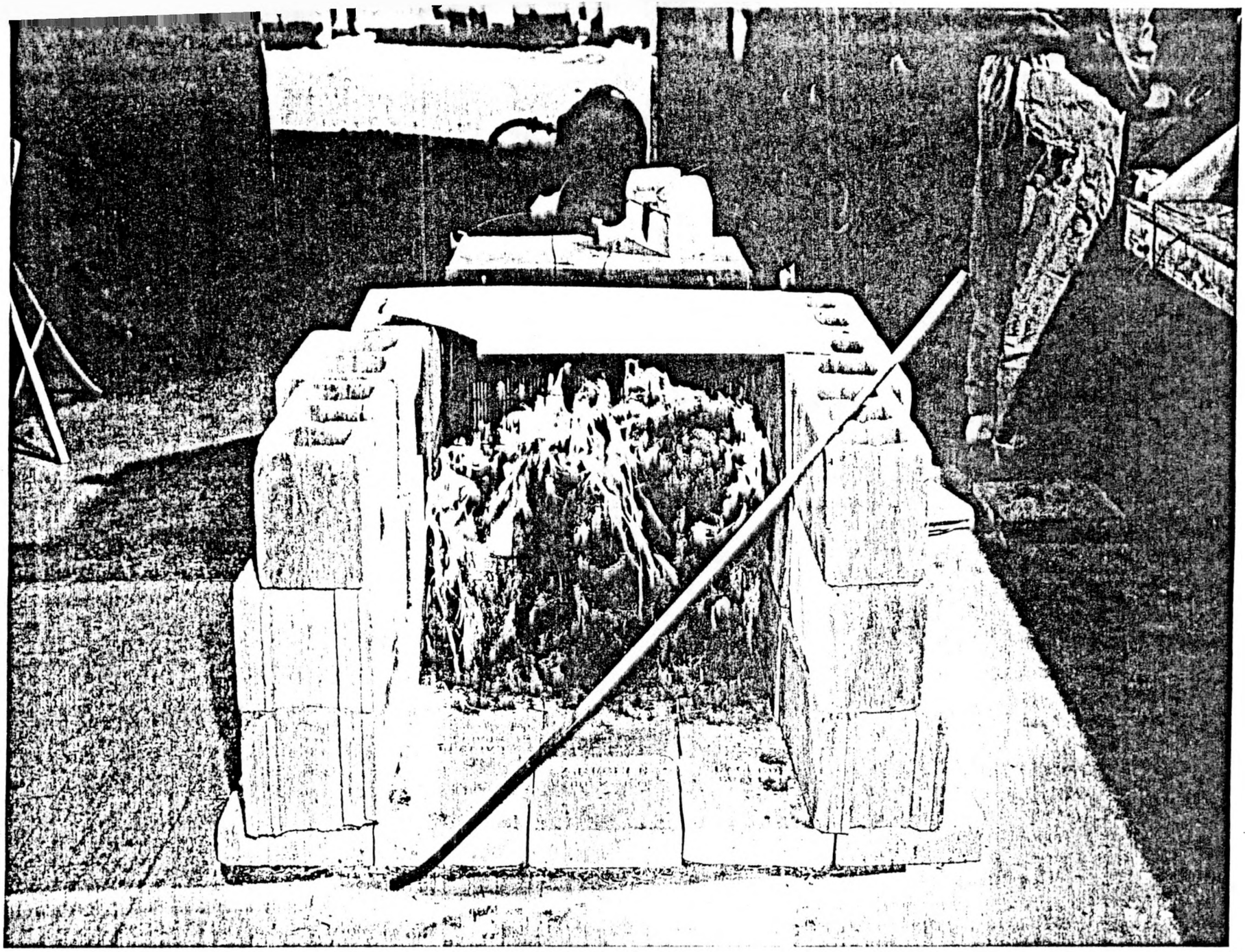

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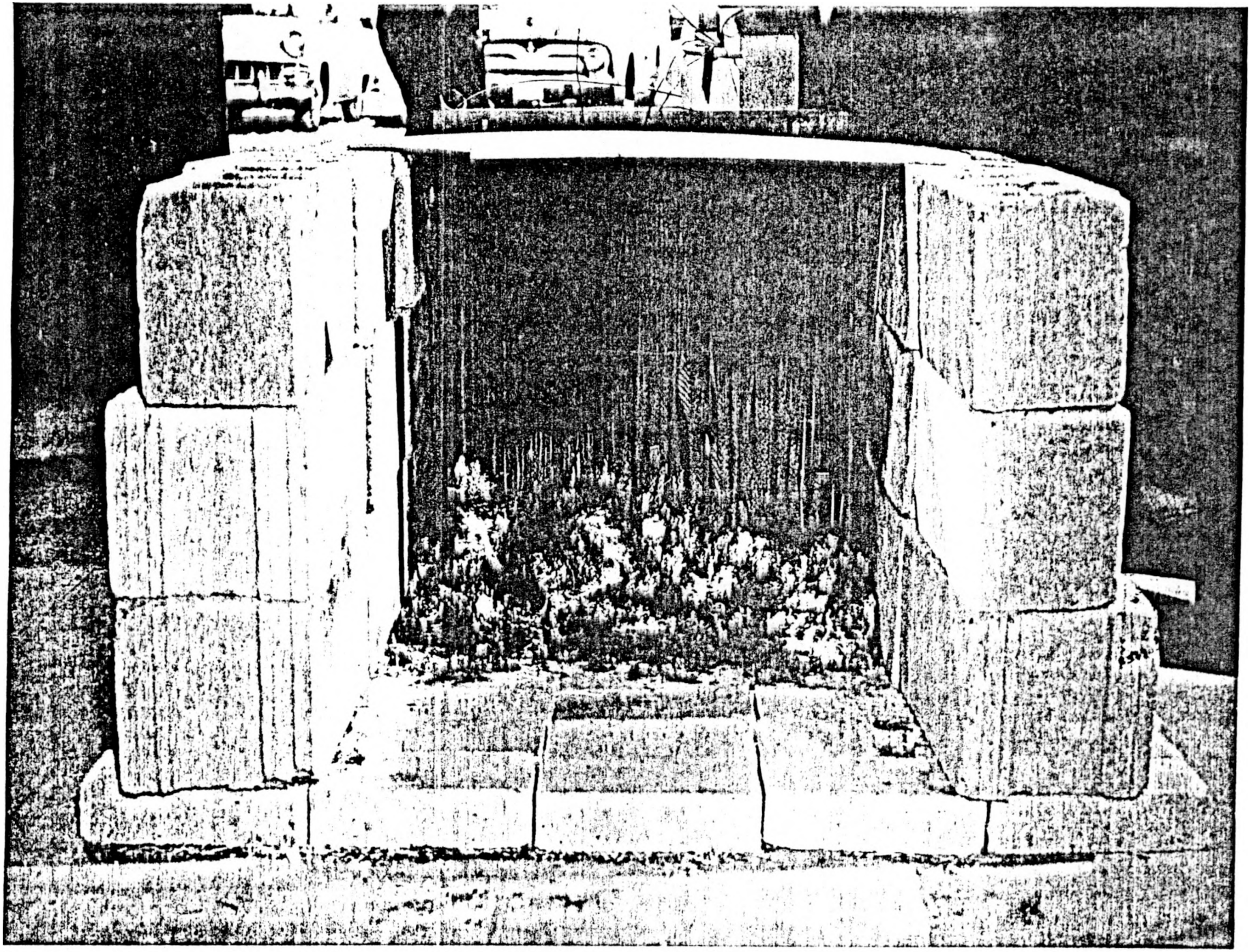
PICTURE NO. 2

Same filter as in Picture No. 1.

Firing material almost consumed. Separator contortion can be noted.



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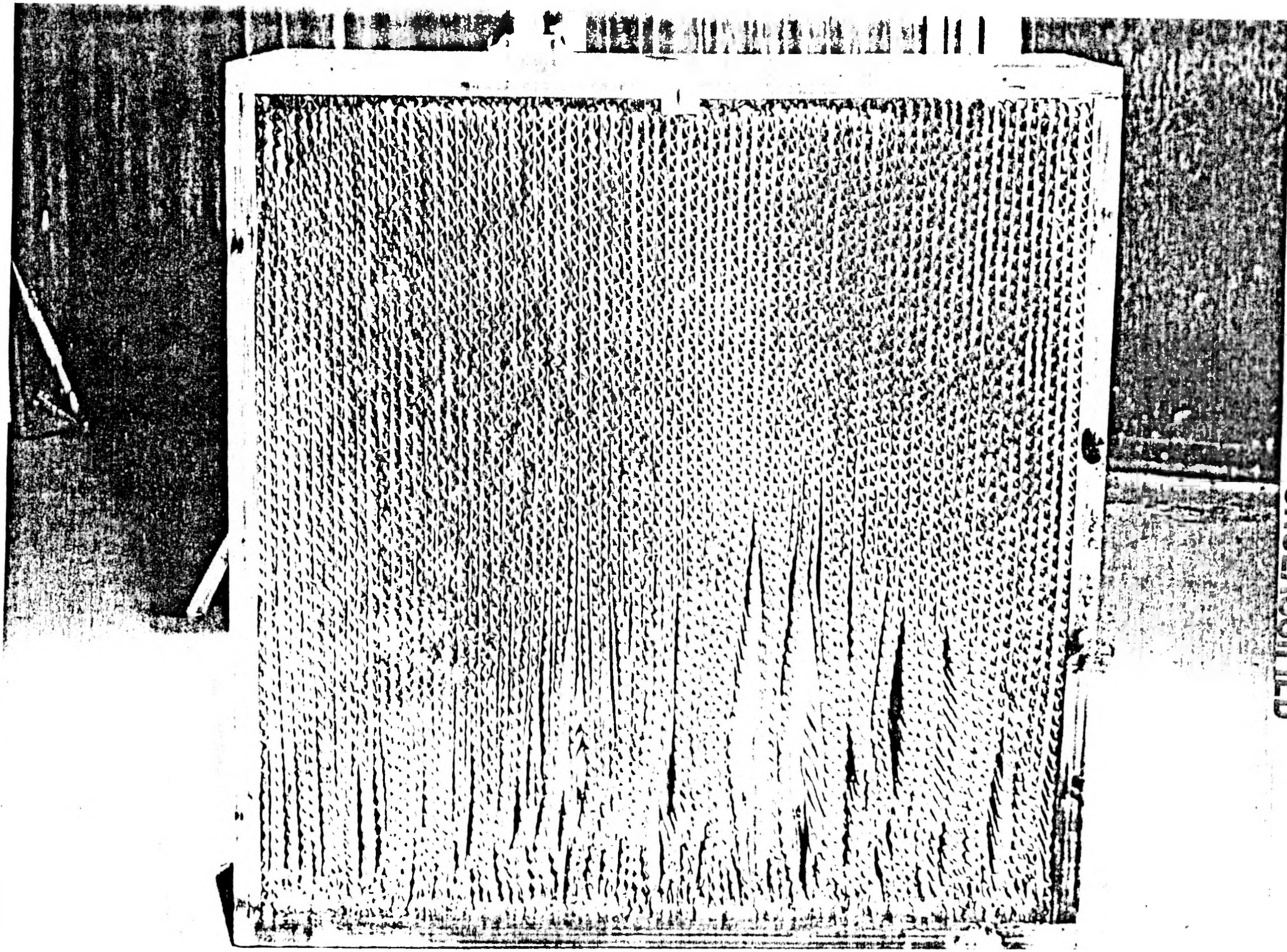
PICTURE NO. 3

(same filter)

Showing front face of filter after test. Note openings between the separators. Filter media is destroyed.



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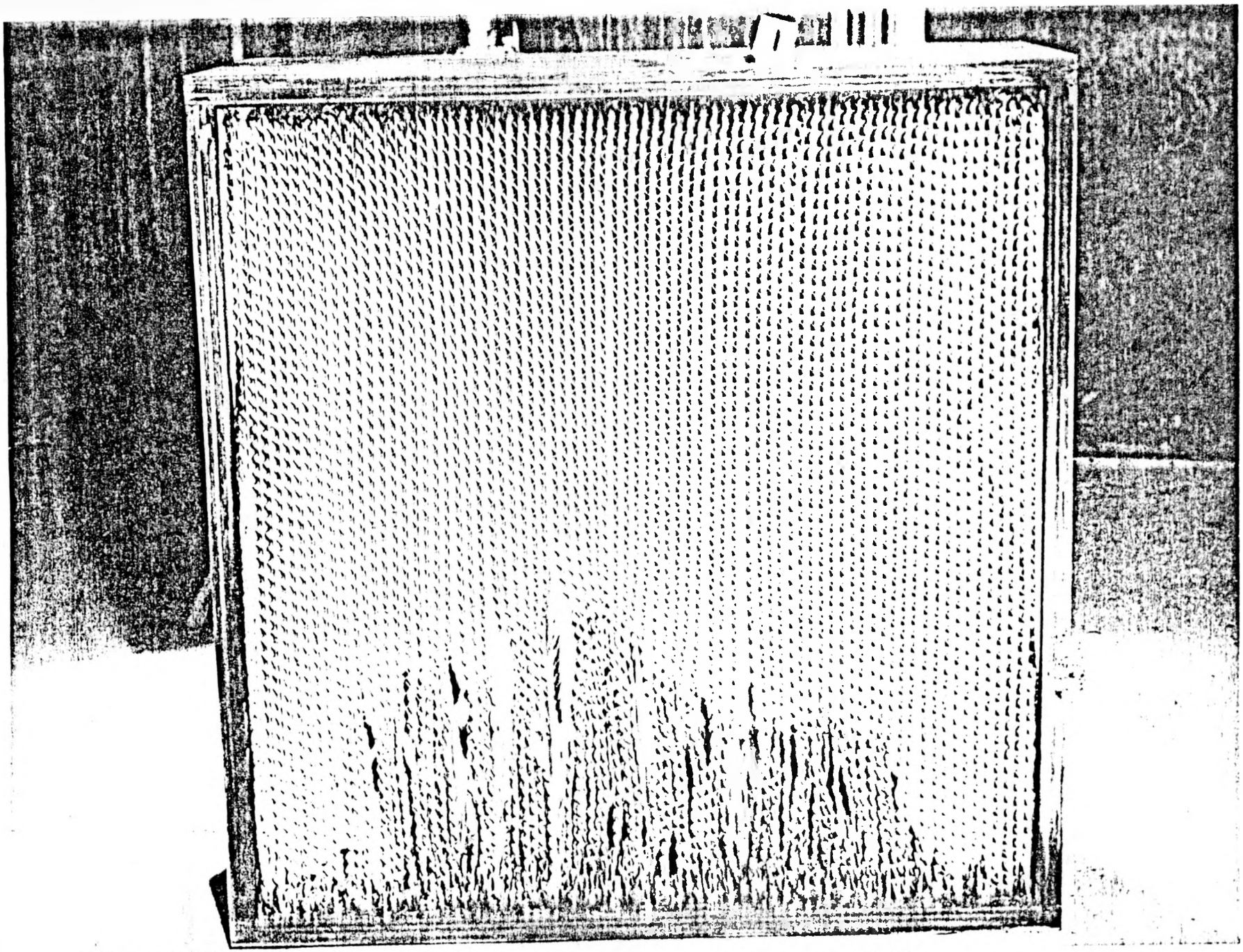
PICTURE NO. 4

(same filter)

Back side of filter after test.



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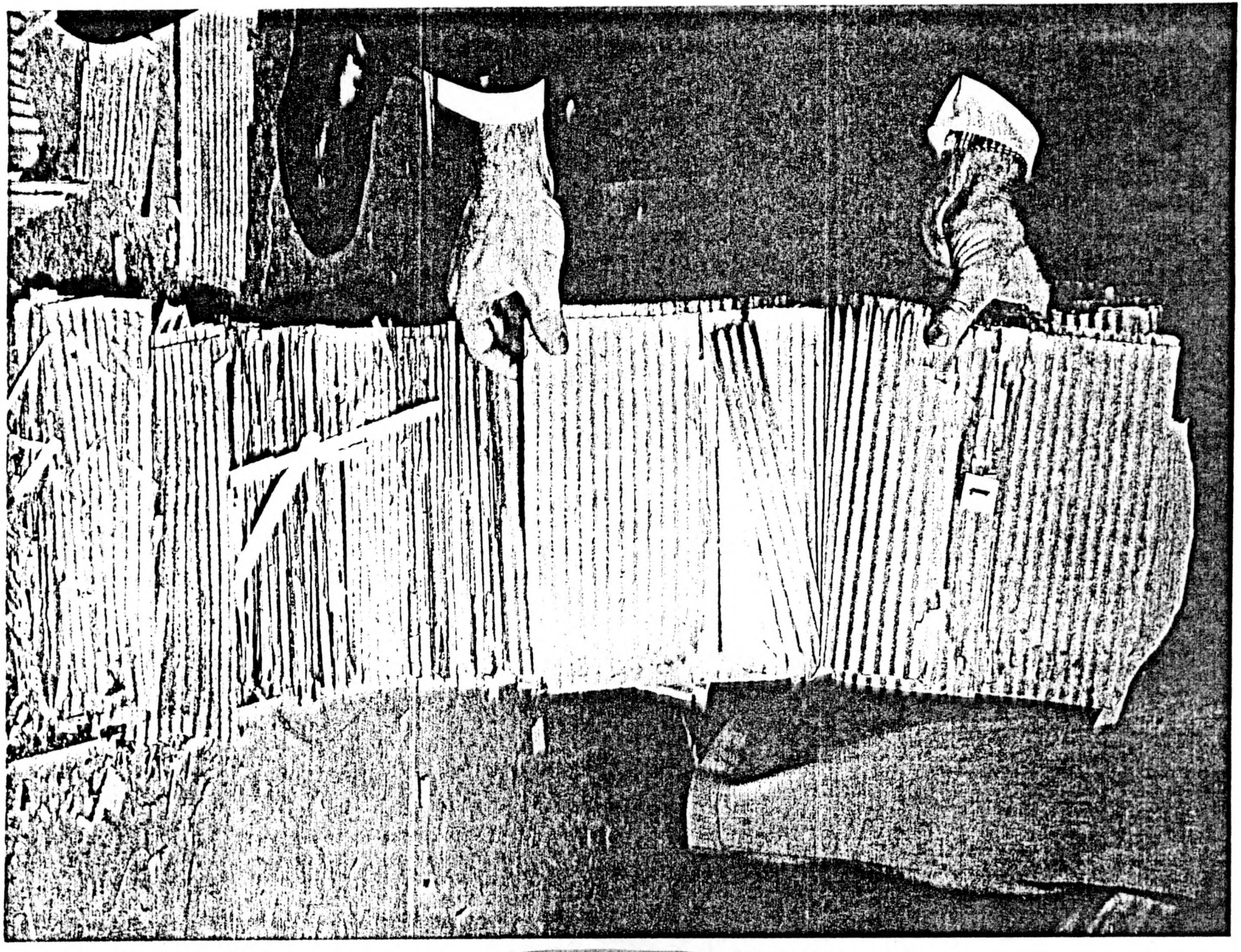
PICTURE NO. 5

(same filter)

Filter has been opened up. Note globules of glass adhering to the separators.



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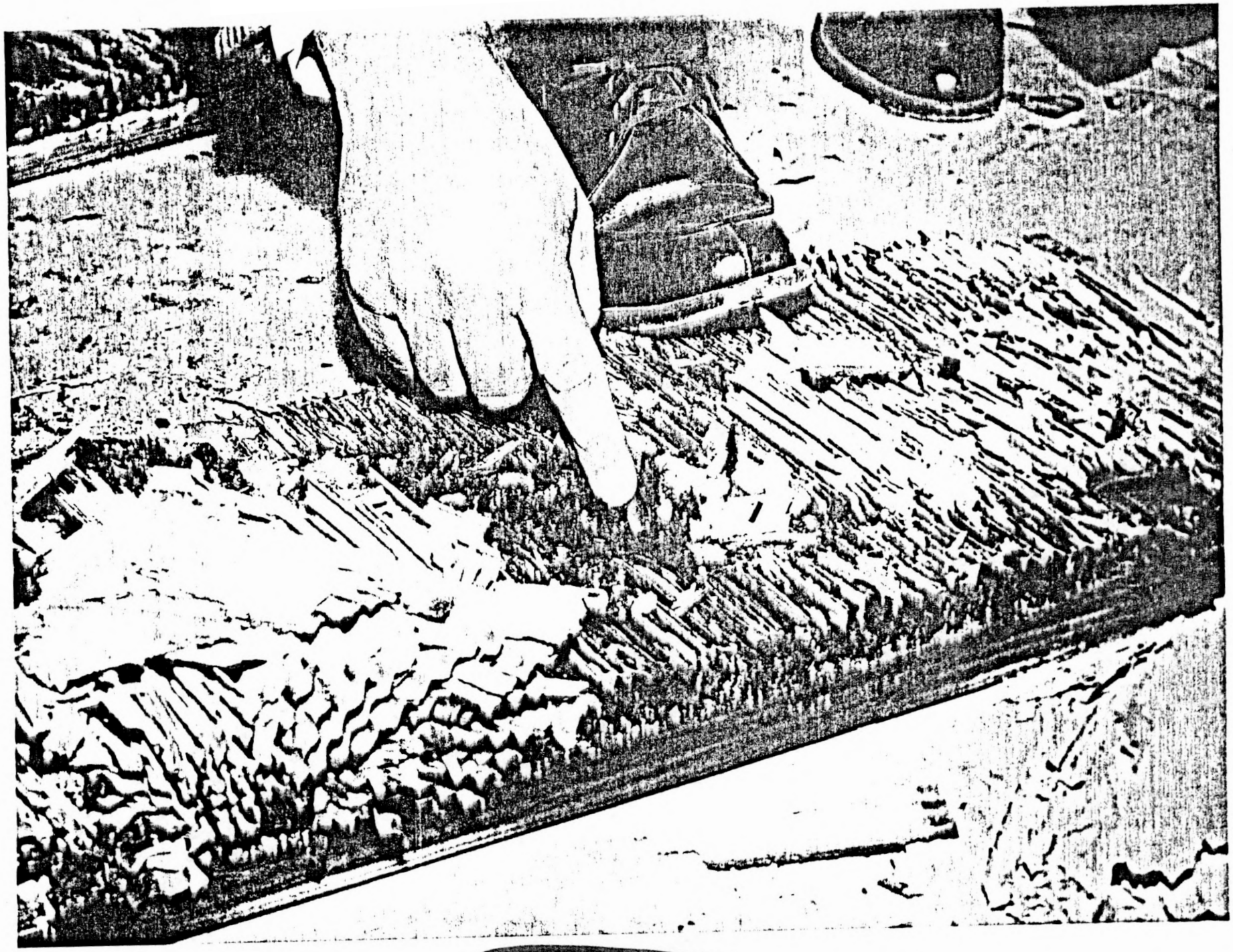
PICTURE NO. 6

(same filter)

Note charring of adhesive. This, however, only occurred where adhesive was exposed to greatest concentrated fire.



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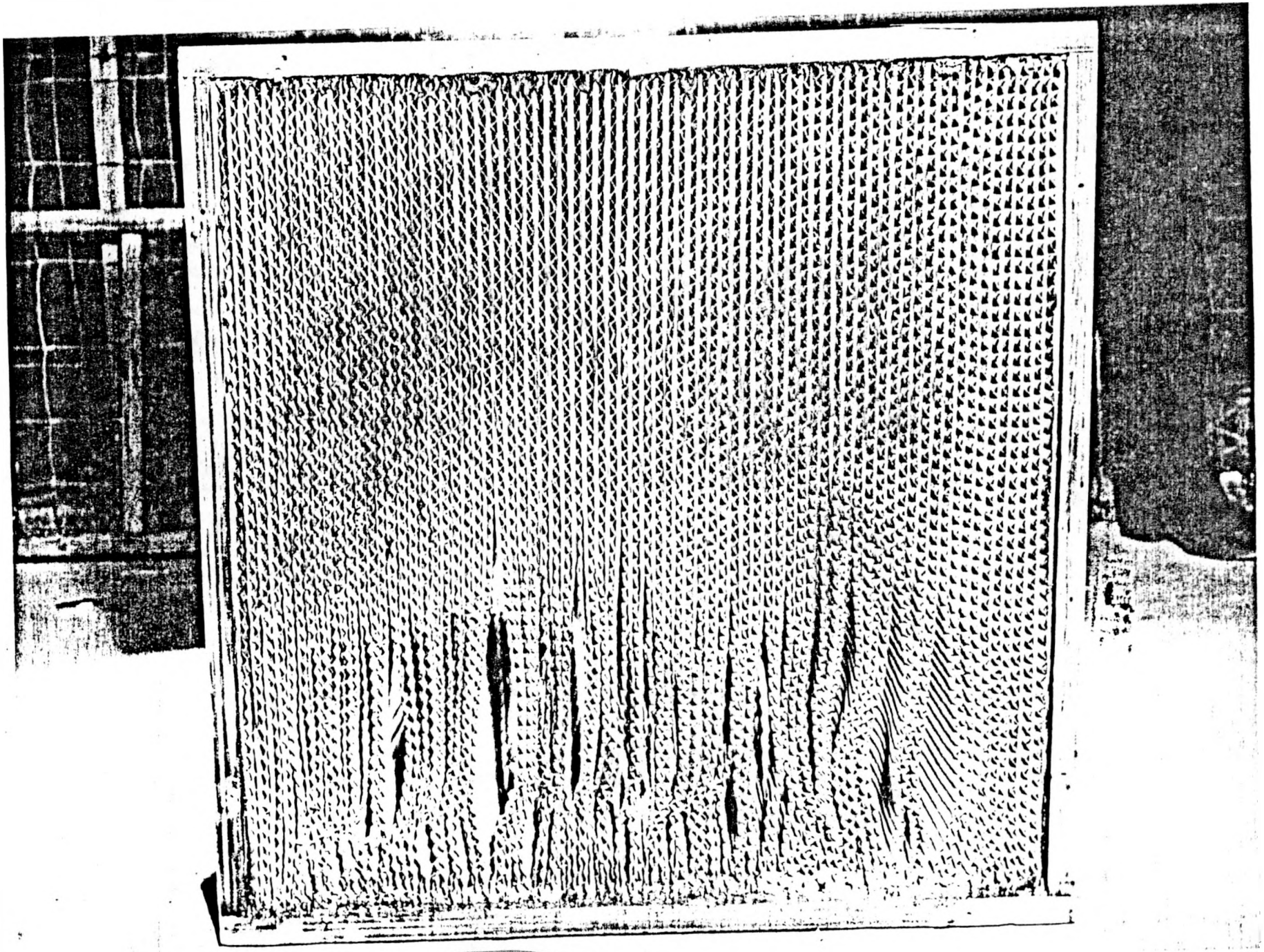
PICTURE NO. 7 TEST 2

Adhesive wood frame. This is the same type filter as in Picture No. 1. The only difference is in the adhesive.

Picture shows the front face of filter after test.



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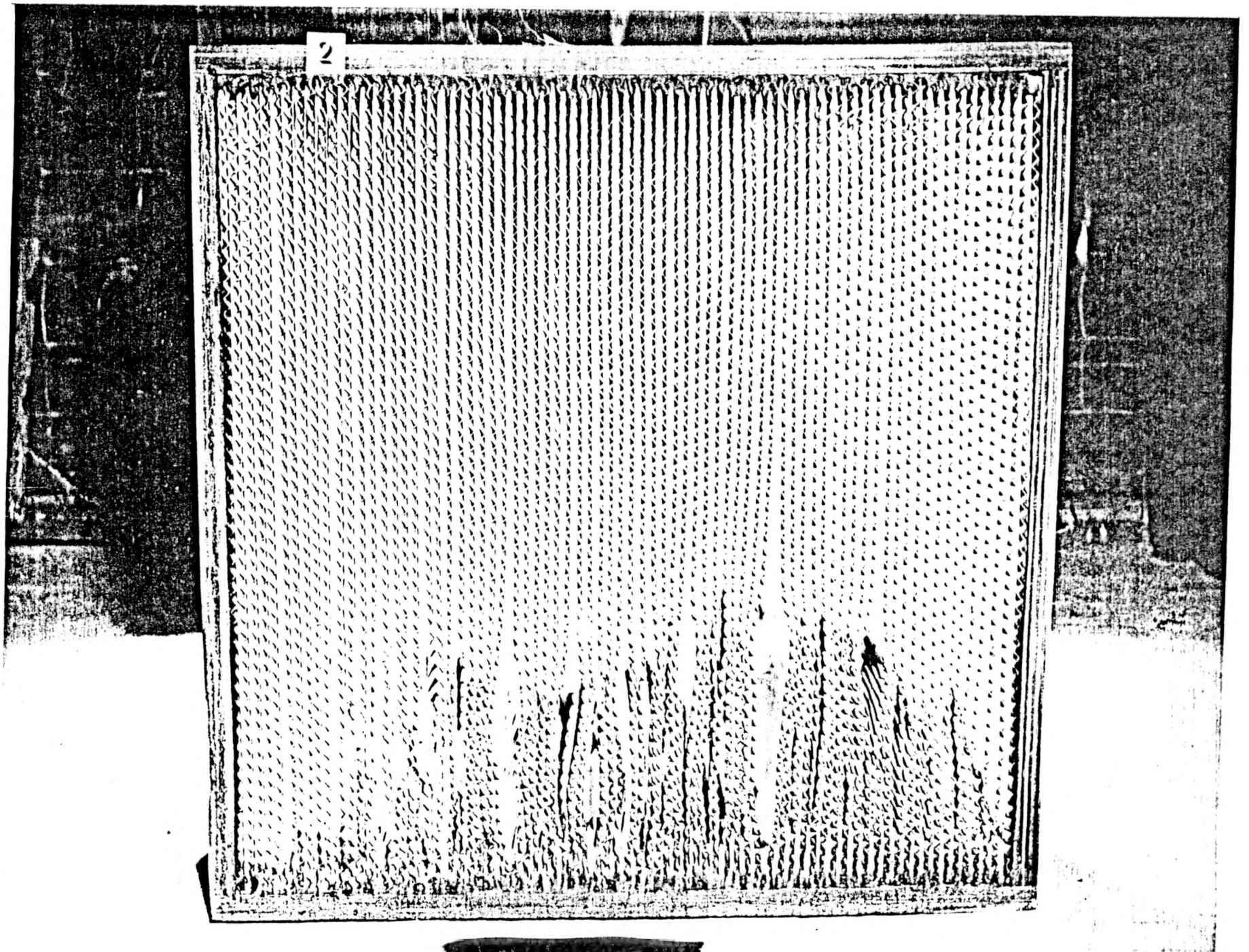
PICTURE NO. 8

Same filter as in Picture No. 7.

Showing back side of filter.



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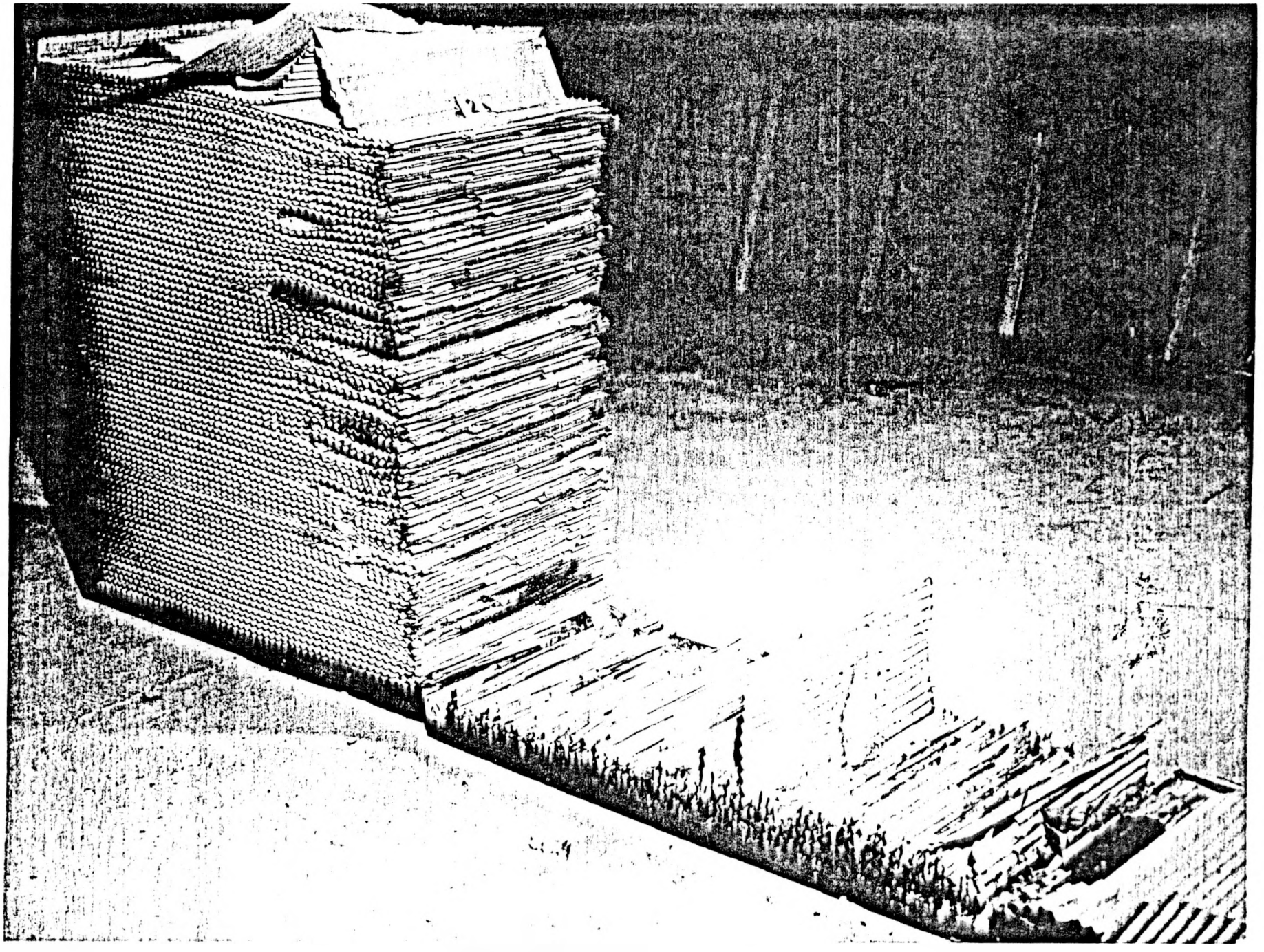
PICTURE NO. 9

Same filter as in Picture No. 7.

Filter has been torn apart to determine fire effect on adhesive, media and separators. Note adhesive has a firm hold on separators.



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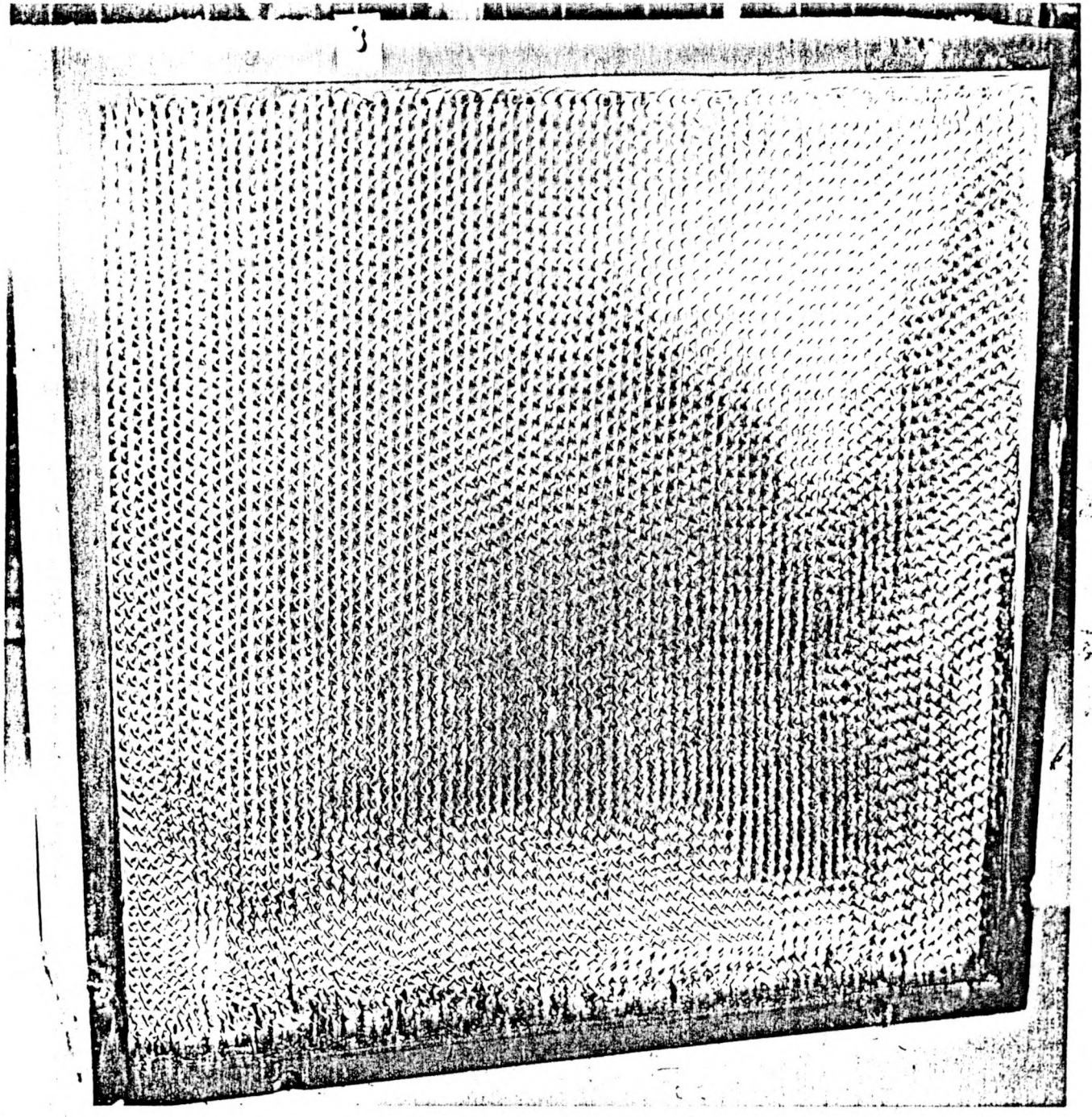
PICTURE NO. 10 TEST 3

Adhesive asbestos frame. Sloped separators.
Showing front face of filter after test.



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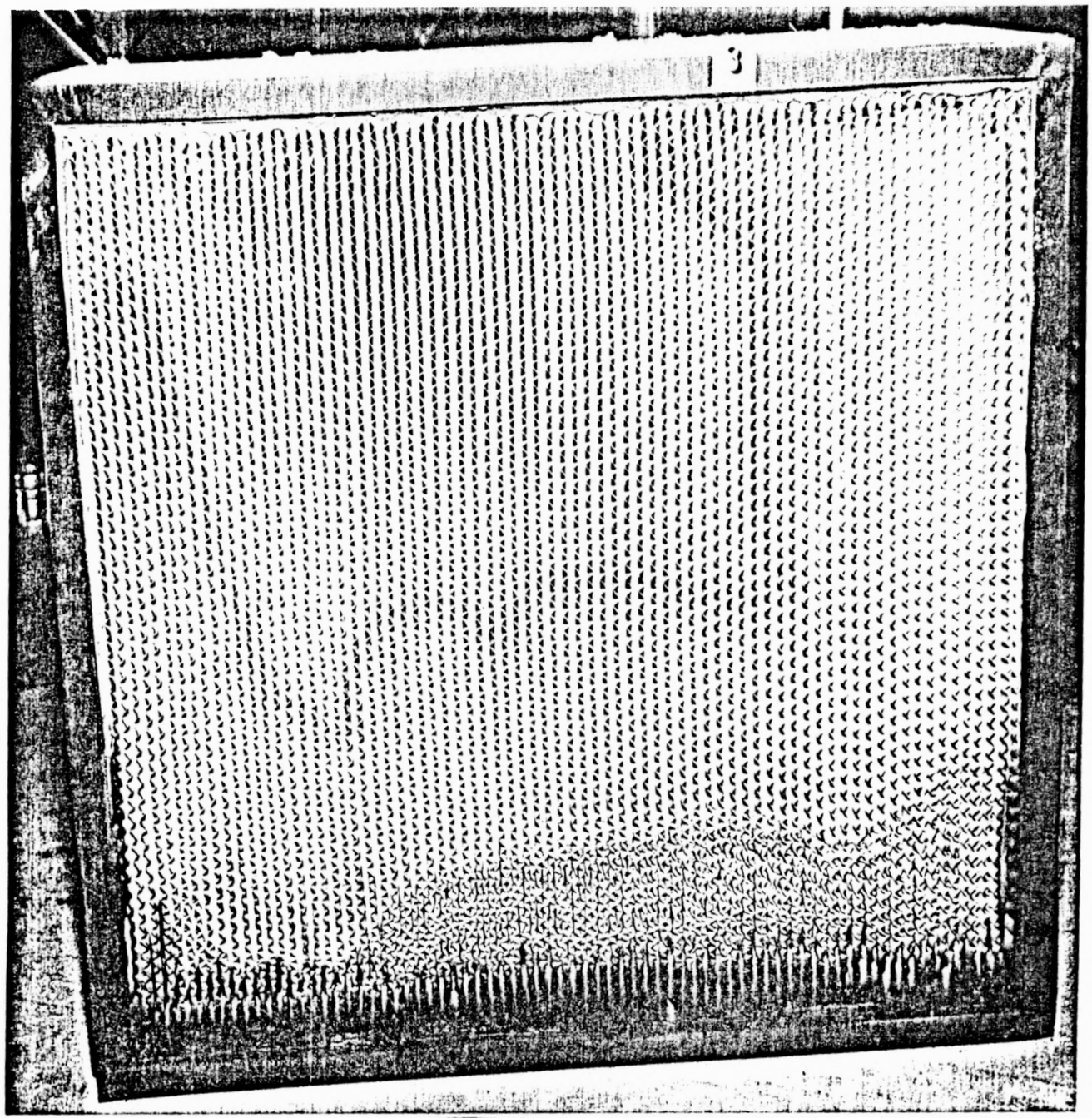
PICTURE NO. 11

Same filter as in Picture No. 10.

Showing rear face of filter.



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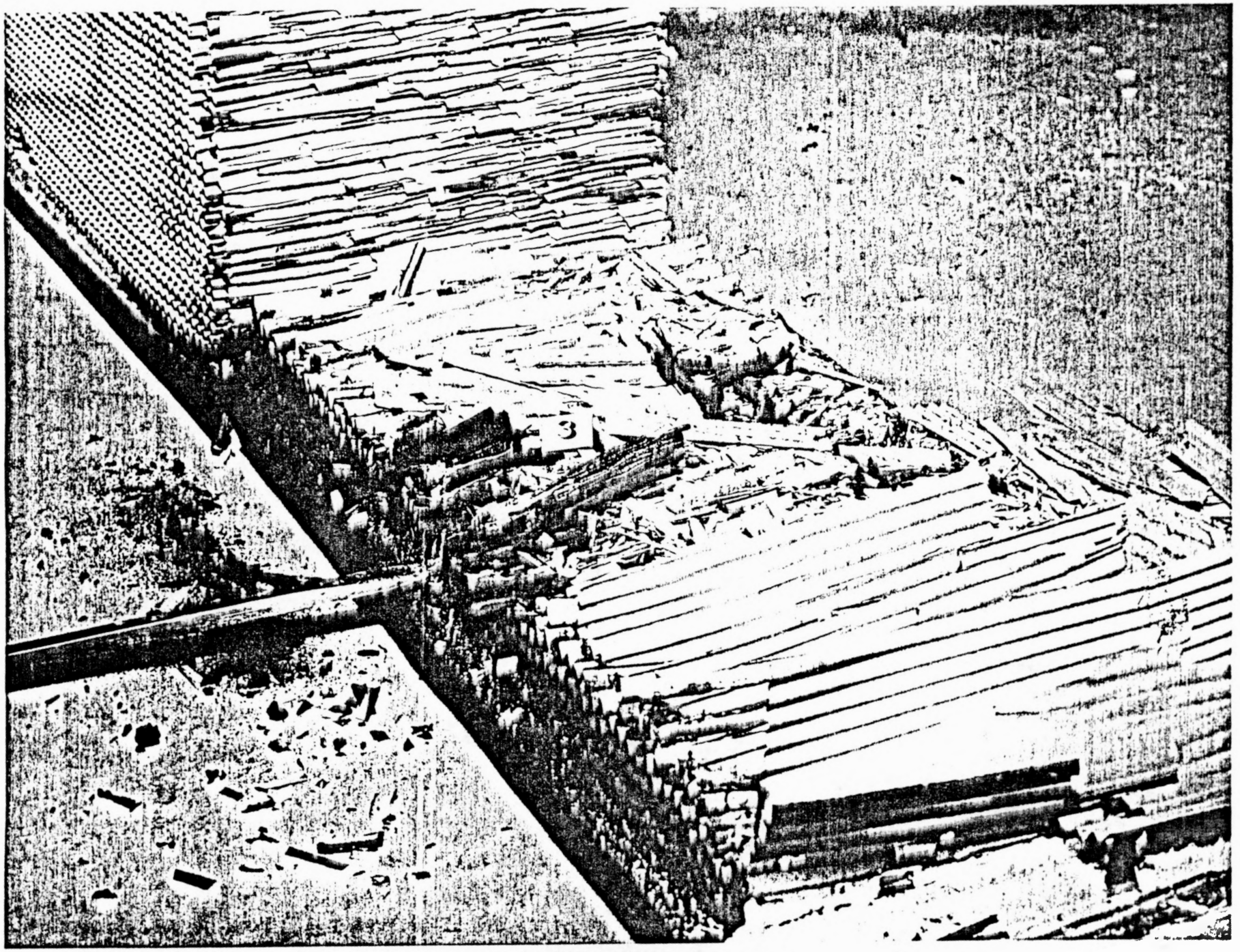
PICTURE NO. 12

Same filter as in Picture No. 10.

Adhesive, although charred on the surface, is still pliable at point of contact to the frame.



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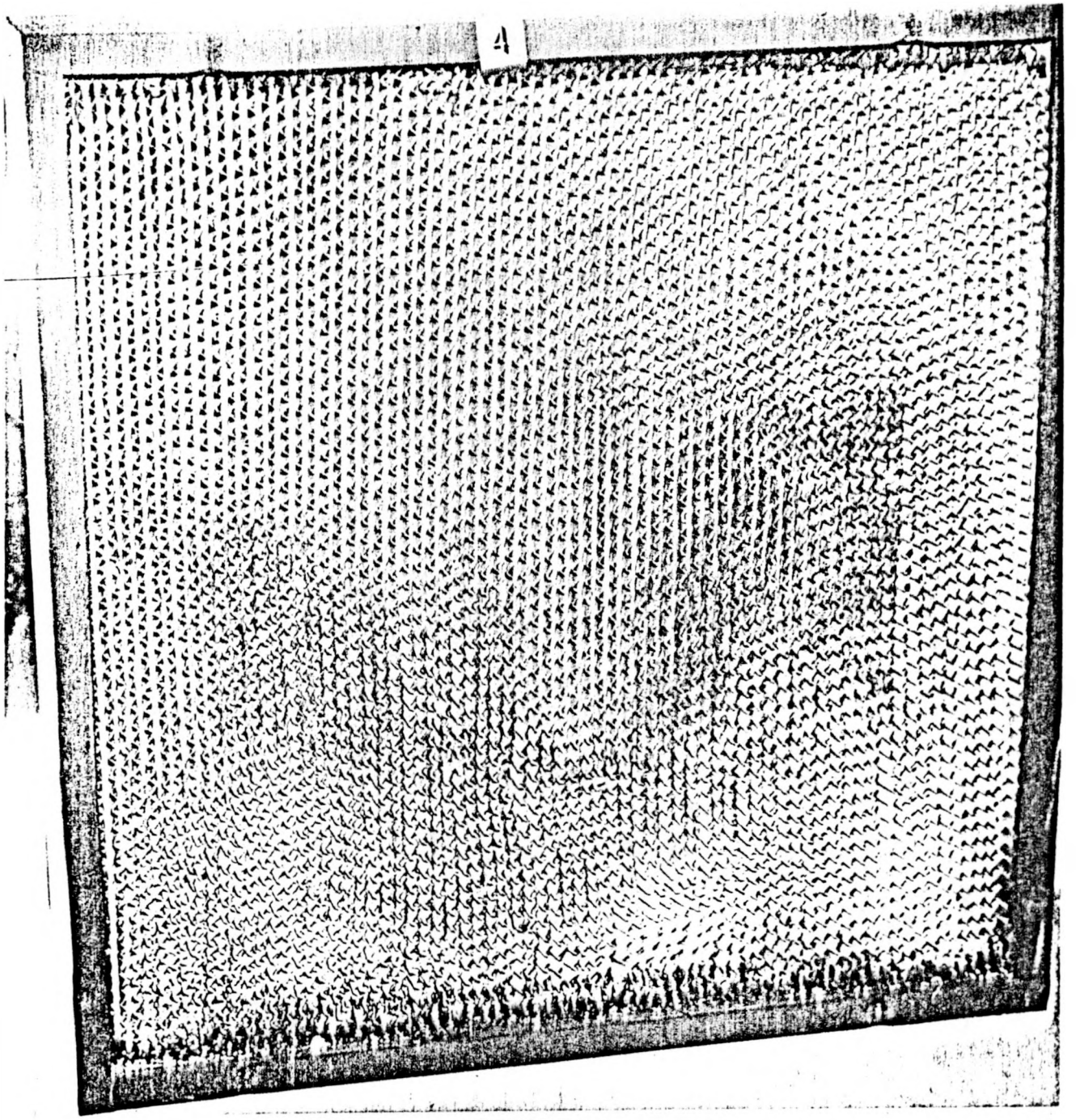
PICTURE NO. 13 TEST 4

Adhesive Sloped separators. Showing front face of filter. Wood frame.



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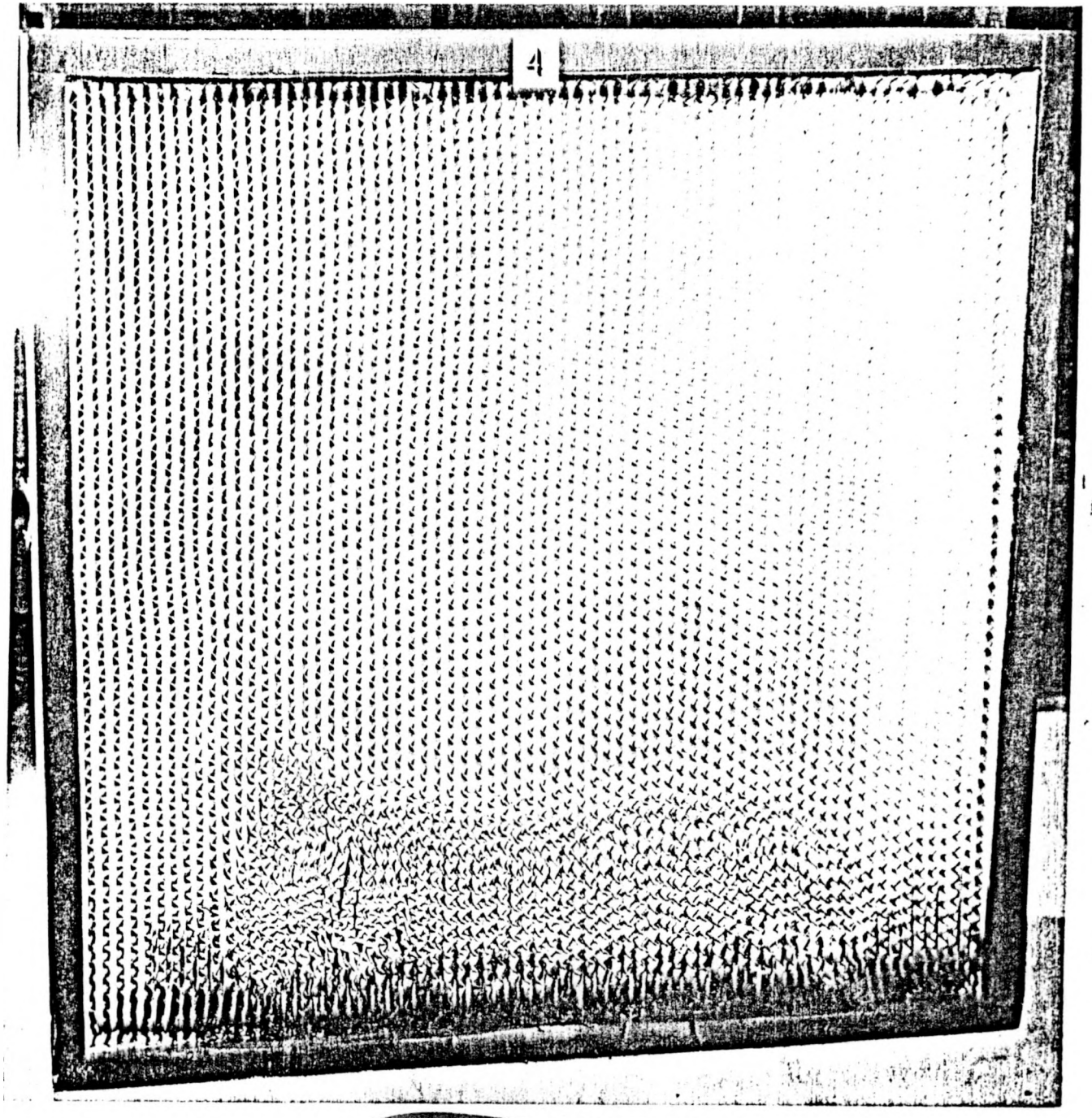
PICTURE NO. 14

Same filter as in Picture No. 13.

Showing rear face. This filter showed least apparent effect of fire exposure.



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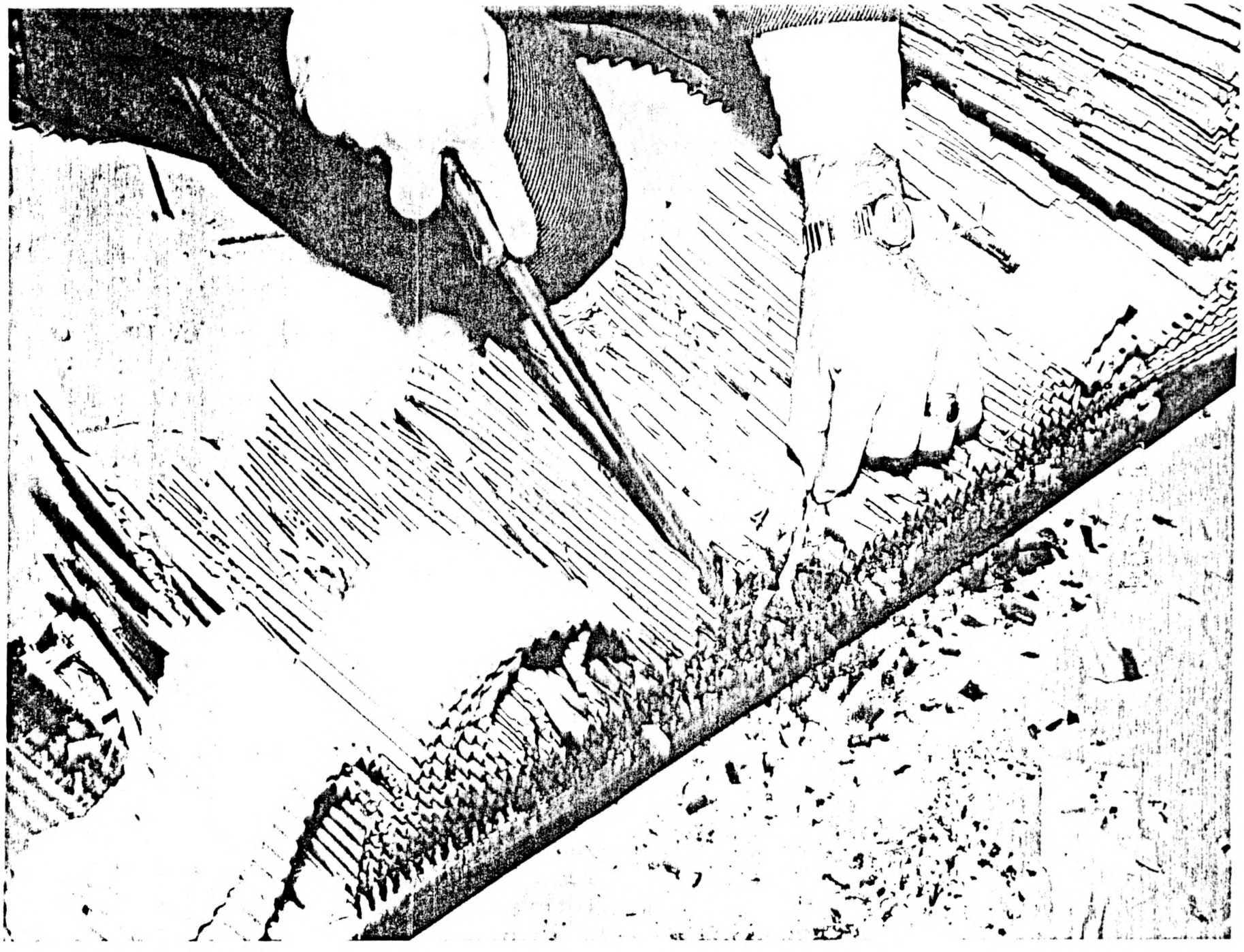
PICTURE NO. 15

Same filter as in Picture No. 13.

Note adhesive still retains hold of separators and media. Where intensive fire contacted the filter, the separators are embrittled.



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PICTURE NO. 16

Same filter as in Picture 13.

Note that adhesive is only slightly charred on the surface, and is pliable underneath, and retains good adhesion to the frame.

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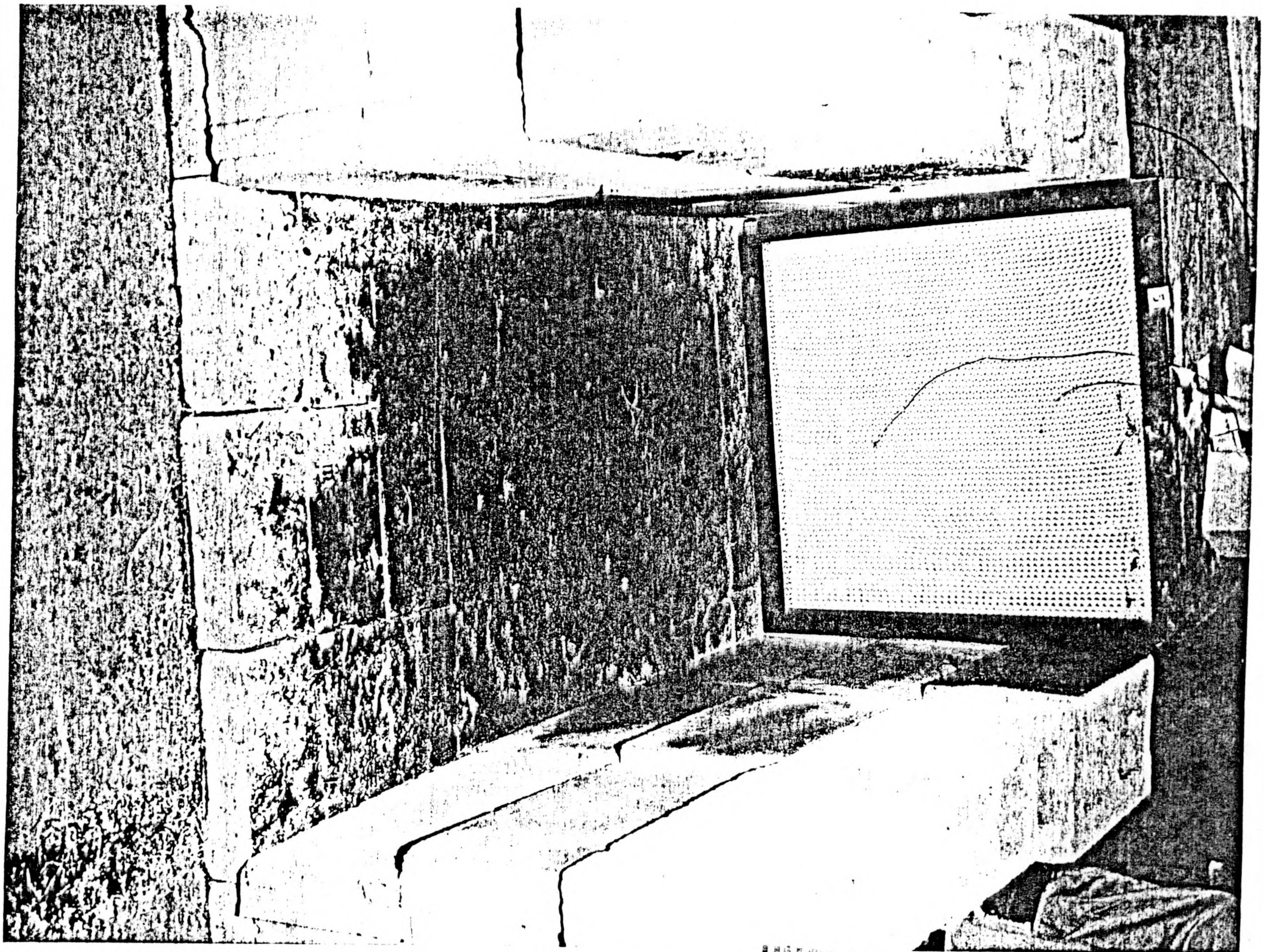
PICTURE NO. 17 TEST 5

Adhesive asbestos frame, sloped separators.

Note location of thermocouples on front face. Sensing tips are inserted one inch inside front edge of media.



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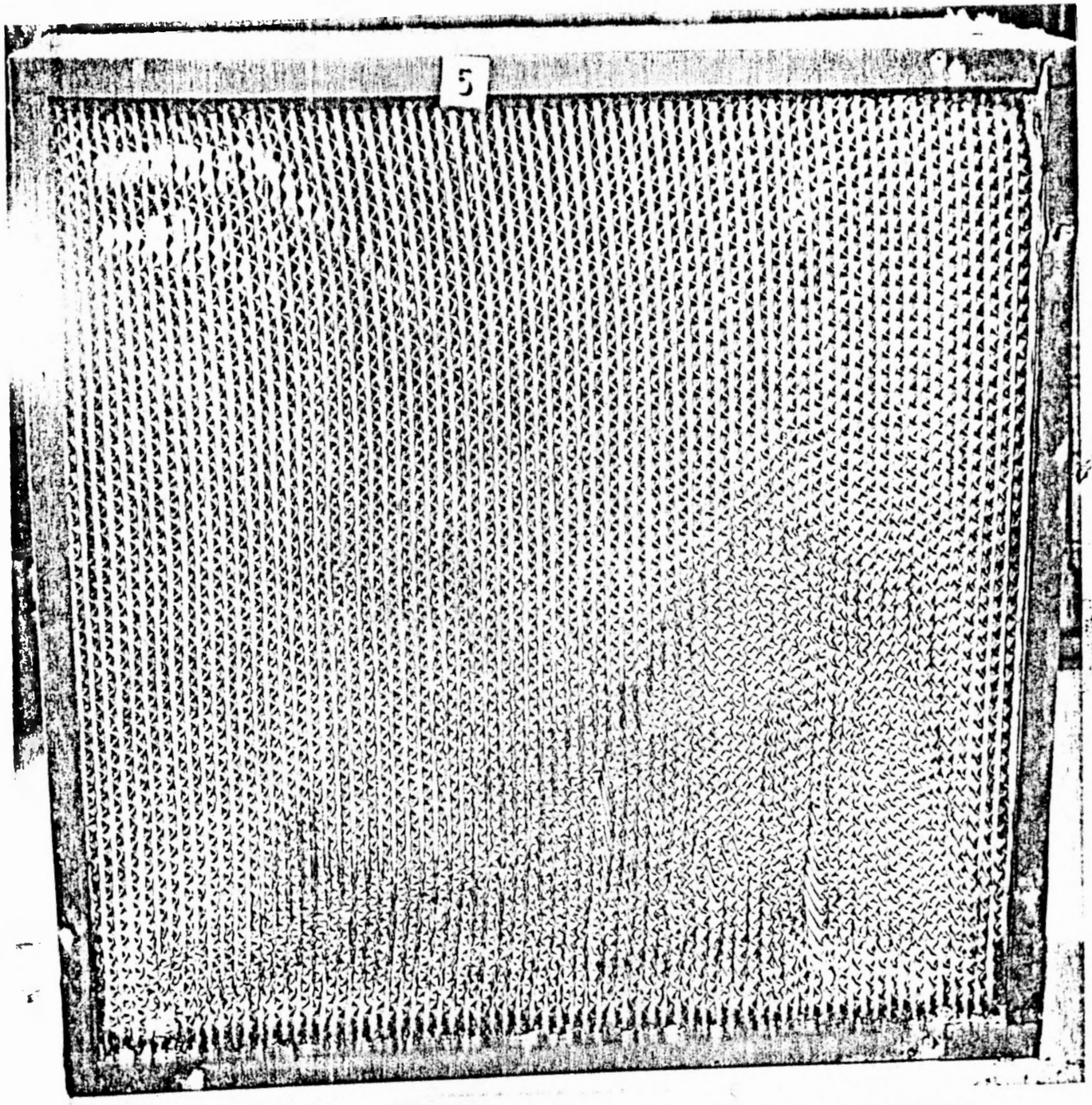
PICTURE NO. 18

Same filter as in Picture 17.

Showing front face of filter after test. Score marks were made when removing the filter from the test chamber.



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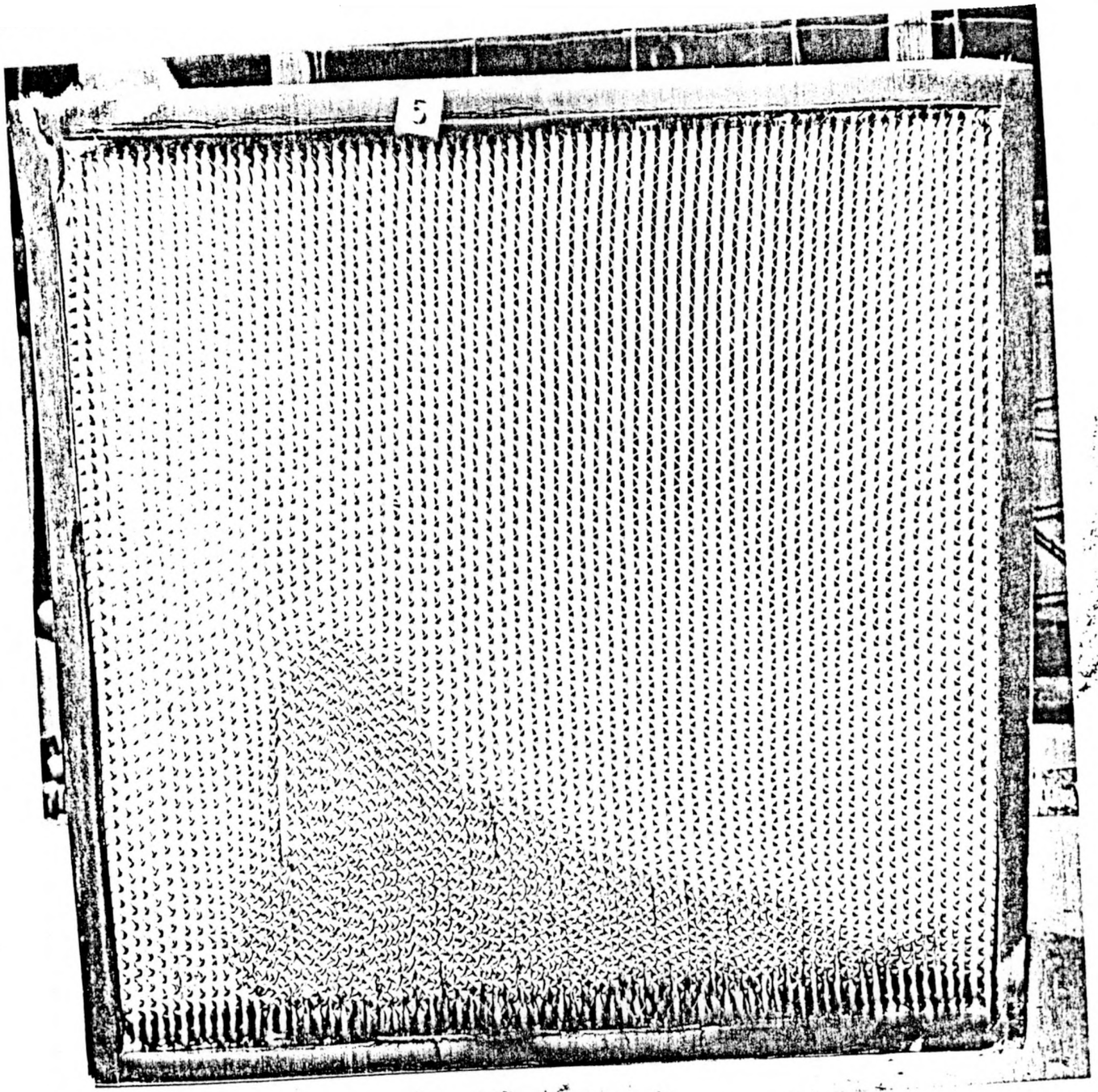
PICTURE NO. 19

Showing rear face of filter after testing.

Note apparent minor effect on separators.



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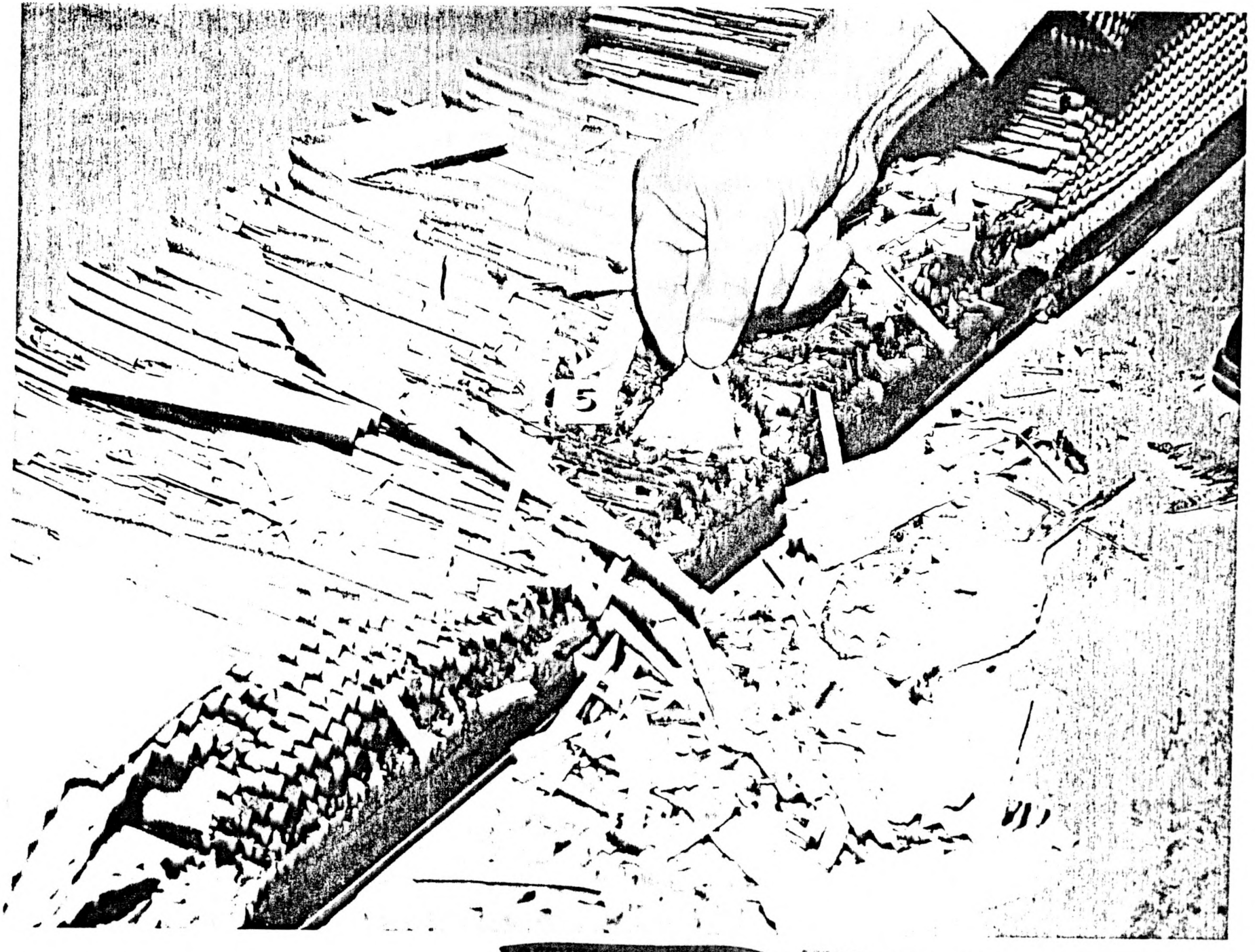
PICTURE NO. 20

This picture points out the resistance of the adhesive to fire exposure. Adhesive is charred on the surface but tacky below the surface.

Note that separators have become extremely brittle and fragile. Spots showing on the broken pieces of separators are globules of glass, all that remains of the filter media. This is typical of all glass media.



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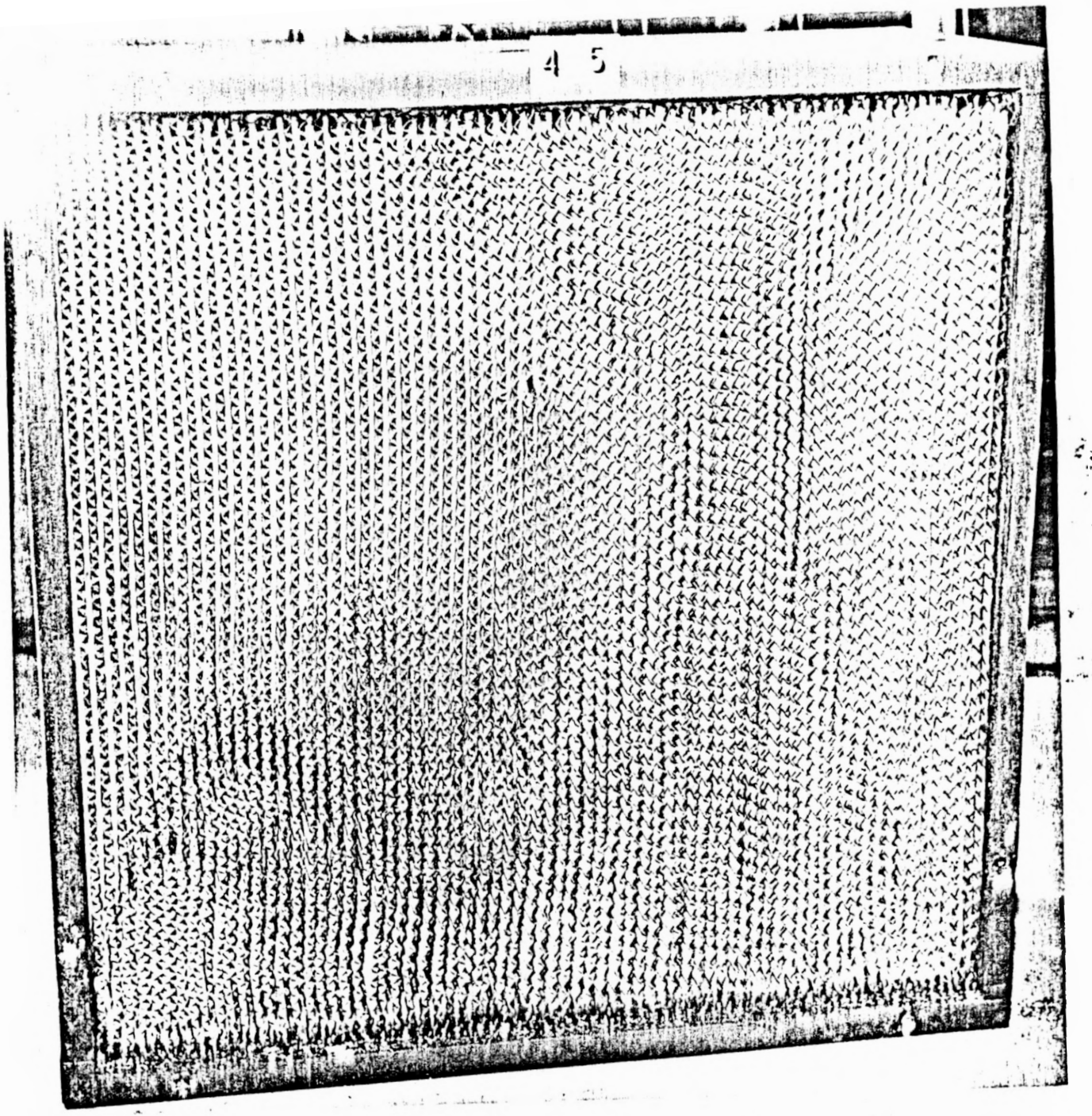
PICTURE NO. 21 TEST 6 (45)

Adhesive "bondmaster," wood frame, sloped separators.
Showing front face of filter after testing.



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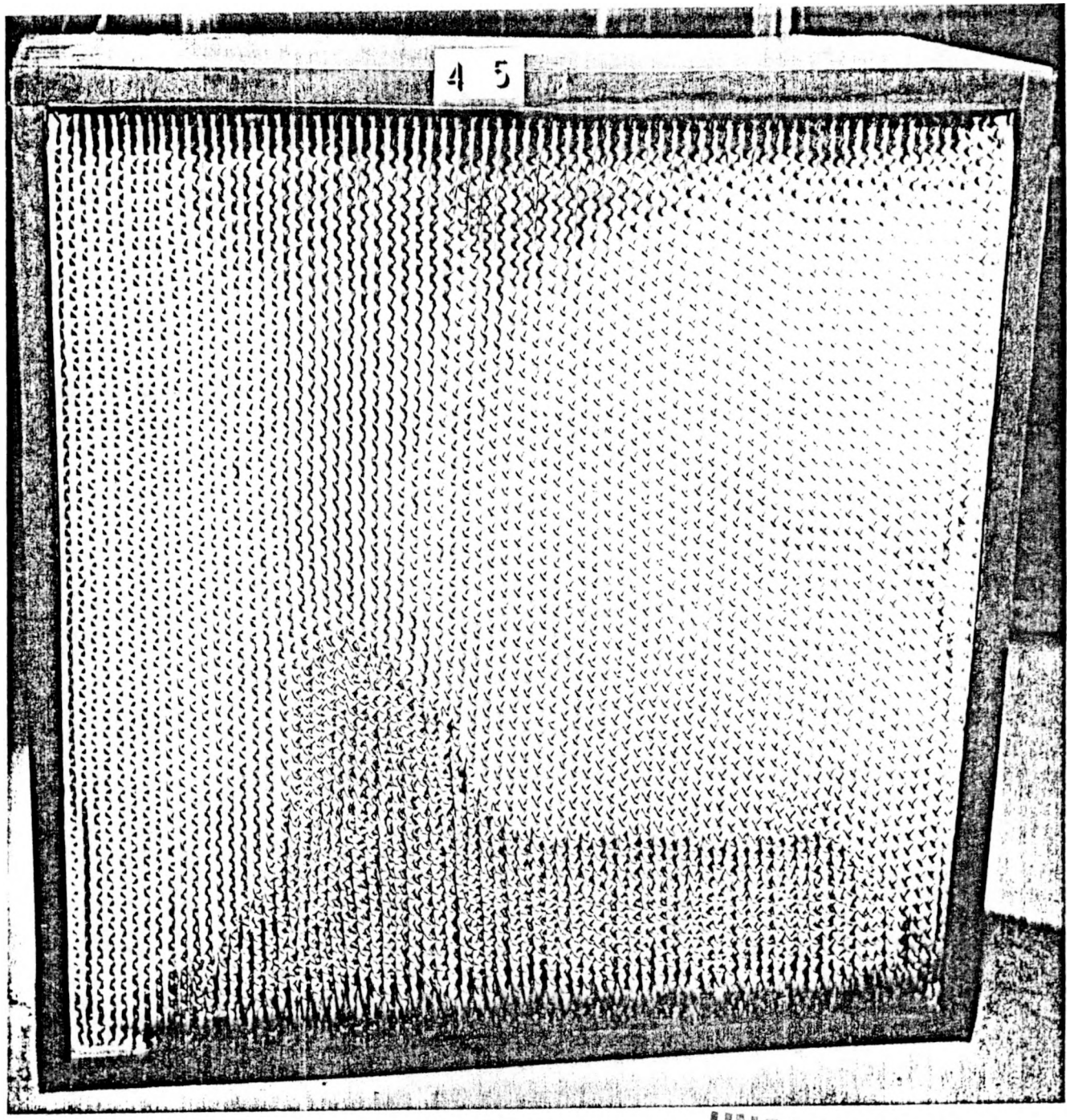
PICTURE NO. 22

Same filter as in Picture No. 21.

Showing rear face of filter. Note that separators are still in line and serve as a flame barrier.



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PICTURE NO. 23

Same filter as in previous picture.

Filter has been torn down after firing for inspection.

Note that separators are still held firmly to the frame. The opposing slopes in the separators are easily discerned in this picture.

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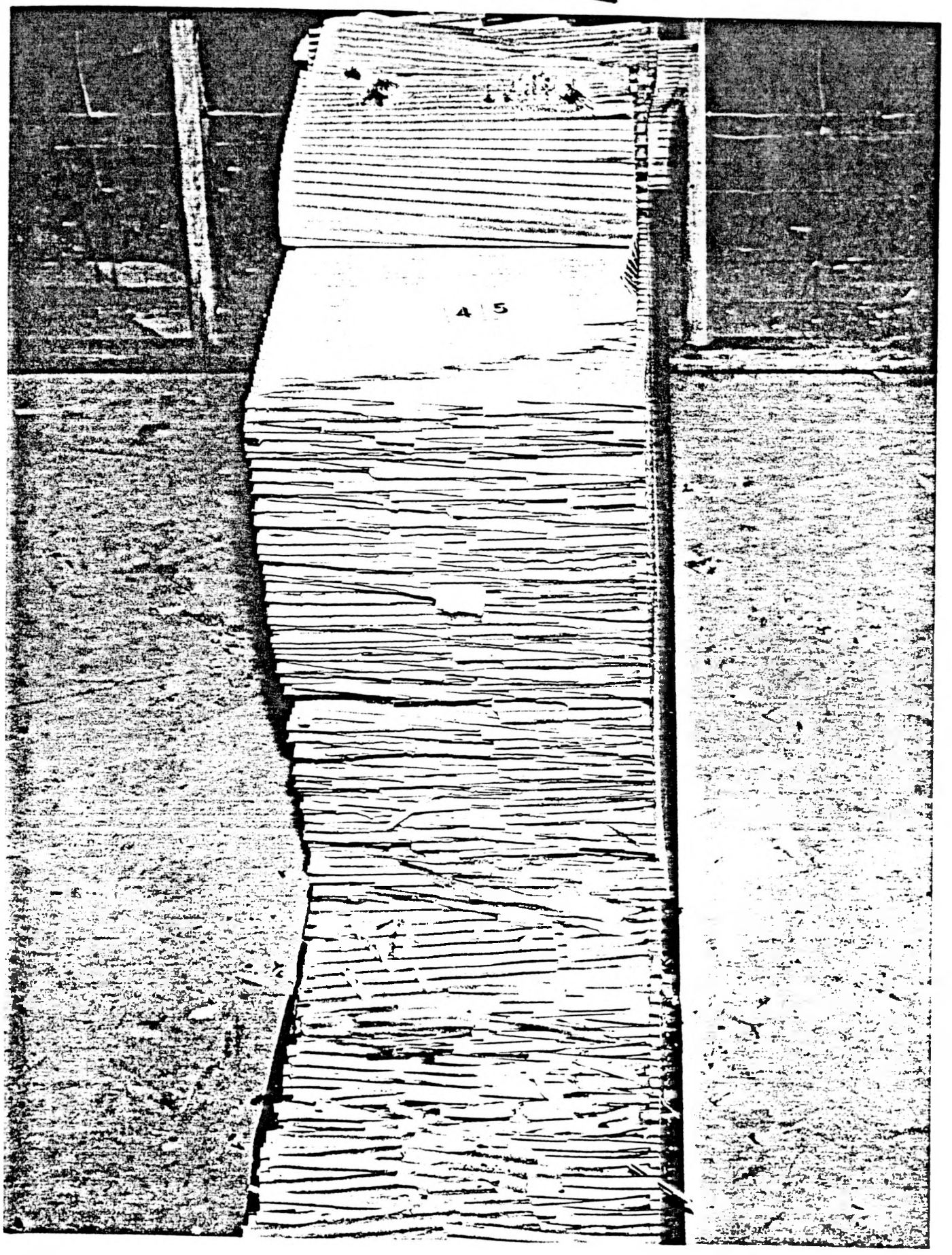

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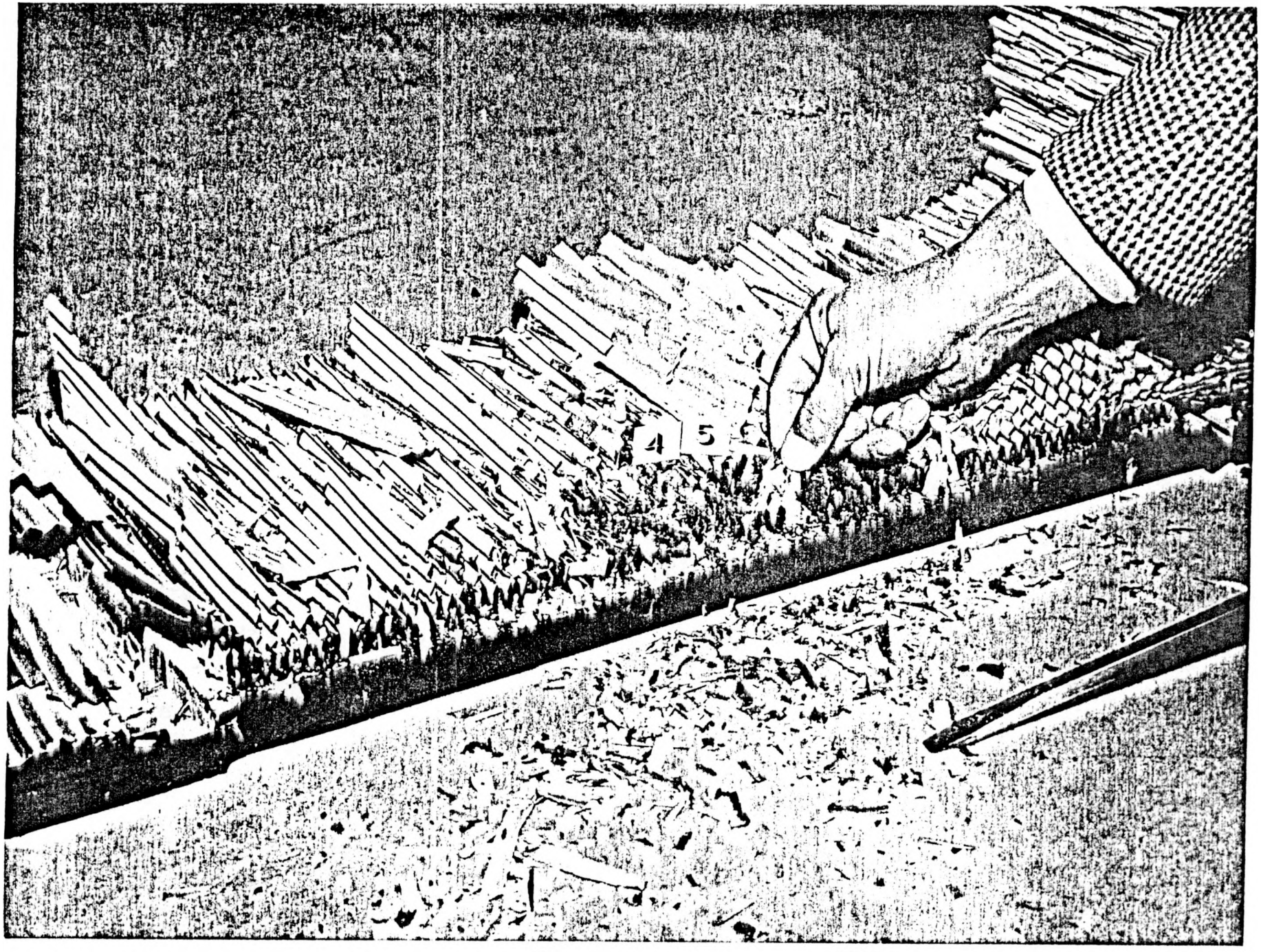
PICTURE NO. 24

Same filter as in previous picture.

Note that adhesive is still pliable.



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PICTURE NO. 25 TEST 7 (55)

Adhesive not specified, wood frame, without separators. Screen incorporated in fabrication on front and back of filter.

Showing filter installed for testing. Note screen.

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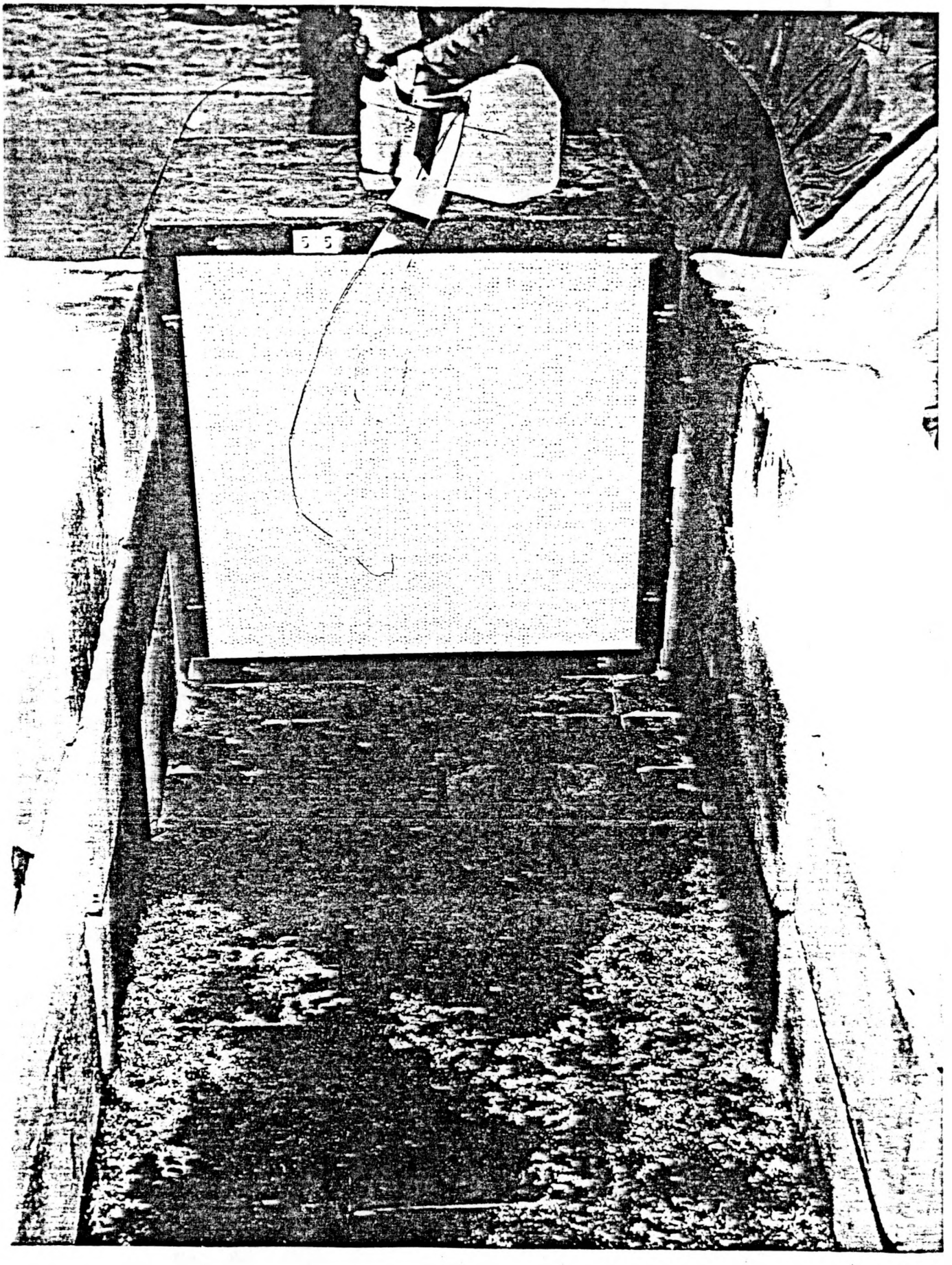

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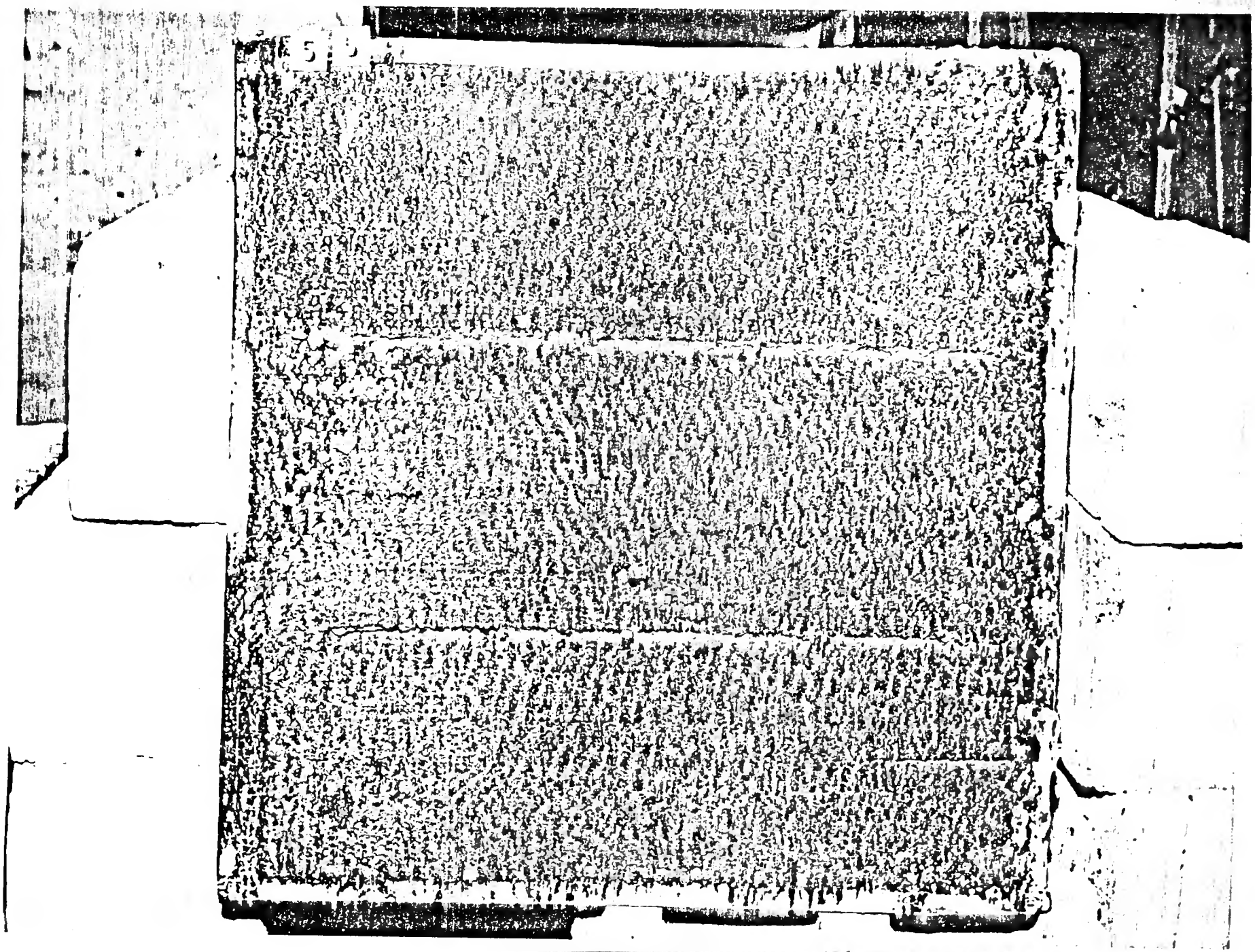
PICTURE NO. 26

Same filter as in previous picture.

Showing front side of filter and screen. The screen material swelled to the extent that airflow through the filter was completely shut off. However, the filter media was destroyed before the screen action took effect.



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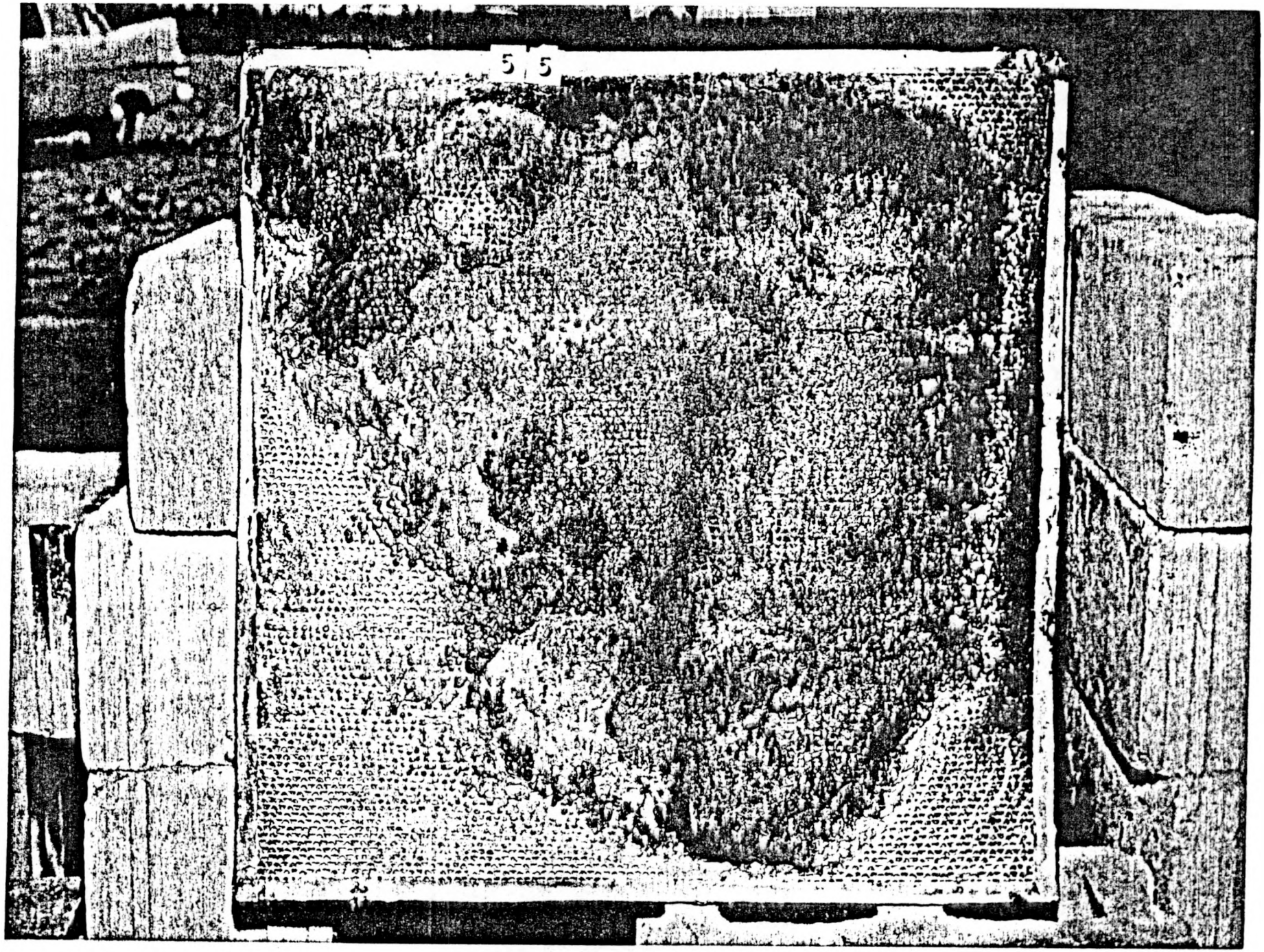
PICTURE NO. 27

Same filter as in previous picture.

Showing rear side of filter. Note how screen material has swelled.



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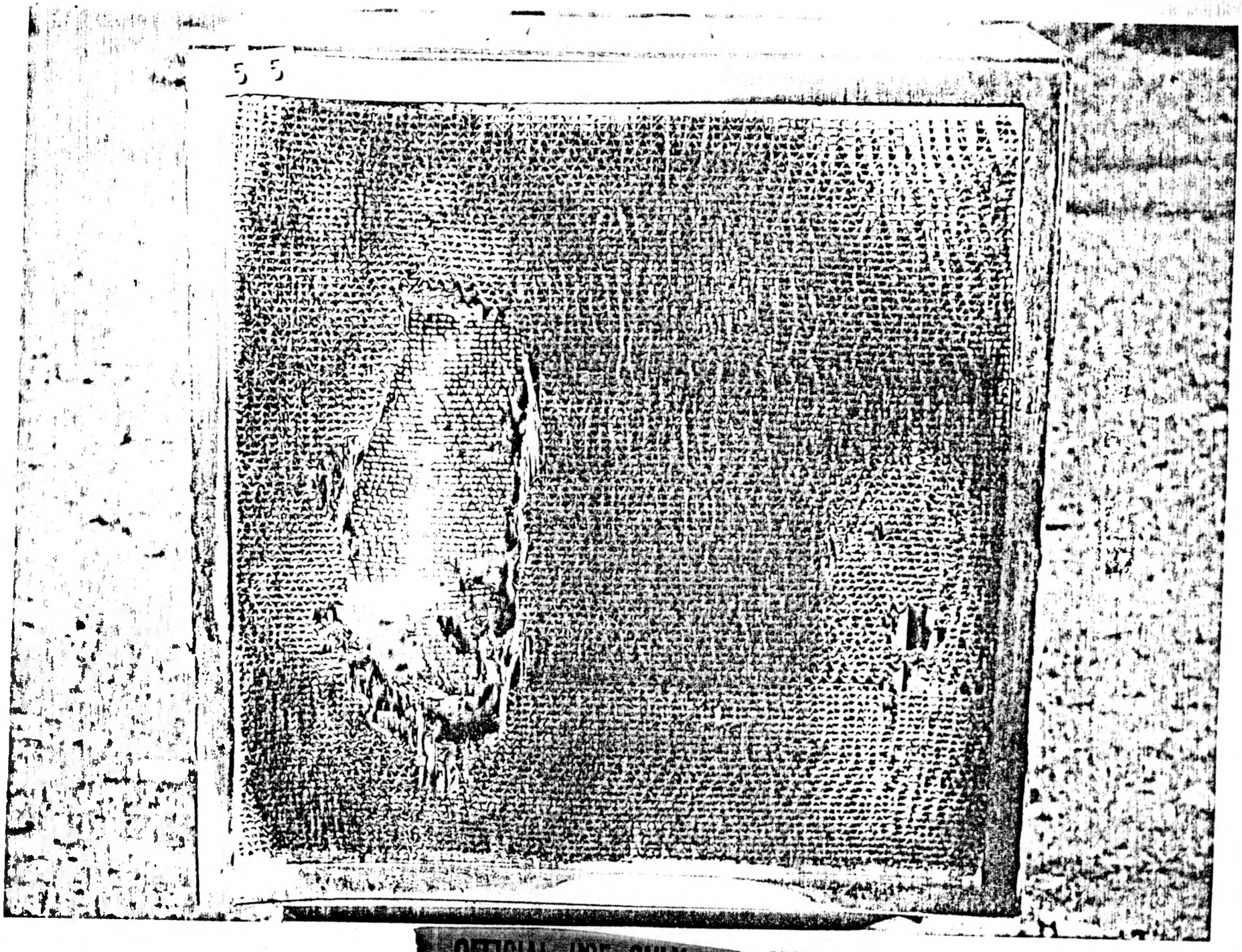
PICTURE NO. 28

This picture of the filter with a portion of the screen removed shows that the media has almost completely disintegrated.



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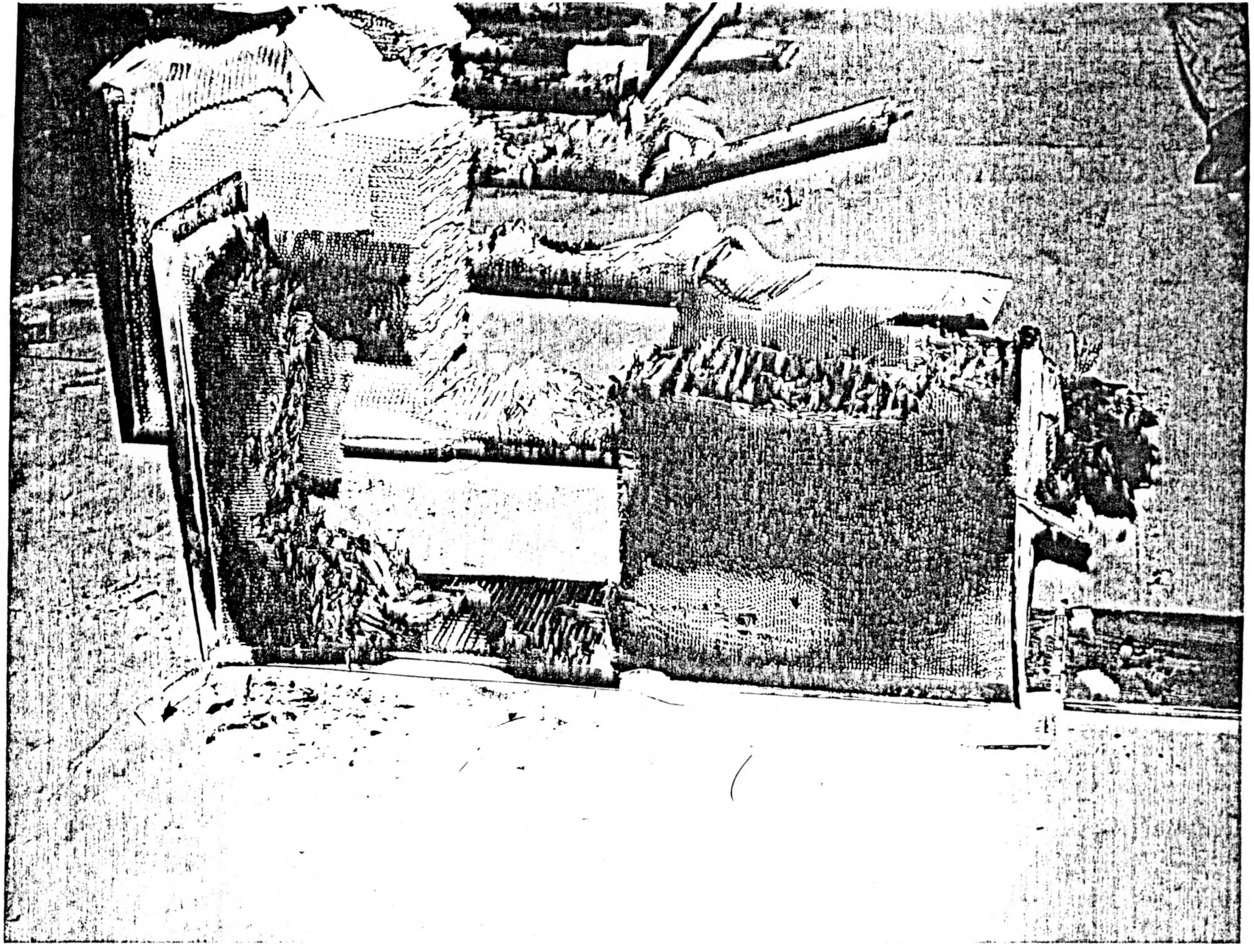
PICTURE NO. 29

The Honeycomb filter torn down for inspection.



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AEC-GE RICHLAND WASH.

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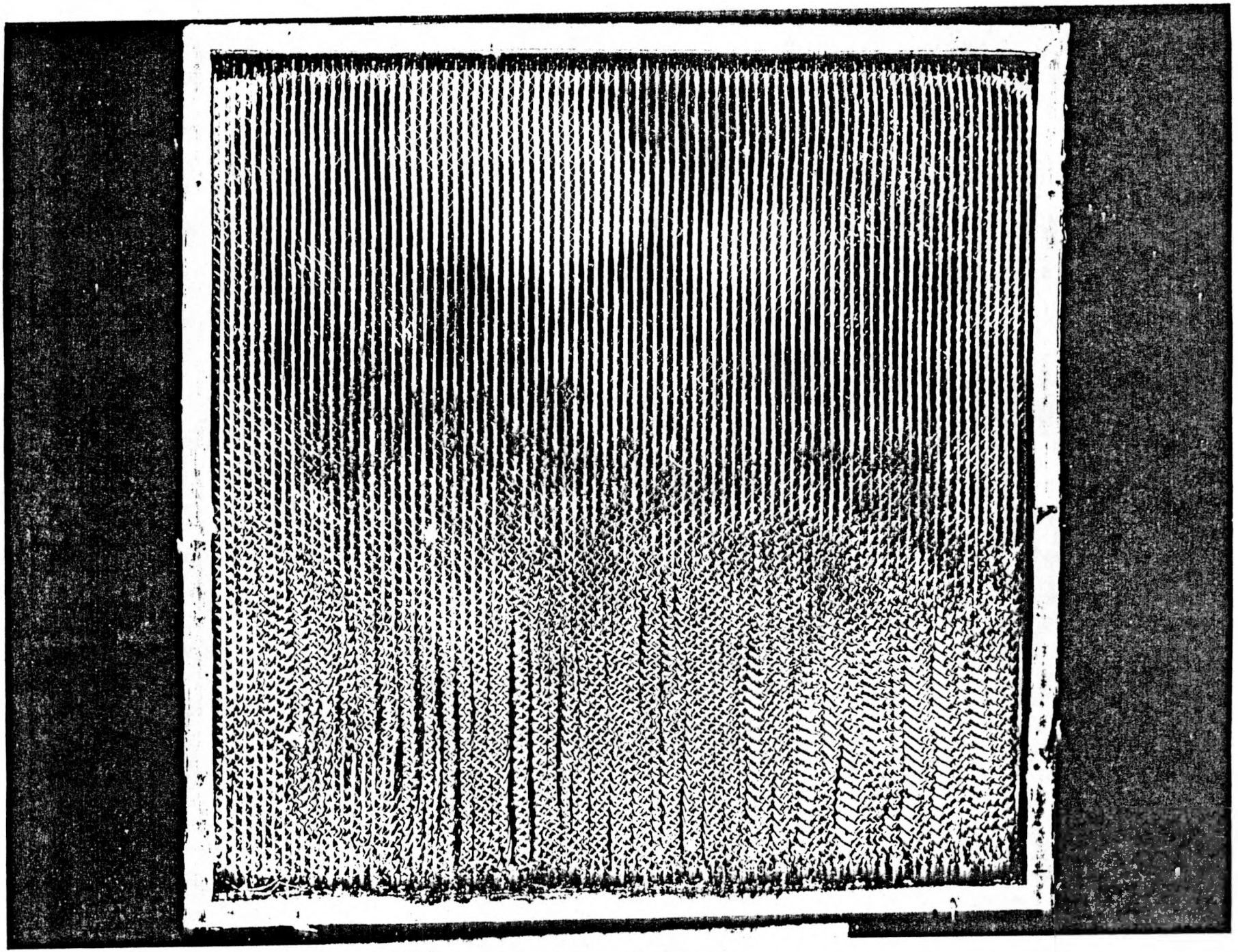
PICTURE NO. 30 TEST 8

Wood frame, with separators, adhesive not specified.
Showing front face of filter after testing.



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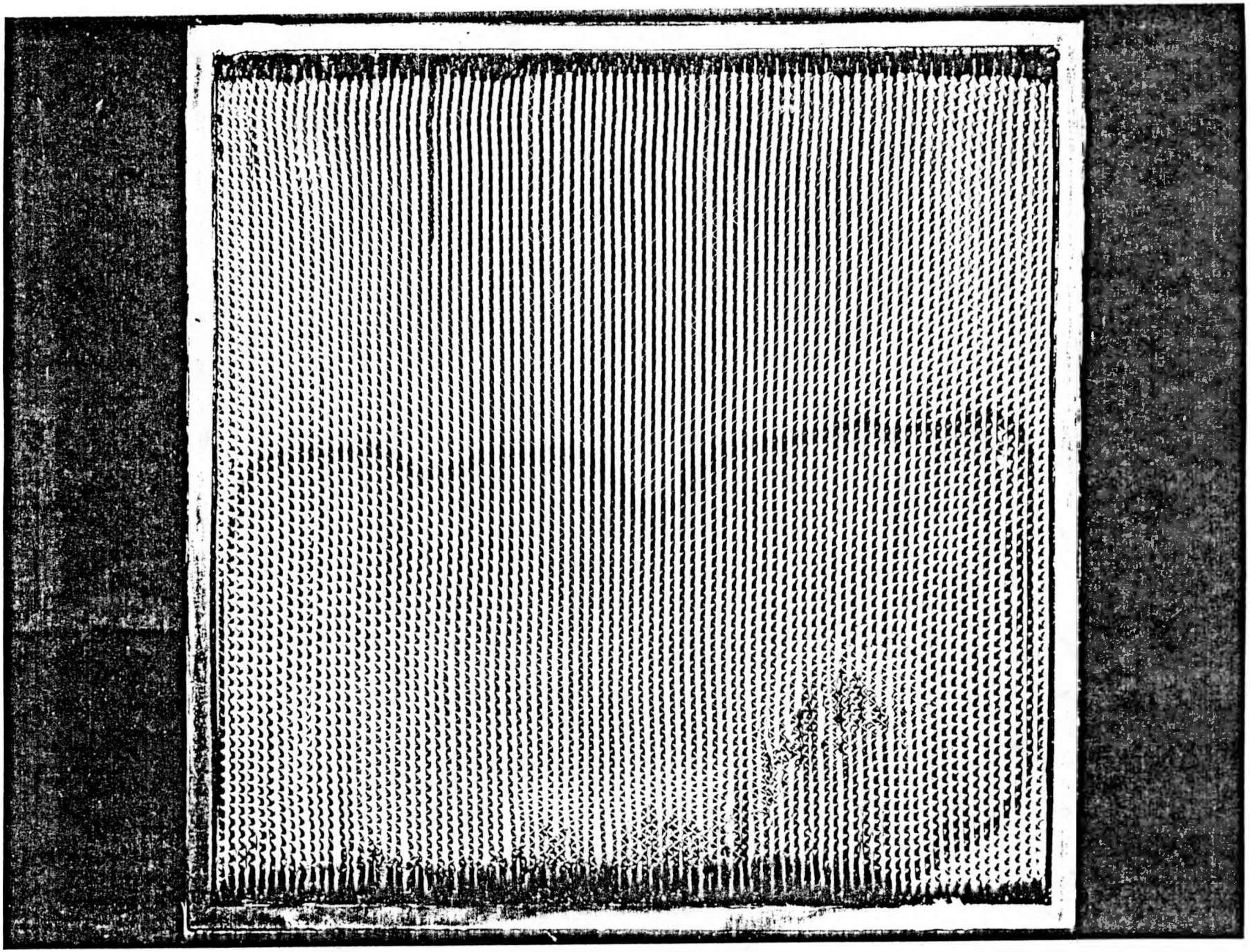
PICTURE NO. 31

Same filter as in Picture No. 30.

Showing rear face.



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PICTURE NO. 32

Showing same filter torn down for inspection after testing. Adhesive is charred where exposed to concentrated firing.

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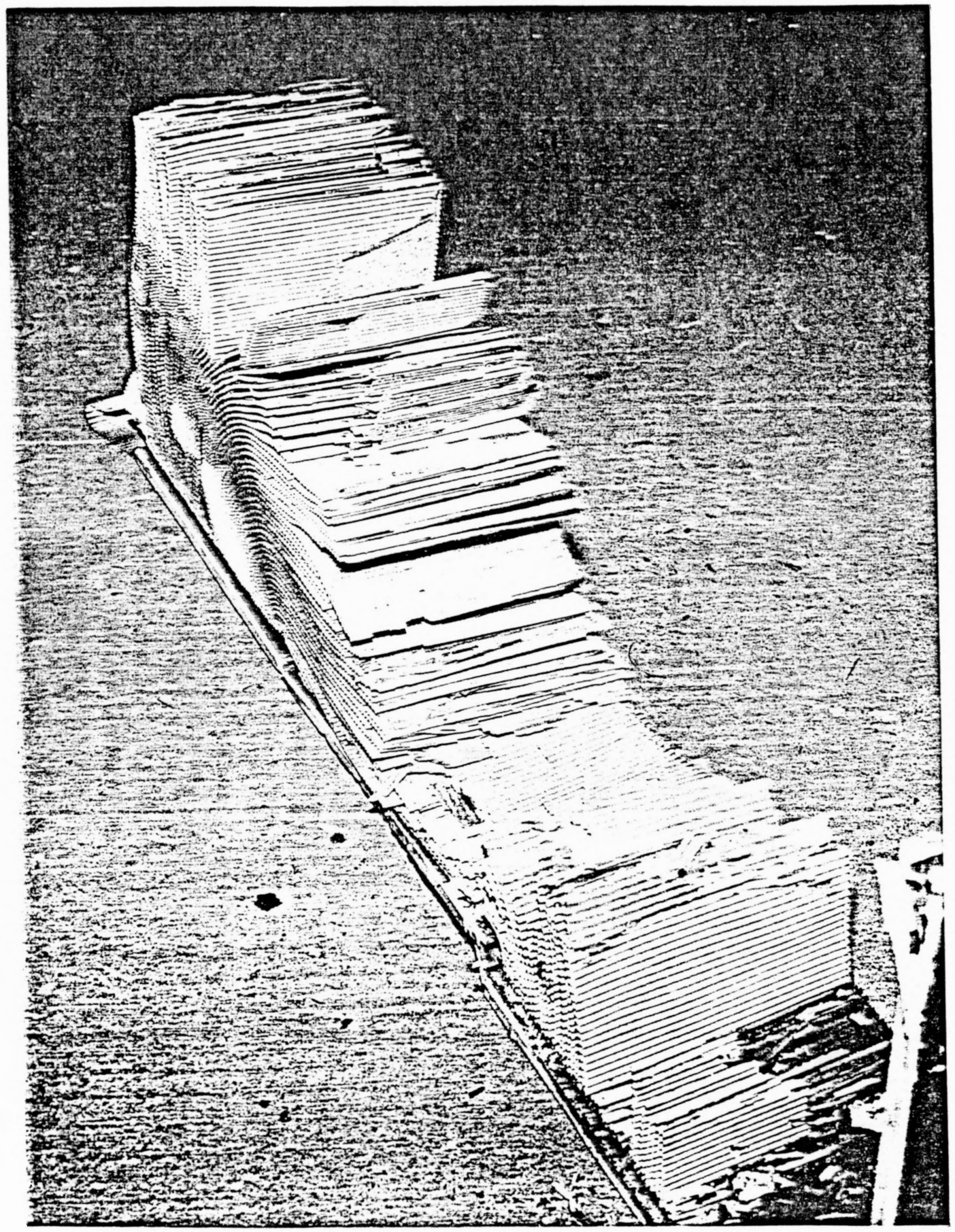

AEC-GE RICHLAND, WASH

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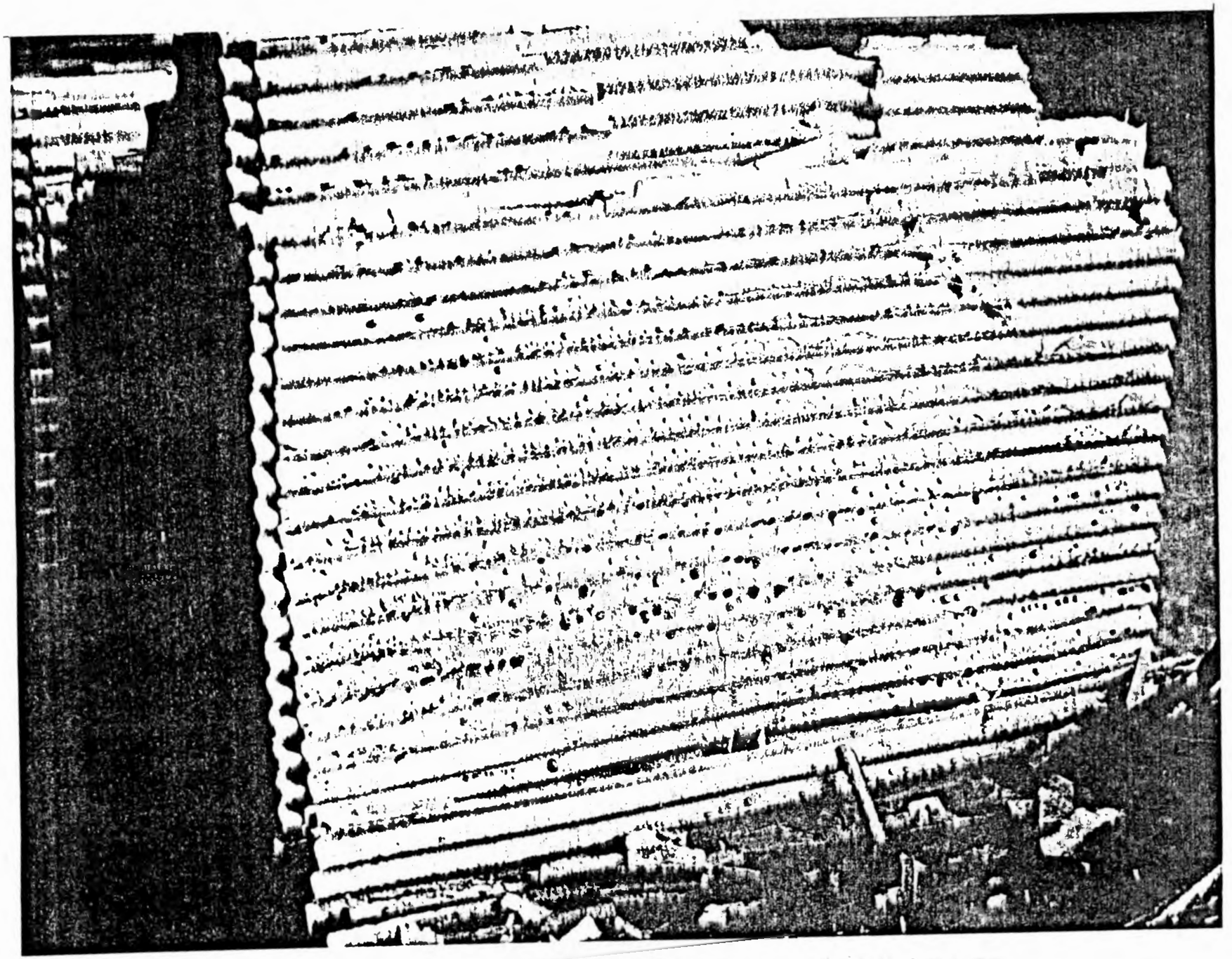
PICTURE NO. 33

Showing glass globules adhering to the separators after firing. This is typical of all this type filter, and is the reason for emphasizing that "when once exposed to fire, these filters should be replaced immediately."



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COPY

January 5, 1960

D. A. Hoover
1704-B Building
100-B Area

PROTOTYPE TESTS - REACTOR CONFINEMENT FILTERS

The prototype filters (requested to be tested) for the IPD confinement program have been tested for penetration and pressure drop. The findings are listed below.

Honeycomb Type (Tested with standard frames)

1.	DOP Penetration	.065% at 1000 cfm.	Resistance	1.38"WG.
2.	" "	.045% " " "	"	1.24"WG.
3.	" "	.045% " " "	"	1.40"WG.

Space Filter (Tested with standard frames)

1.	DOP Penetration	.008% at 1000 cfm.	Resistance	0.96"WG.
2.	" "	.010% " " "	"	0.96"WG.
3.	" "	.020% " " "	"	1.04"WG.

The #3 filter was rechecked following a humidity test by J. Palmer. Penetration was .038%. Resistance 1.04". (Tested on standard frames). The #3 filter was rechecked with modified frames. Due to the hard filter gaskets it was not possible to obtain quantitative data on penetration although it was found that consistent leakage occurred at each of the lock joints of the gaskets.

(Tested with standard frames)

1.	DOP Penetration	.060% at 1000 cfm.	Resistance	0.82"WG.
2.	" "	.078% " " "	"	0.84"WG.
3.	" "	.038% " " "	"	0.84"WG.

The #3 filter was given a humidity test by J. Palmer and rechecked as follows: DOP Penetration 25% - Resistance 3."WG. Holes in medium were visible before test. (Tested with standard frames).

(Tested with standard frames)

DOP Penetration	.038% at 1000 cfm.	Resistance	1.06"WG
" "	.030% " " "	"	1.06"WG
" "	.030% " " "	"	1.06"WG

F. E. Adley, Manager
Industrial Hygiene Operation

cc: E. L. Etheridge
W. D. Norwood
J. H. Palmer
D. W. Tuttel

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January 5, 1960

Memorandum to File:

HIGH EFFICIENCY FILTERS - MOISTURE TEST
DECEMBER 15, 16 & 17, 1959

Introduction

Humidity tests were conducted on prototype filters submitted by manufacturers. The filters were submitted and tested in compliance with the filter specifications devised for Project No. CG-1-791 (100 Area Confinement Program), which states "The complete filter unit shall be capable of withstanding 100 per cent relative humidity air and 10 inches water pressure differential for a period of 3 hours at a temperature of 160°F. Flow at these conditions shall be a minimum of 100 scfm. Each unit shall be dried out and then subjected to the dioctyl phthalate penetration test at rated air flow. Minimum efficiency shall be 99.95 per cent based upon dioctyl phthalate (DOP) penetration of 0.05 per cent for 0.3 micron diameter homogeneous particles at rated air flow."

Summary

each submitted three prototypes for testing, and the submitted three standard-type filters with separators and three of the "Honeycomb" type which are constructed without separators.

One each of the sets of prototypes was randomly selected for the humidity tests. Four filters in all were subjected to the 100 per cent saturated air test. Of these, only the standard filter completely withstood the test without deterioration, as test data will show. filter developed holes in the media, resulting in a final DOP penetration of 25 per cent. filter collapsed almost immediately upon exposure to 100 per cent humidified air, and to the extent that nothing could be gained by submitting it to further DOP testing. The "Honeycomb" filter failed in a similar manner.

filter, which successfully passed the humidity tests, does not fully meet the specifications as to the following:

a. The gasket material is not of 5-10 durometer. It is furnished in neophrene of 60 durometer.

b. The gasket material, as supplied, does not adhere to the filter frame sufficiently.

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c. The words "Air Flow" and "Top" are not marked on the top of the frame.

We discussed these items with West Coast representative, on a recent visit, and he assured us that these items would be corrected.

Dioctyl phthalate (DOP) tests results obtained by Industrial Hygiene, under F. E. Adley, accompany this report.

Humidity Test Data

Test 1 -

Manufacturer's test data - DOP .002%. Res: .70" w.g. rated flow 1,000 cfm.

Hanford test data (as received) - DOP .038%. Res: .84" w.g. 1,000 cfm (by Frank Adley).

Humidity test data - Prior to humidification - Res: .85" w.g. flow 1,039 cfm (as measured in R.H. test machine).

Humidity test data - Upon reaching 100% humidification -

Time	D.P. Inches W.G.	Flow CFM	Inlet Temp °F
9:10 am	4.50	150	100
9:15 "	4.70	80	105
10:00 "	4.50	70	158
11:10 "	10.00	-	160
12:00 noon	10:00	-	160
12:30 pm	Test discontinued	-	started drying out filter.

Test 2 -

Manufactuerer's test data - DOP .018%. Res: .85", flow 1,000 cfm.

Hanford test data (as received) - DOP .012% Res: 1.04" w.g. (by Frank Adley).

Humidity test data - Prior to humidification - Res: .90" w.g., flow 1,374 cfm (as measured in R.H. test machine).

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Test 2 (continued)

Humidity test data - upon reaching 100% humidification -

Time	D.P. Inches W.G.	Flow CFM	Inlet Temp °F
10:20 am	2.3	973	160
11.20 "	2.3	973	160
12:20 pm	2.3	973	160
1:20 "	2.3	973	160
2:20 "	2.3	973	160

Test 3 -

Manufacturer's test data - DOP .022%. Res: .98" w.g. flow 1,000 cfm.

Hanford test data (as received) - DOP .030%. Res: 1.06" w.g. (by Frank Adley).

Humidity test data - Prior to humidification - Res: 1.0" w.g. flow 1370 cfm (as measured in R.H. test machine).

Humidity test data - Upon reaching 100% humidification -

Time	D.P. Inches W.G.	Flow CFM	Inlet Temp °F
9:50 am*	4.9	535	160
9:52 "	4.0	653	160
9:54 "	3.5	738	160
9:56 "	3.0	877	160
10:05 "	2.5	931	160
10:25 "	2.2	1,049	160

*Filter broke through almost immediately on start of test. This disqualified filter for further consideration.

DOP Machine Tests (After filters were dried out)

Filter - DOP 25%. Res: 3.0" w.g.

Filter - DOP .038%. Res: 1.04" w.g.

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In addition to the above tests, a "honeycomb" type filter was tested, but failed completely on humidification, so was given no further consideration.

J. H. Palmer, Supervisor
Power Engineering

JHP:ta

Attachement

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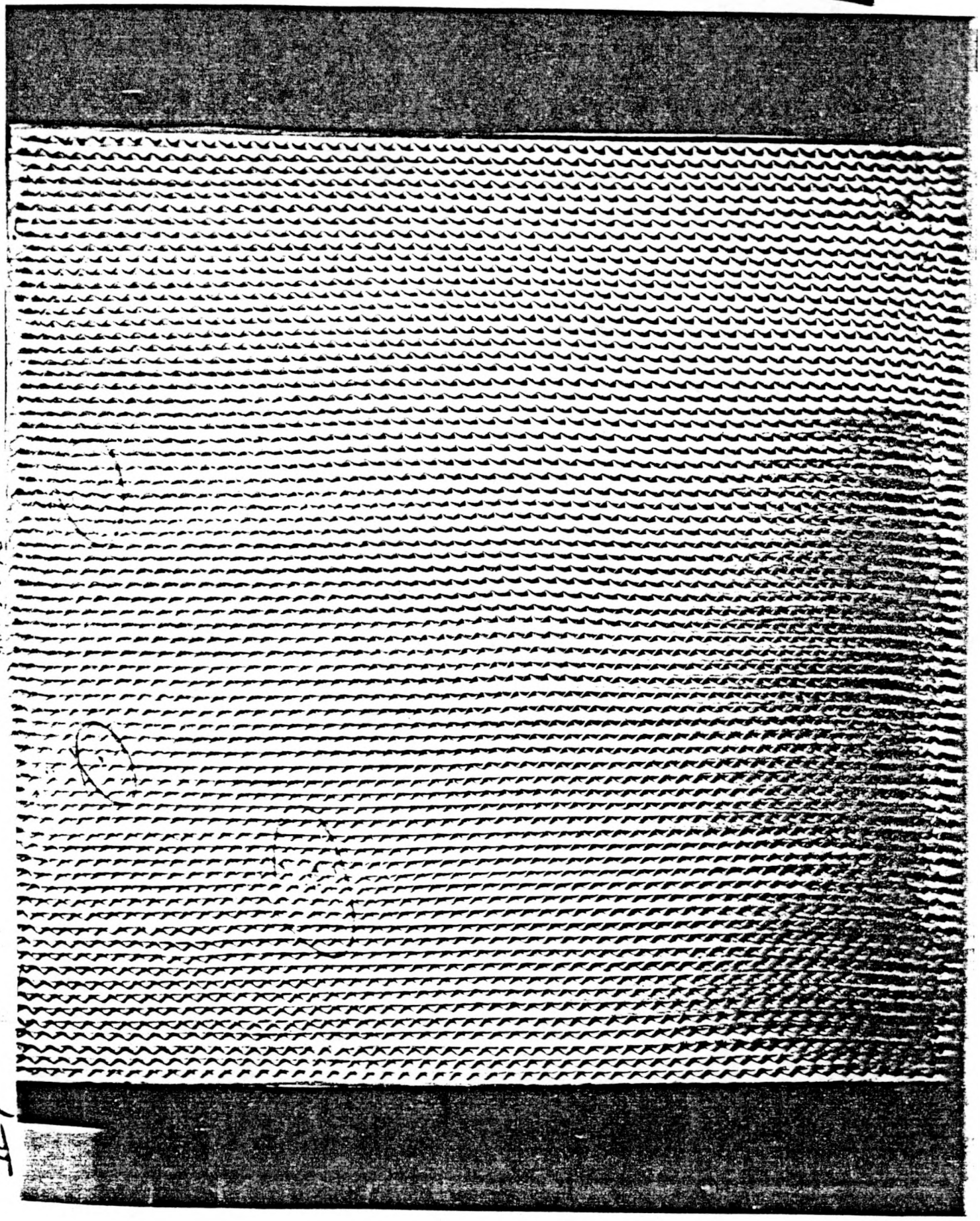

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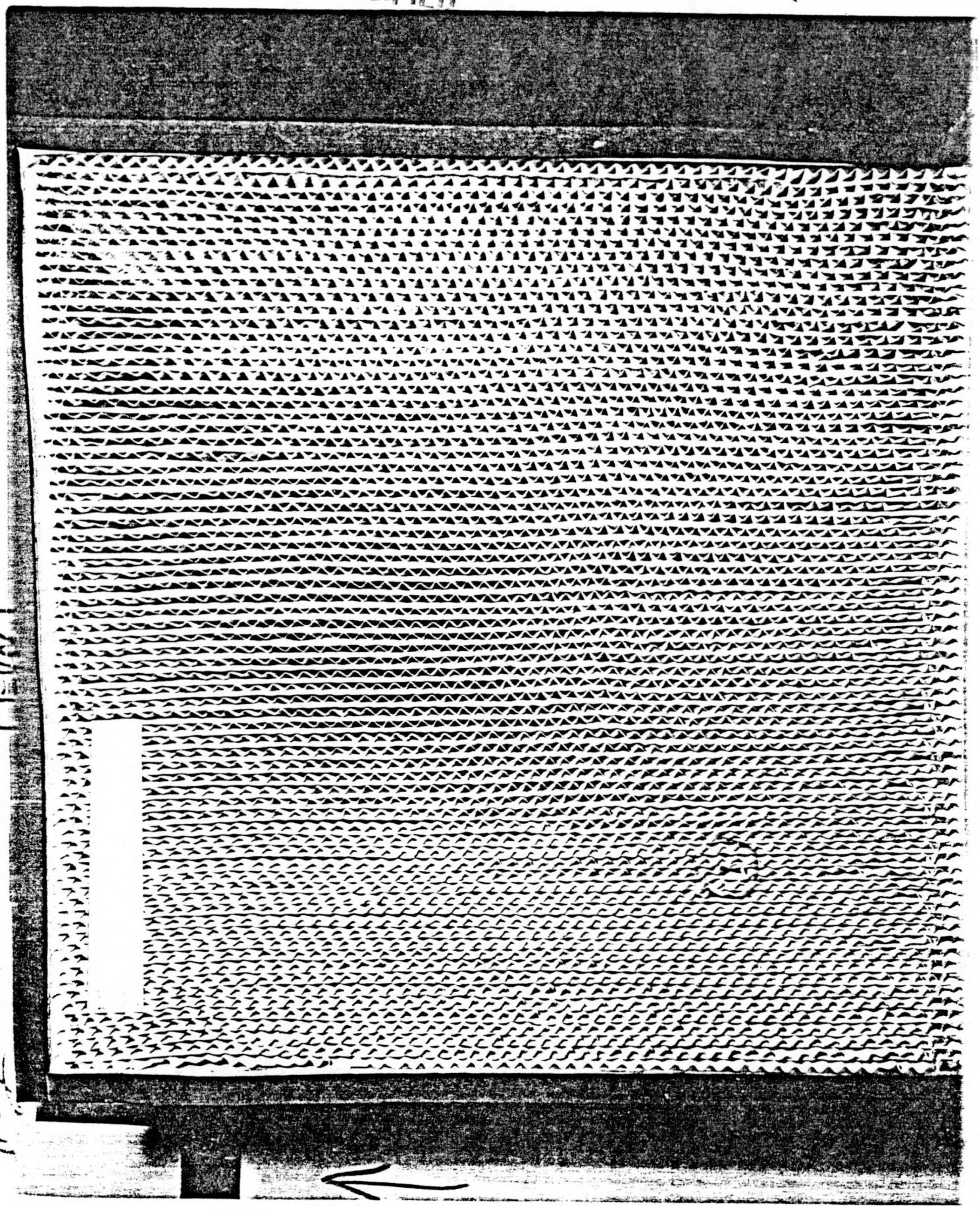

FRAME

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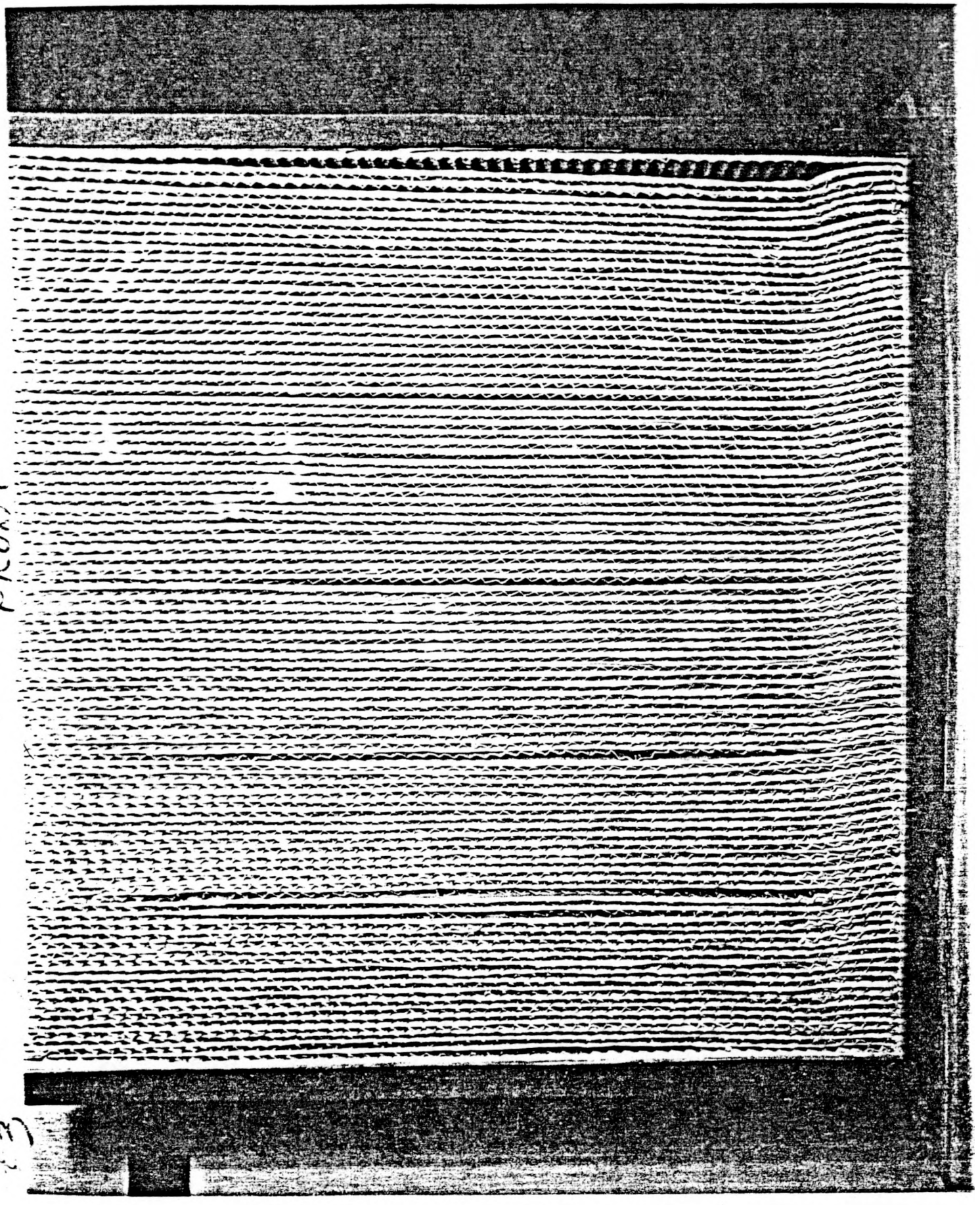

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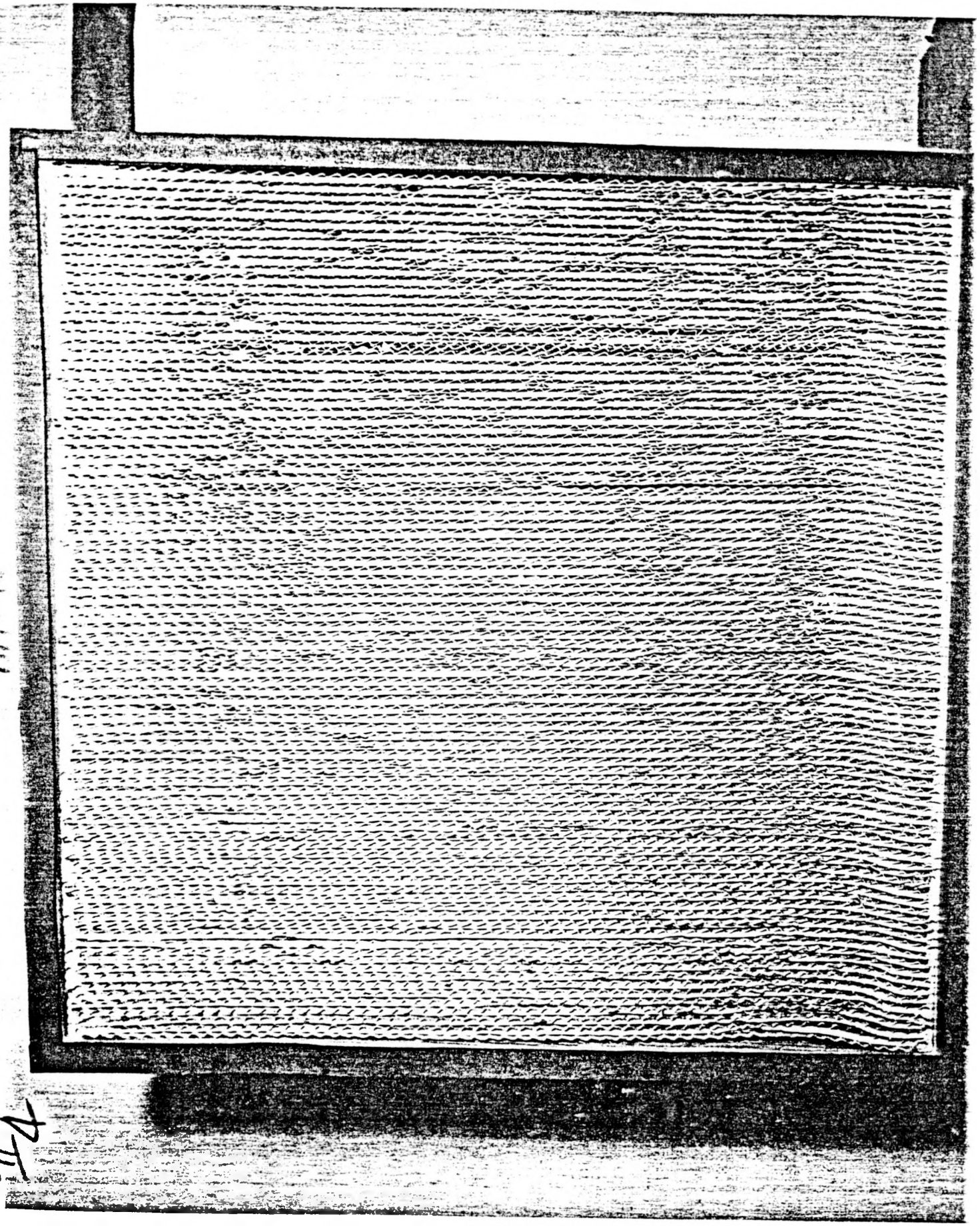

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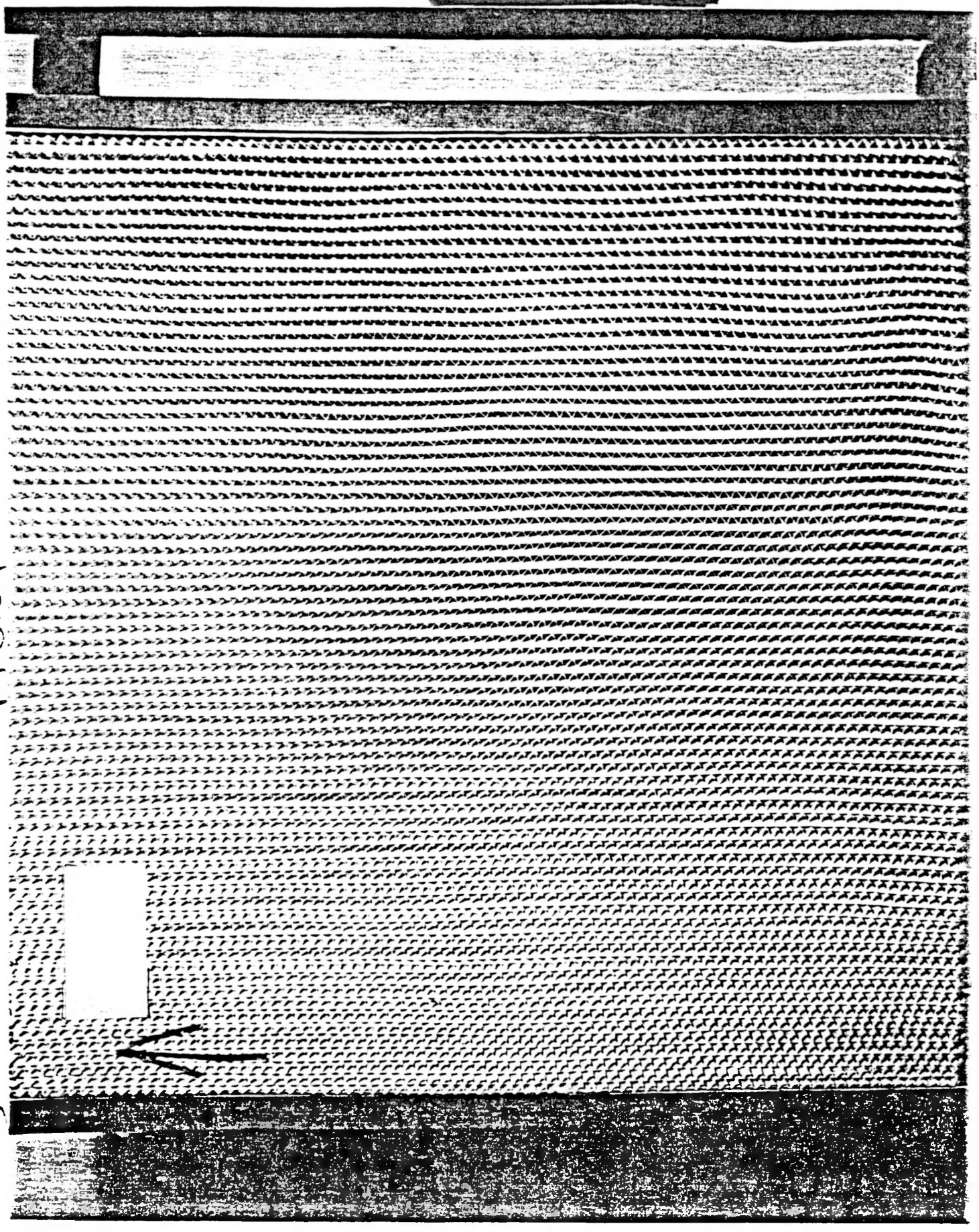

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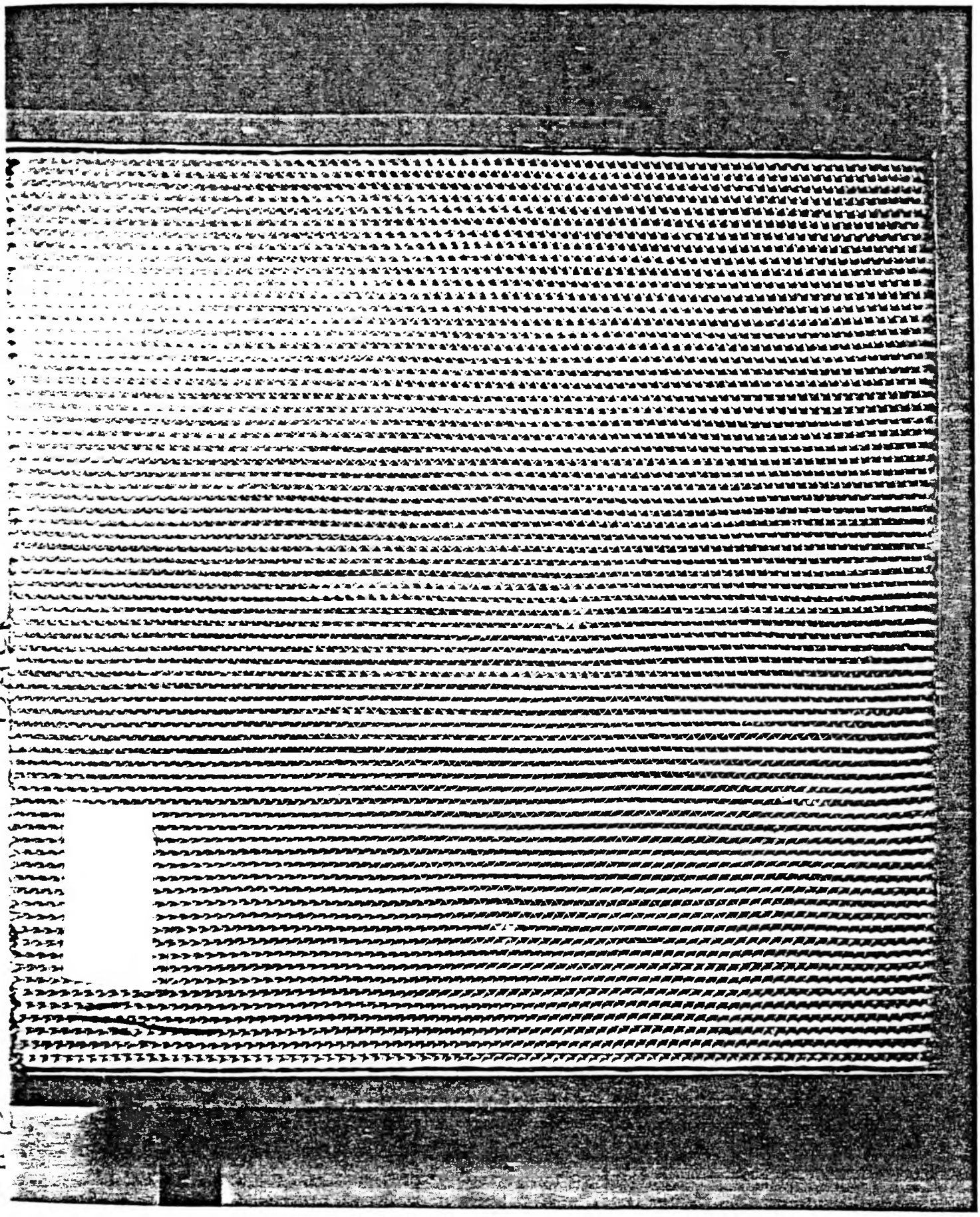
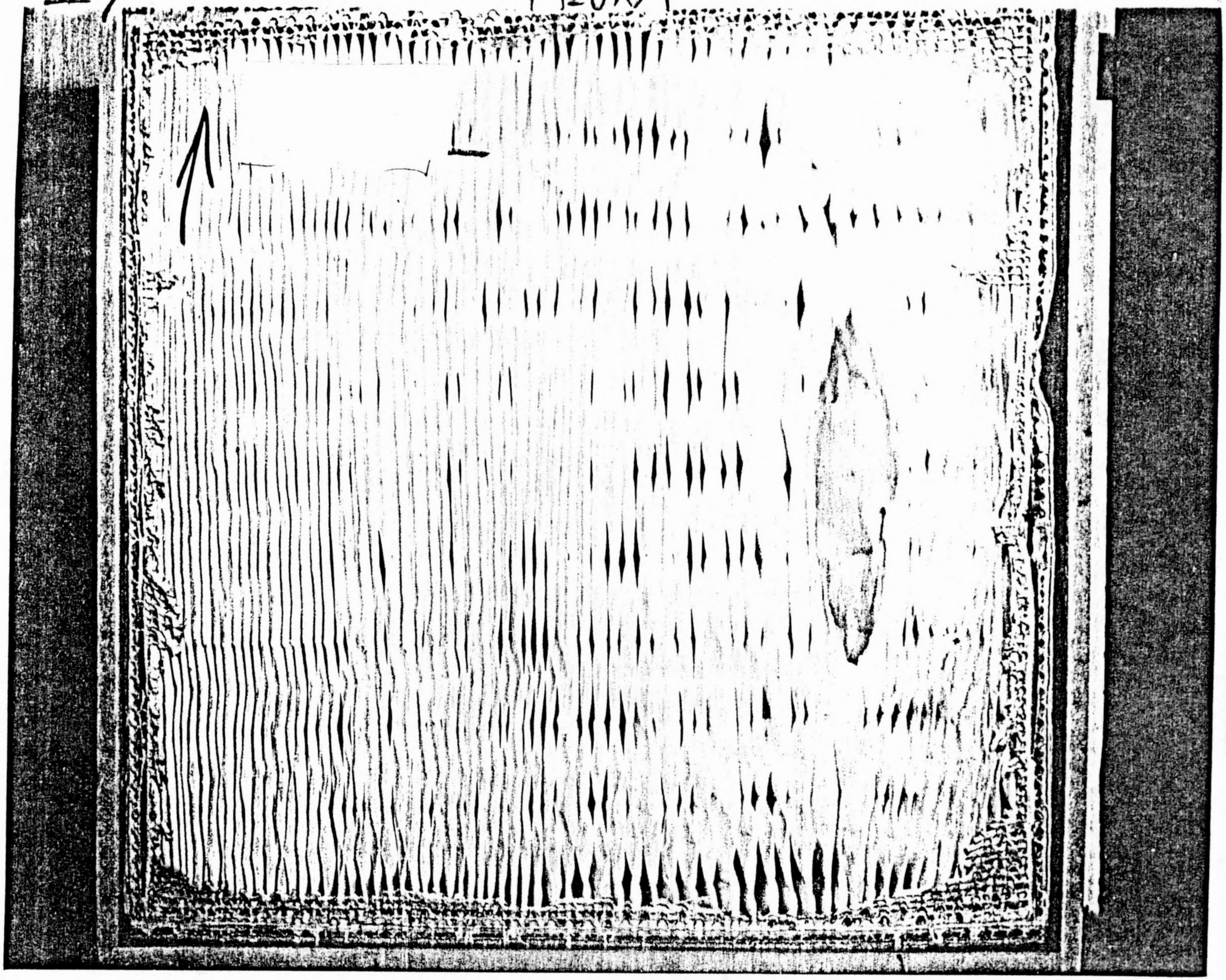


#7

FRONT



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