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(27)

METALLURGICAL INVESTIGATION OF CRACKING IN THE BORIC ACID PIPING AT PRAIRIE ISLAND 1

(SUMMARY OF RESULTS)

NRC PRESENTATION, FEB. 8, 1983

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METALLURGICAL AND NDE ANALYSIS

NUCLEAR TECHNOLOGY DIVISION

WESTINGHOUSE ELECTRIC CORPORATION

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SUMMARY OF RESULTS

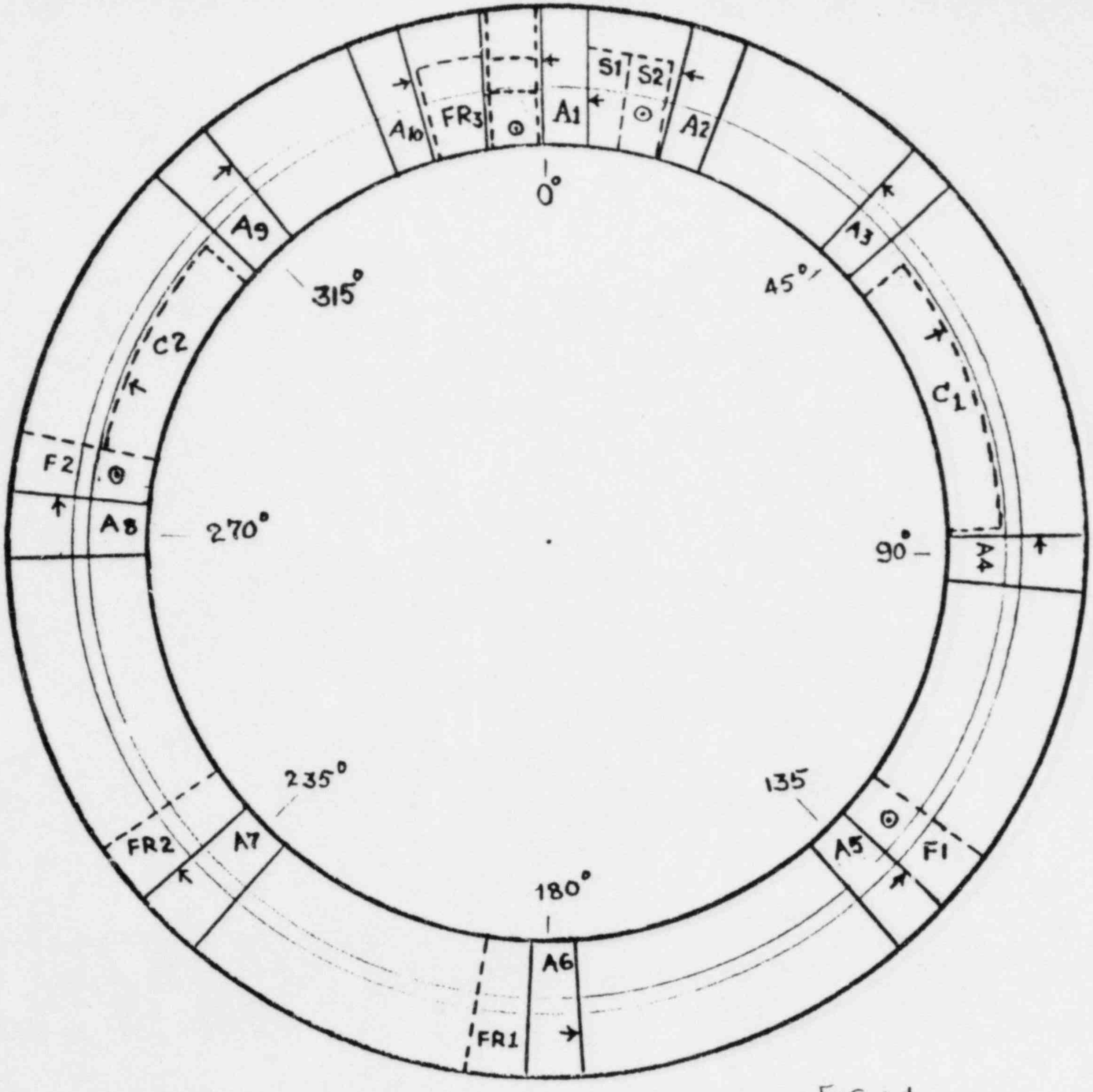
THIS REPORTS SUMMARIZES THE PRELIMINARY FINDINGS OF THE METALLURGICAL INVESTIGATION OF CRACKING IN THE STAGNANT BORIC ACID PIPING LEADING FROM BORIC ACID STORAGE TANK TO THE SAFETY INJECTION PUMP AT THE PRAIRIE ISLAND UNIT 1 STATION. THE EXAMINATION ARE BASED ON A SIX INCH LONG 8-INCH DIAMETER PIPING TAKEN FROM THE PIPE-TO-ELBOW WELD REGION OF THE BORIC ACID LINE. THE EVALUATIONS CONSISTED OF SURFACE EXAMINATIONS, METALLOGRAPHIC EXAMINATIONS, FRACTOGRAPHIC EXAMINATIONS, AND CHEMISTRY EVALUATIONS.

VISUAL AND LOW POWER LIGHT MICROSCOPIC EXAMINATION OF THE INSIDE DIAMETER (ID) AND OUTSIDE DIAMETER (OD) SURFACES OF THE PIPE SAMPLE IN THE AS-RECEIVED CONDITION SHOWED THAT THE ID SURFACE OF THE PIPING IS COVERED WITH THICK BLACK OXIDE. THE OD SURFACE APPEARED RELATIVELY CLEAN. REMOVAL OF THE ID SURFACE OXIDE BY LIGHT SANDING (DRY) REVEALED THE PRESENCE OF NUMEROUS CRACKS IN THE PIPE MATERIAL STARTING FROM NEAR THE WELD AND EXTENDING 1 TO 1.5 INCHES INTO THE PIPE MATERIAL. MINOR CRACKING WAS ALSO SEEN OCCASSIONALLY IN THE ELBOW PARTICULARLY NEAR THE WELD. THE ID SURFACE OF THE ELBOW REGION SHOWED SHALLOW PITTING. THE CRACKING IN THE PIPE APPEAR TO BE CIRCUMFERENTIAL IN GENERAL. HOWEVER, SOME REGIONS WHERE CRACKS APPEAR TO BE AXIALLY ORIENTED WERE ALSO SEEN. BASED ON THE RESULTS OF SURFACE EXAMINATIONS, THE PIPE WAS SECTIONED AND SPECIMENS WERE TAKEN OUT FOR VARIOUS METALLOGRAPHIC, FRACTOGRAPHIC AND CHEMISTRY EVALUATIONS.

A NUMBER OF CIRCUMFERENTIAL AND AXIAL SECTIONS TAKEN FROM THE WELD REGION OF THE PIPING WERE POLISHED AND EXAMINED METALLOGRAPHICALLY BOTH IN THE AS-POLISHED AND POLISHED AND ETCHED CONDITION, TO ESTABLISH THE DEPTH AND DISTRIBUTION OF CRACKS AND THEIR RELATIONSHIP TO THE LOCAL MICROSTRUCTURE. THE RESULTS SHOWED THAT THE CRACKING WAS INITIATED ON THE ID SURFACE AND PROPOGATED RADIALLY OUTWARD. CRACKING EXTENDED UP TO ONE TO TWO INCHES FROM THE WELD. SPECIMENS POLISHED ON THE ID SURFACE SHOWED THAT THE CRACKING IS CIRCUMFERENTIAL IN GENERAL, ALTHOUGH AXIAL CRACKS WERE ALSO SEEN OCCASIONALLY. AT LOCATIONS NEAR THE 0^{O} (TOP REGION) CRACKING EXTENDED FROM THE ID SURFACE TO ALL THE WAY UP TO THE OD SURFACE OF THE PIPING. THE CRACKS WERE PRIMARILY TRANSGRANULAR AND BRANCHED OUT IN NATURE ALTHOUGH OCCASIONALLY SOME DEGREE OF INTERGRANULARITY WAS ALSO SEEN. THIS CRACKING BEHAVIOR RESEMBLES TYPICAL CHLORIDE TYPE CRACKING IN 304 STAINLESS STEEL. THE MICROSTRUCTURE DID NOT REVEAL EVIDENCE OF APPRECIABLE SENSITIZATION. WET CHEMISTRY ANALYSIS OF THE PIPING AND ELBOW MATERIALS SHOWED THAT THEY CONFIRM TO THE TYPE 304 STAINLESS STEEL SPECIFICATION. X-RAY POWDER ANALYSIS OF THE ID SURFACE OXIDE SHOWED EVIDENCE OF CHLORIDES (UP TO 70 PPM) IN THE OXIDE LAYER. FRACTOGRAPHIC EVALUATIONS AND CHEMISTRY EVALUATION OF CRACK DEPOSITS ARE CURRENTLY PROGRESSING.

MAJOR TASKS

- SURFACE EXAMINATIONS
- METALLOGRAPHIC EXAMINATIONS
- FRACTOGRAPHIC EXAMINATIONS
- CHEMISTRY EVALUATIONS

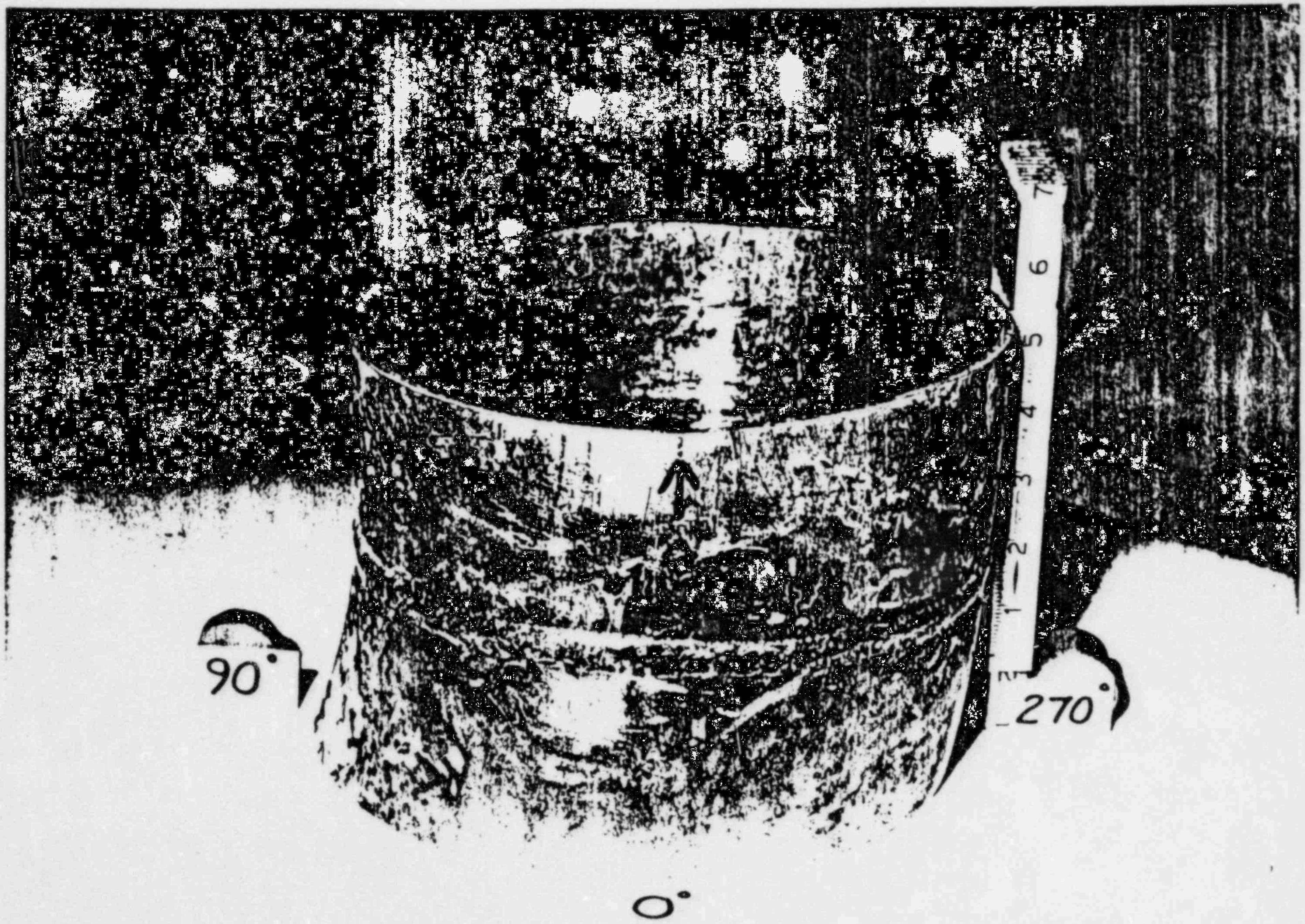


A10
FR3
A1
S1
S2
A2
0°
A9
315°
A3
45°
C1
C2
F2
A8
270°
90°
A4
235°
135
FR2
A7
A5
F1
180°
A6
FR1

FIG: 1

LEGEND - FIGURE-1

A1, A2 . . . A10:	AXIAL SECTIONS FOR METALLOGRAPHY
CA, C2 AND C3:	CIRCUMFERENTIAL SECTIONS FOR METALLOGRAPHY
F1, F2 AND F3:	ID SURFACE METALLOGRAPHY
S1, S2 :	SPECIMENS FOR SENSITIZATION TEST
FR1 AND FR2 :	SPECIMENS FOR FRACTOGRAPHY


90°
270°
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1
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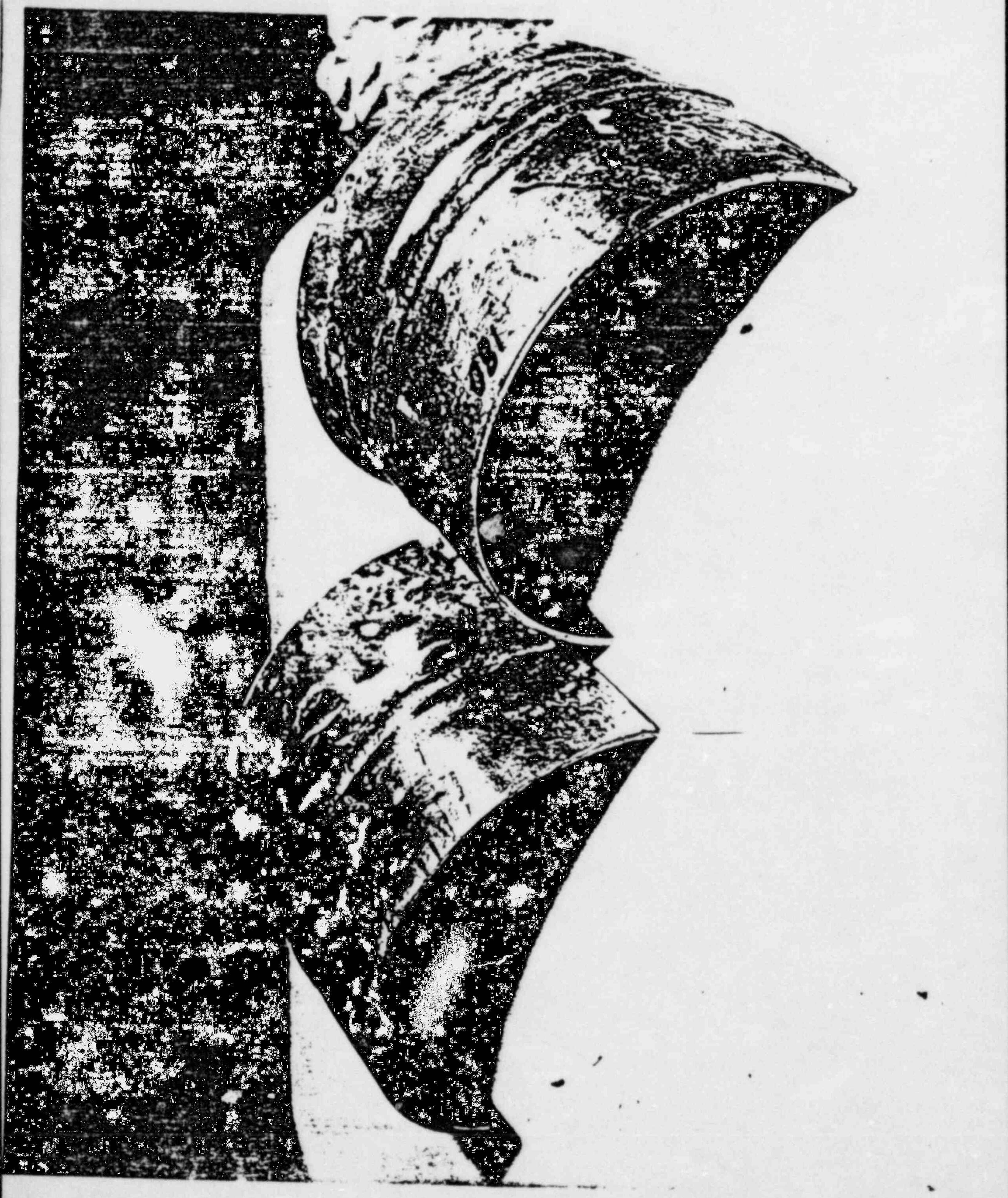

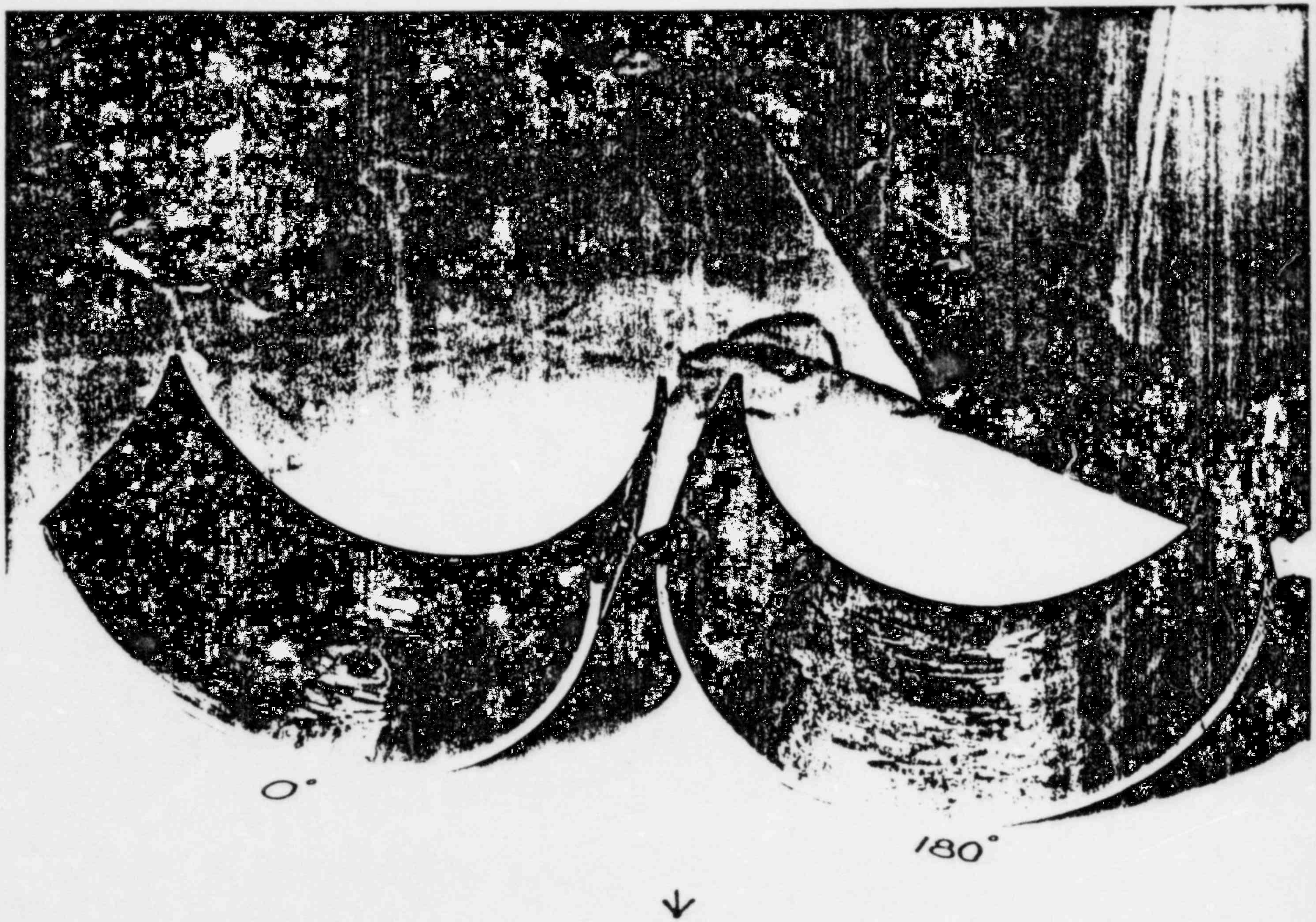
0°
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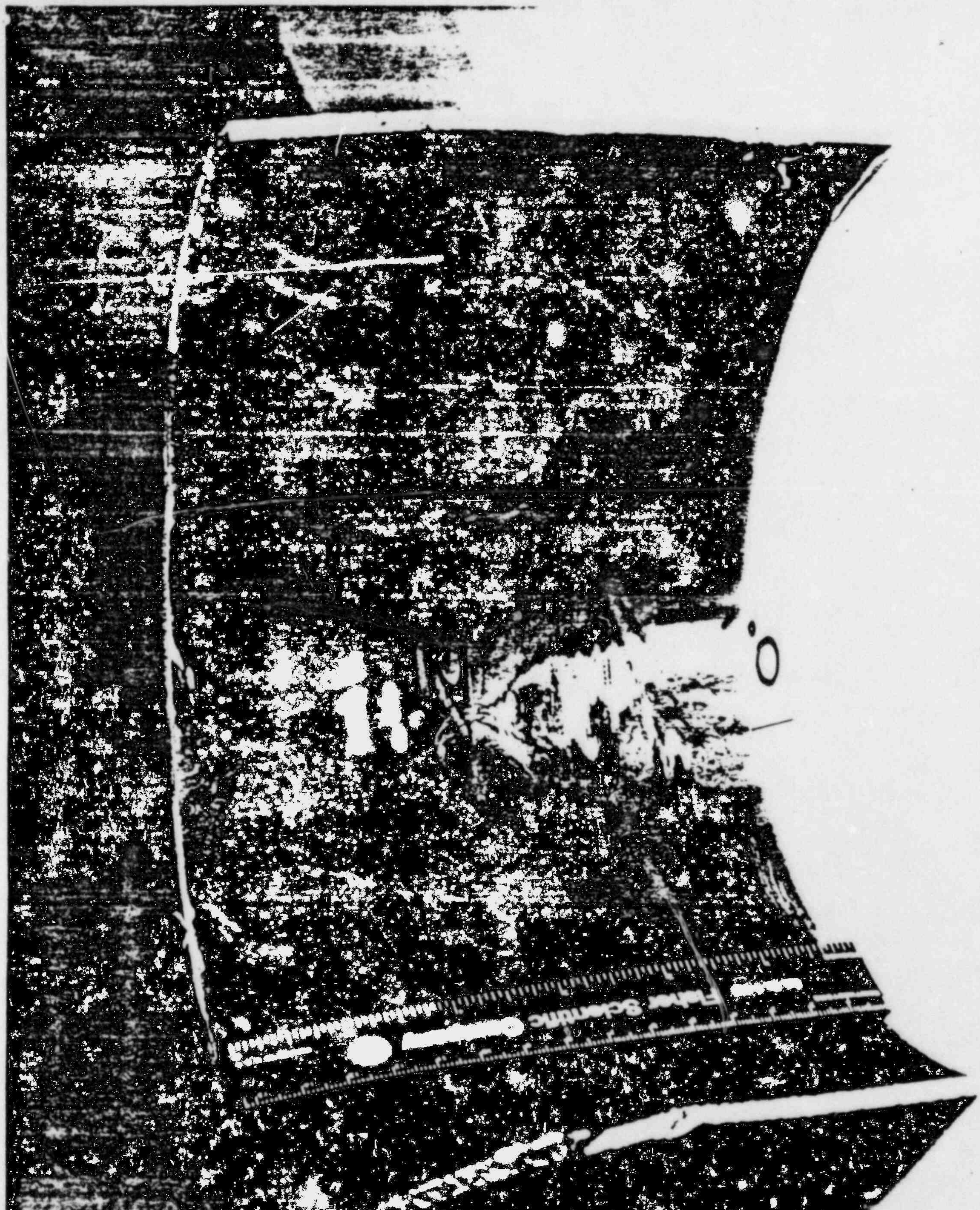
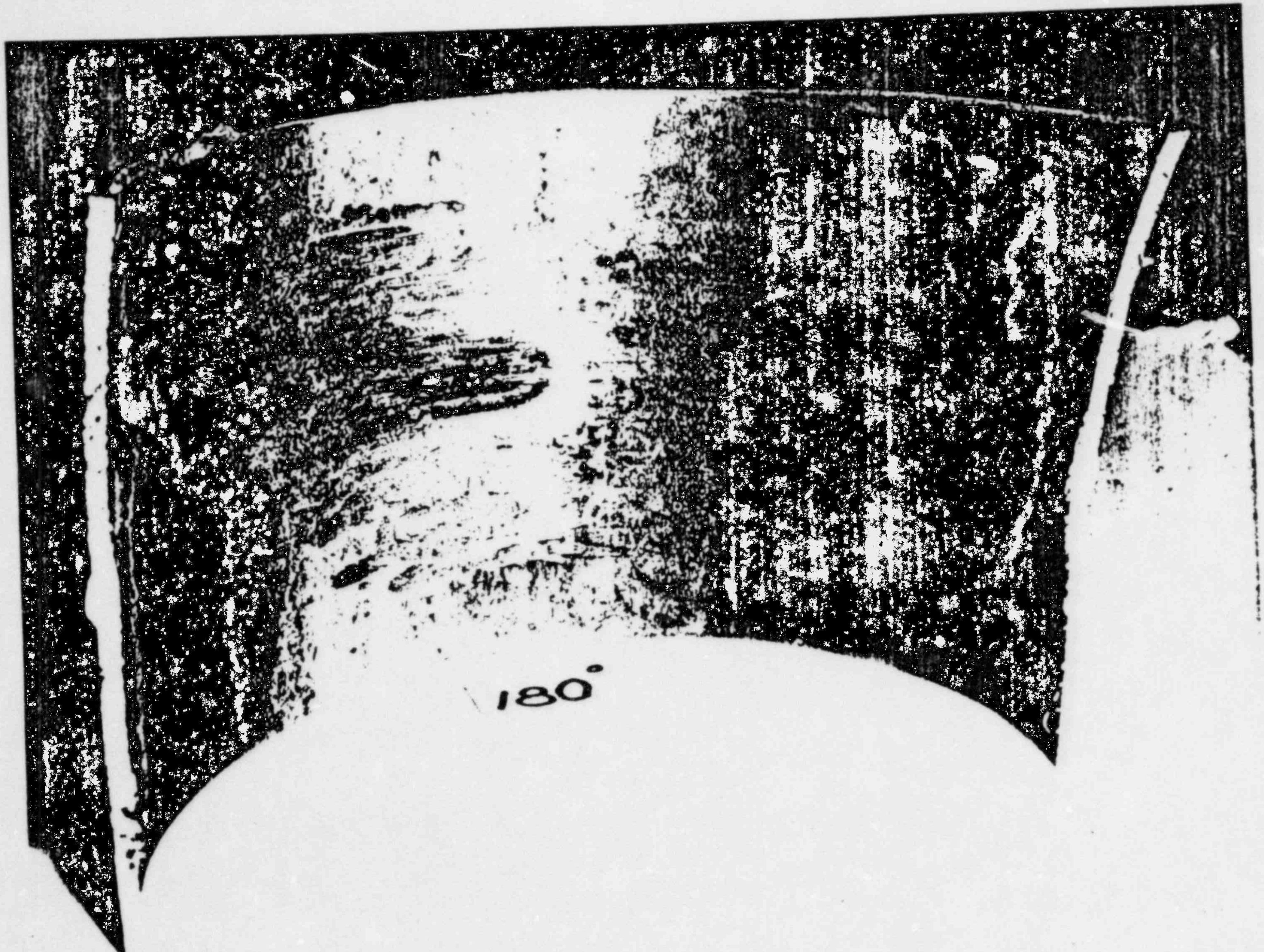
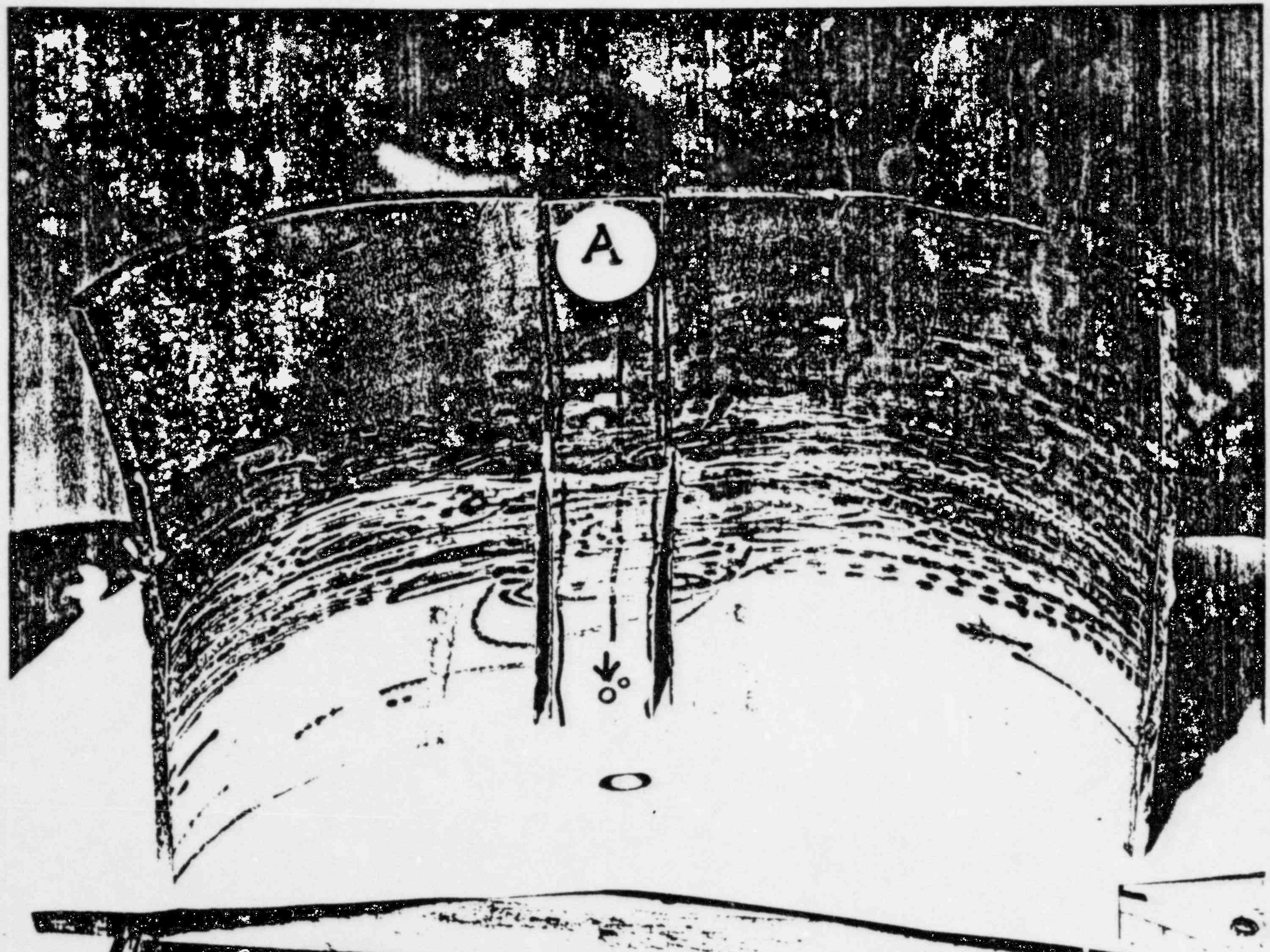
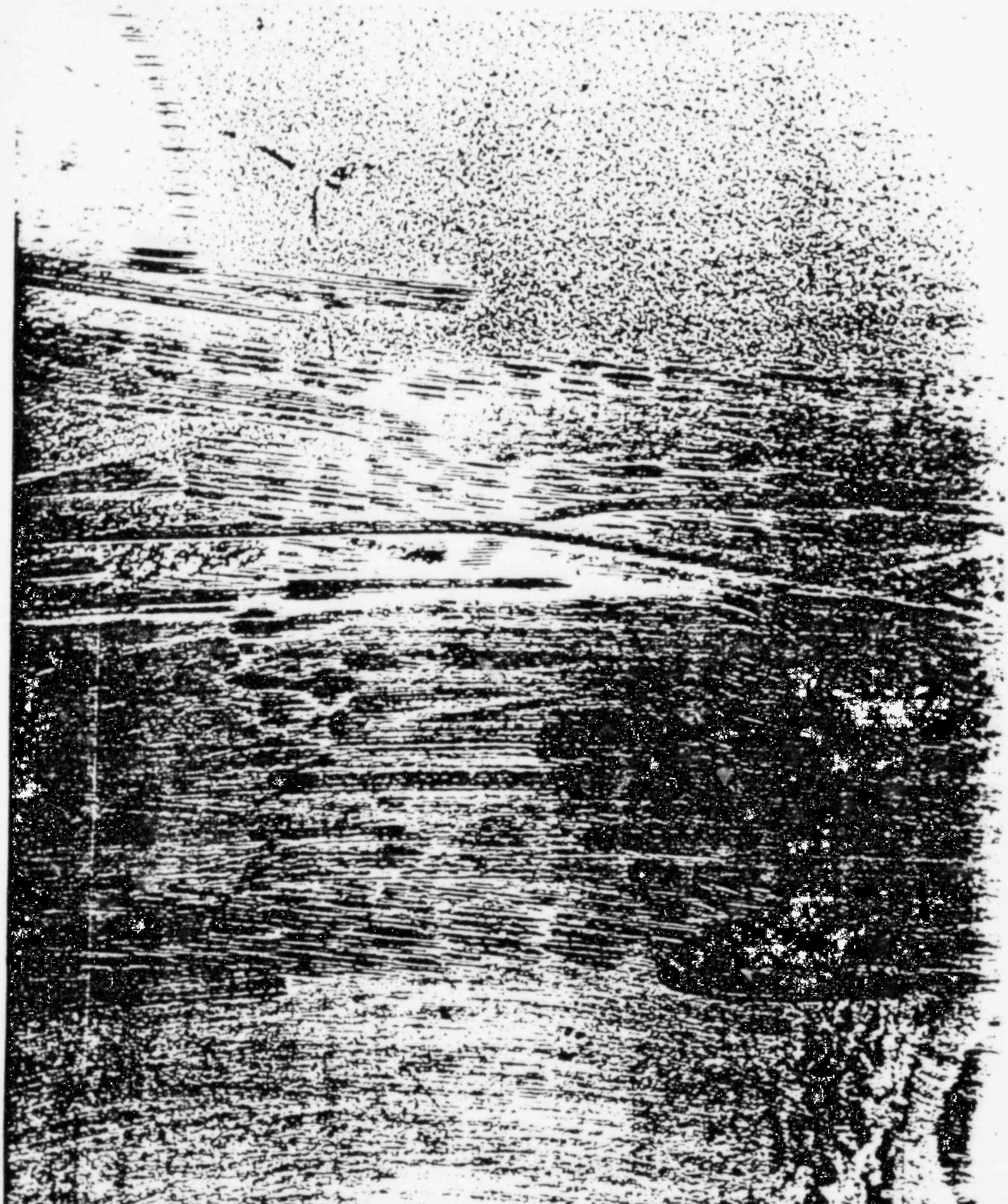
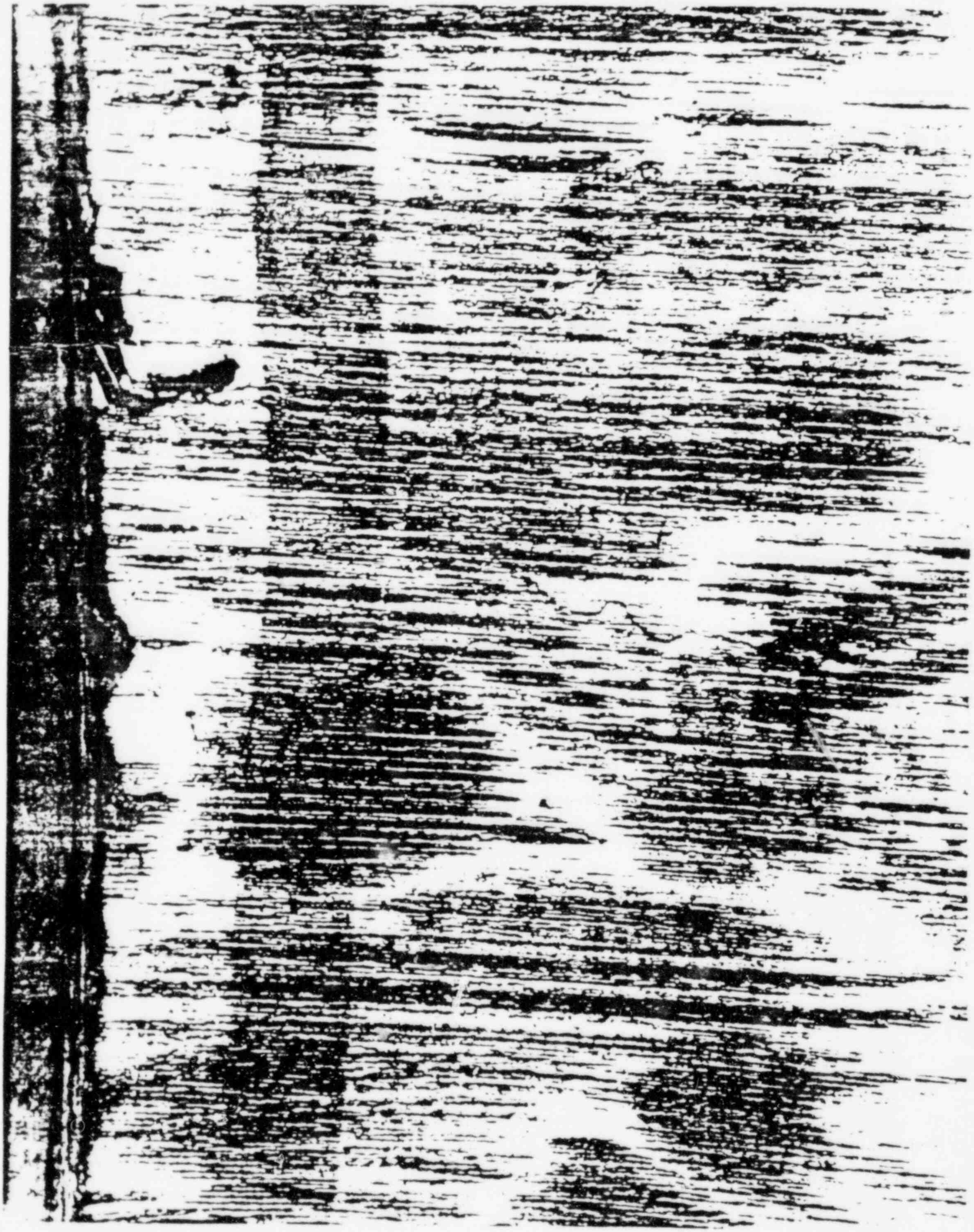
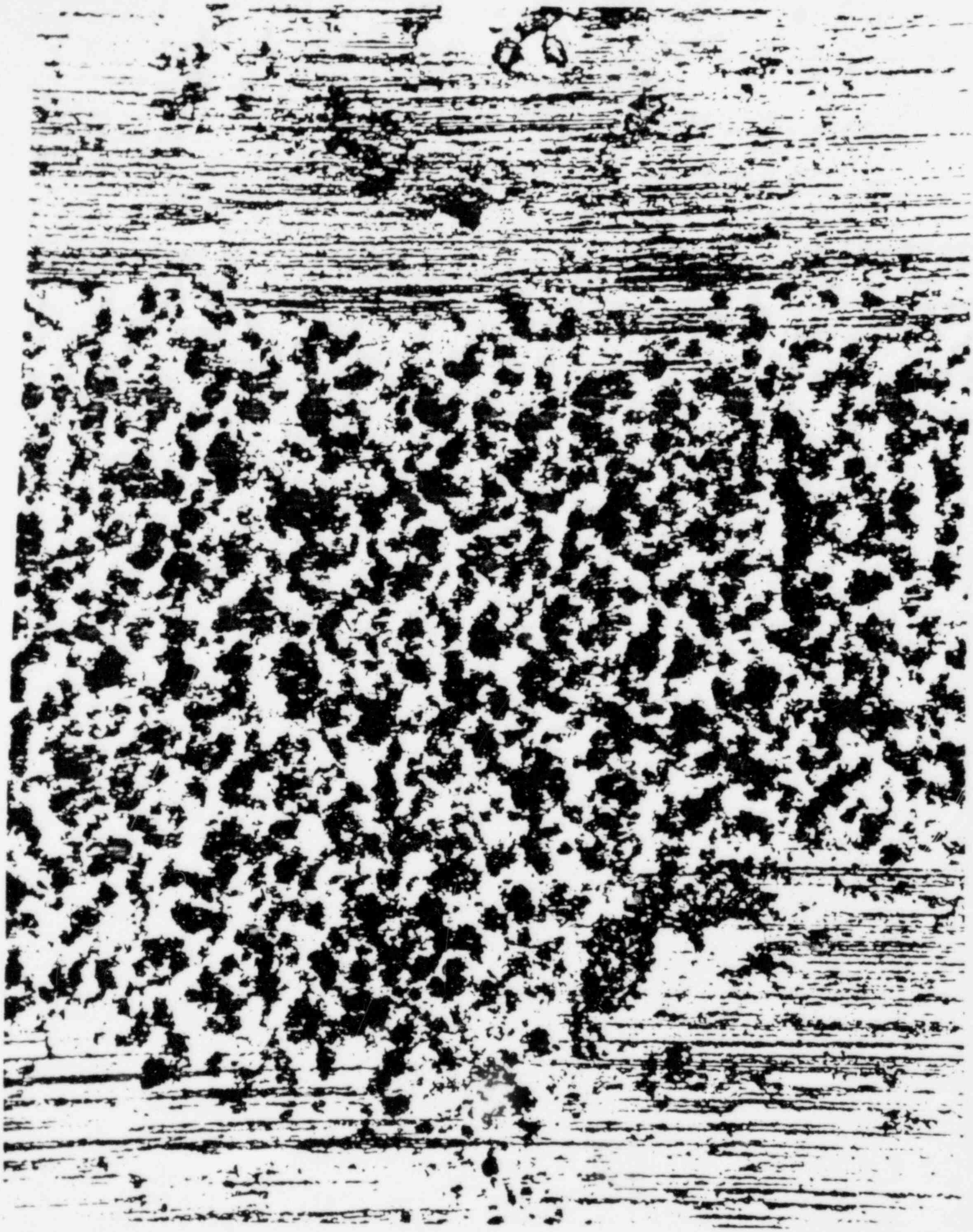

Fisher Scientific

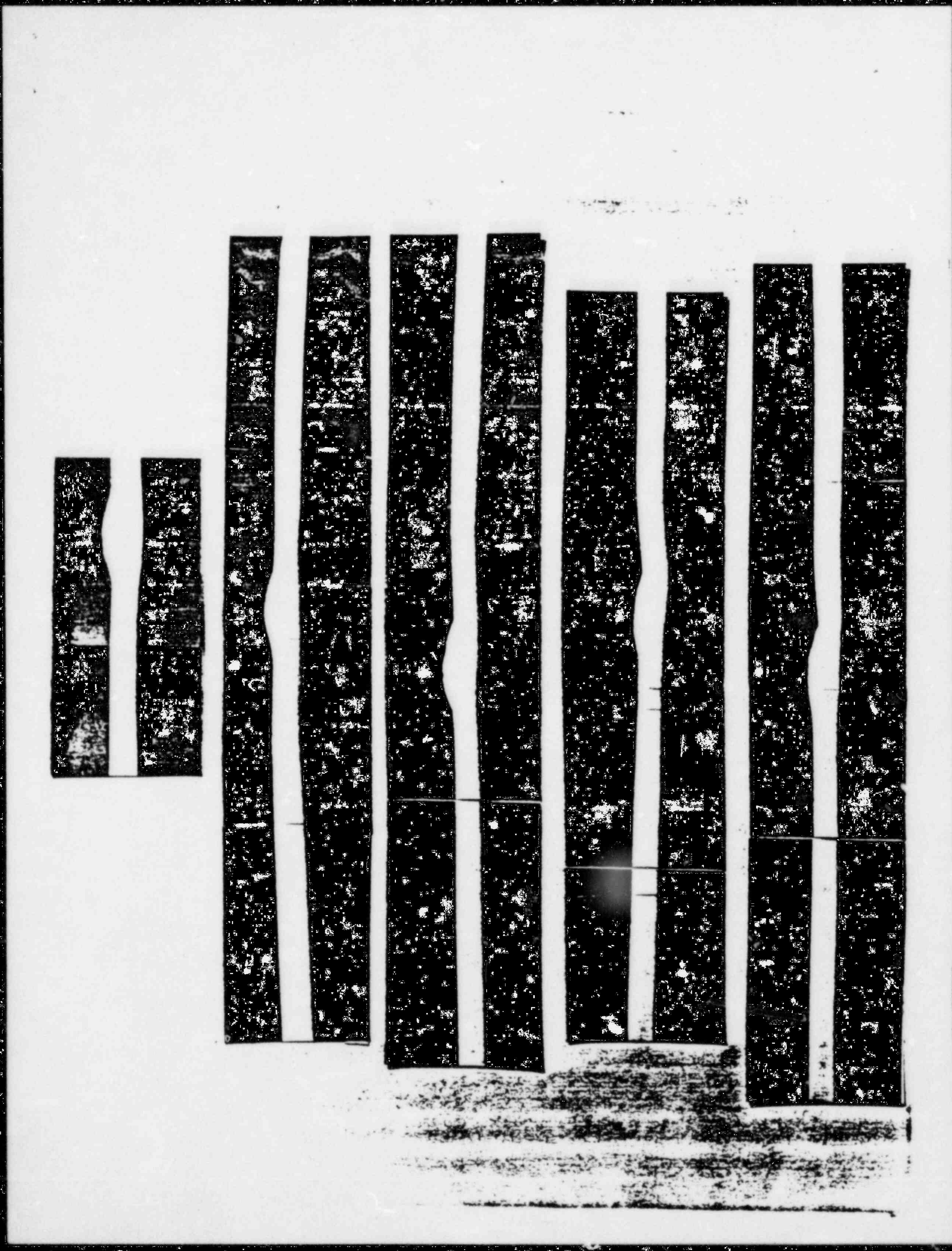

180°

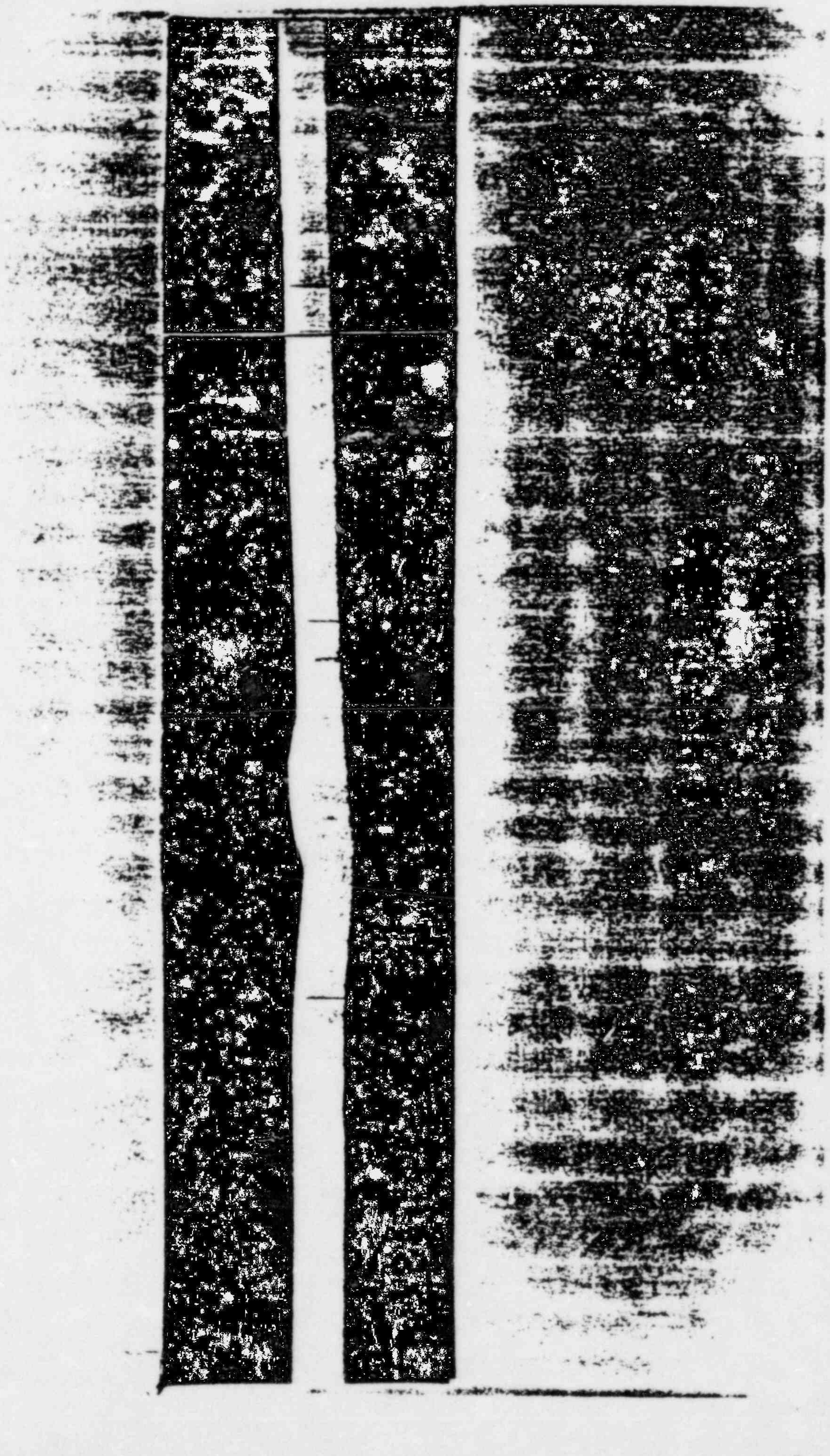

A











31846-A

100X

SAMPLE - A 1

31846-B

50X

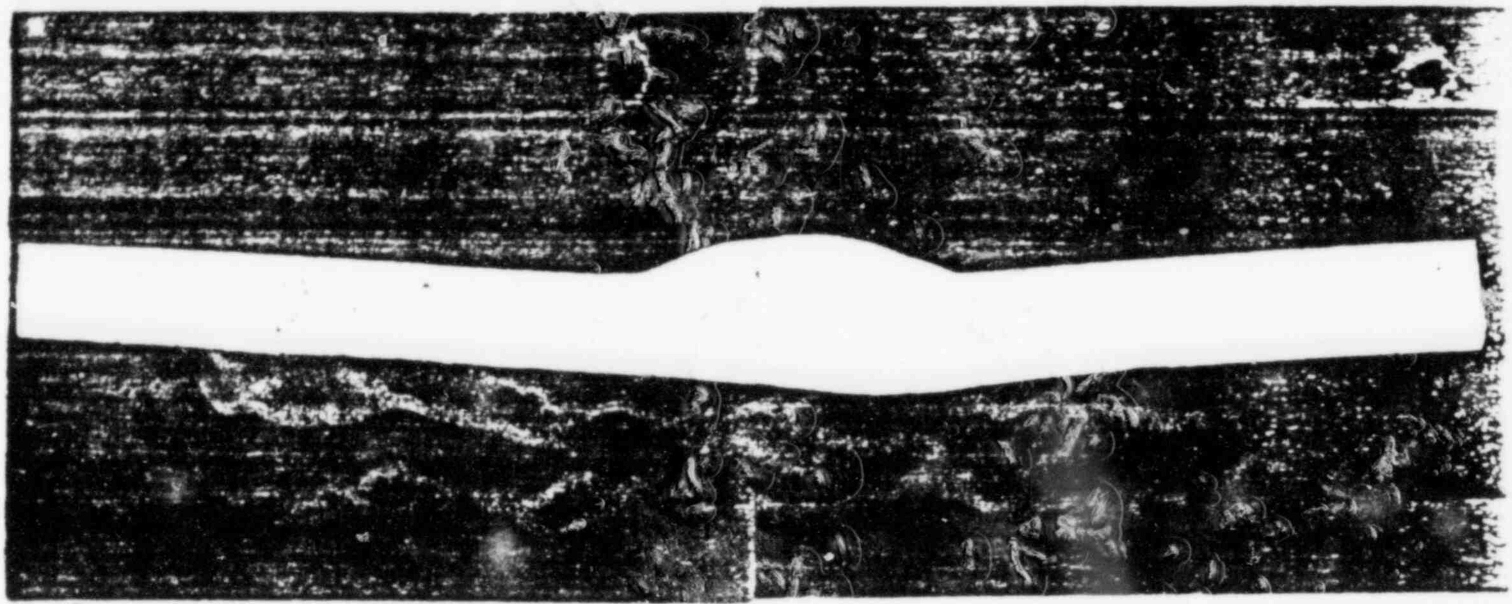
METALLOGRAPHY

31847-B 100X

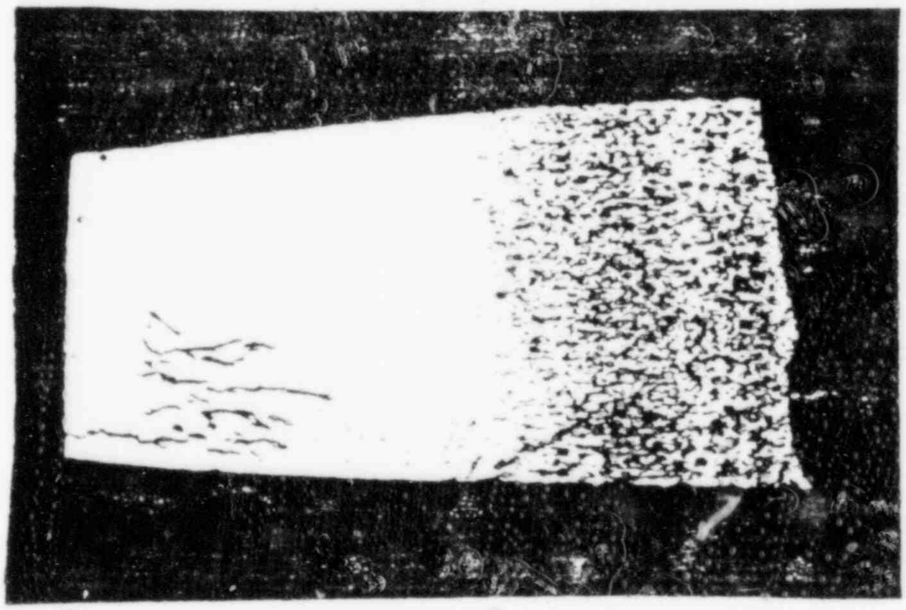
SAMPLE · C3

31847-C 100X

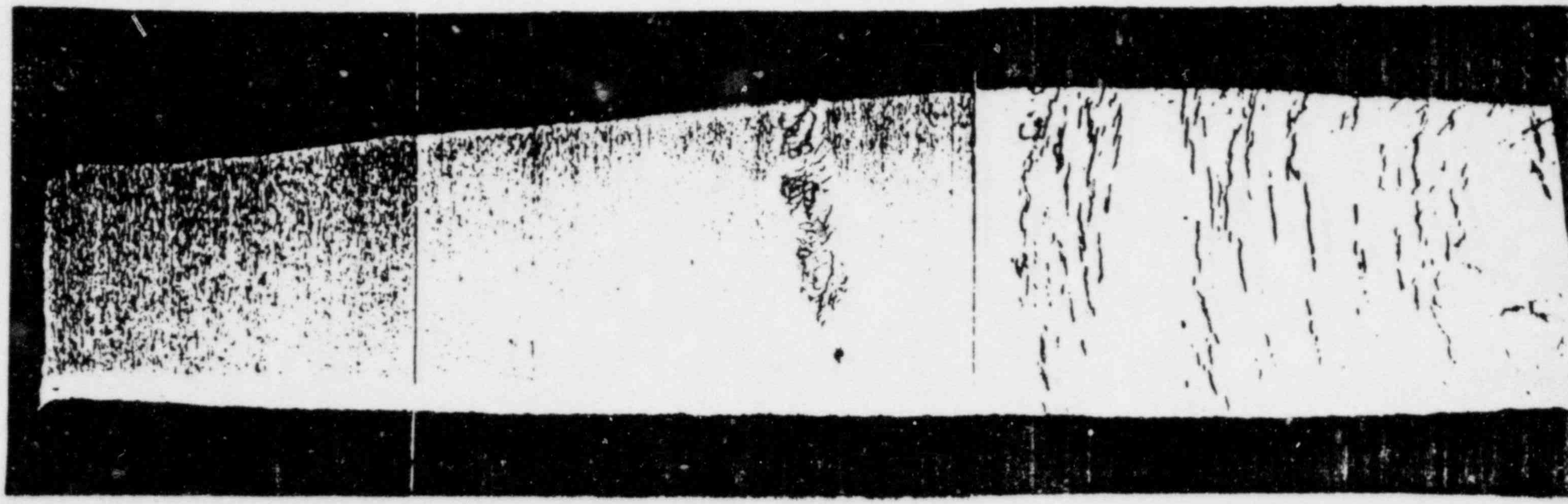
METALLOGRAPHY



34459 S-1



34460 S-2



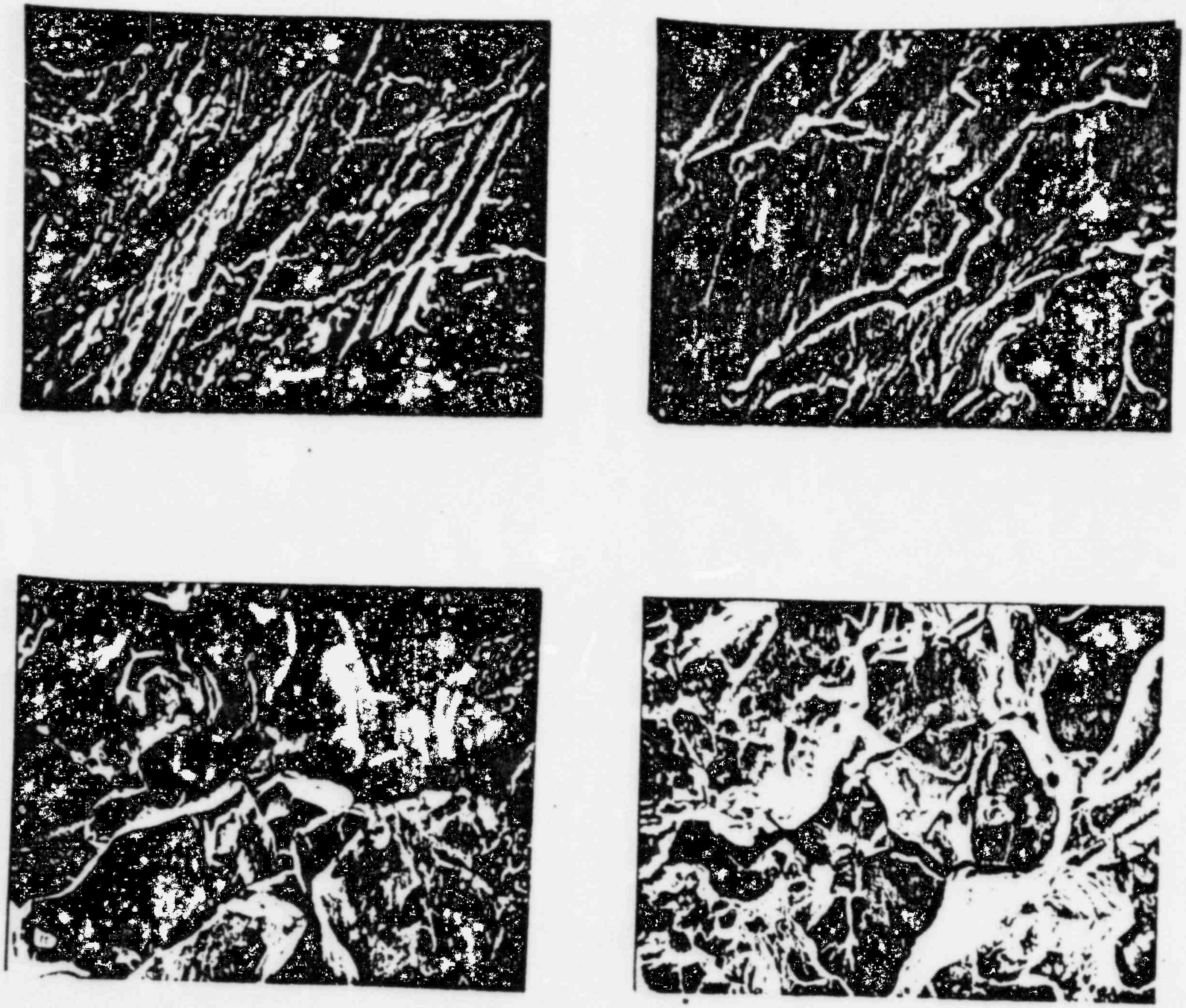
SAMPLE F-3

METALLOGRAPHY

DISTRIBUTION OF CRACKS

(METALLOGRAPHY ON AXIAL SECTIONS)

SECTION	CLOCK LOCATION	CRACKING SEVERITY
A1	0	NUMEROUS CRACKS 100% WALL THICKNESS
A2	10	NONE
A3	45	NONE
A4	90	NONE
A5	135	NONE
A6	180	NONE
A7	225	FEW CRACKS 60% WALL THICKESS
A8	270	NONE
A9	315	ONE CRACK 25% WALL THICKNESS
A10	350	NONE



SCANNING ELECTRON FRACTOGRAPHY

CHEMISTRY EVALUATIONS

1. PIPE AND ELBOW MATERIAL CONFIRMED TO THE TYPE 304 SS SPECIFICATION

2. X-RAY POWDER ANALYSIS RESULTS OF THE ID SURFACE OXIDE SHOWED

   A) BASED ON X-RAY % PEAK INTENSITY

CA	TI	CR	FE	NI	MO	ZR
0.35%	0.56	6.9	85.2	2.56	0.7	0.7

   B) CONTAMINANTS

CHLORIDES	79 PPM
SULPHATE	114 "
FLORIDES	18 "

DAILY REPORT - REGION II

DATE: MARCH 27, 1975

ACILITY	NOTIFICATION	ITEM OR EVENT	REGIONAL ACTION
ARTUP			
RKANSAS POWER AND LIGHT COMPANY NO-1 N 50-313	INSPECTOR AT SITE 3/21/75	UPDATE ON DAILY REPORT OF 11/18 AND 11/19/75 AND 1/30/75, CONCERNING LEAKS (STRESS-CORROSION CRACKS) IN THE REACTOR BUILDING SPRAY SYSTEM SCHEDULE 10 PIPING. THE LICENSEE REPORTED THAT THE PIPE SENSITIZATION MAY BE A RESULT OF MANUFACTURING TECHNIQUES BY SWEPCO, AND MAY INVOLVE A WHOLE CLASS OF PIPE. ALSO, TRACES OF CHLORIDES HAVE BEEN DETECTED IN THE RB SPRAY ADDITIVE (SODIUM THIOSULFATE FOR IODINE REMOVAL) SYSTEM LINES AND STORAGE TANK. AP&L IS INVESTIGATING THE PRESENCE OF THE CHLORIDES IN THE ADDITIVE, AND THE PRESENCE OF ADDITIVE IN THE RB SPRAY SYSTEM PIPING. FOLLOWUP REPORTS WILL BE ISSUED. INCREASED PLANT SURVEILLANCE AND INSPECTION PROGRAMS REMAIN IN EFFECT.	EVALUATE REPORTS A FOLLOWUP AT SITE.
AROLINA POWER AND LIGHT COMPANY RUNSWICK 2 N 50-324	TELECON, 3/26/75	10 DAY ADR - A LICENSEE QA AUDIT OF PIPING RECORDS REVEALED THAT THREE SECTIONS OF INSTALLED 2-INCH REACTOR DRAIN PIPE, 19 FT. LONG, HAD NOT BEEN UT INSPECTED, AS REQUIRED BY THE FSAR. THE PIPE WELDS HAD BEEN PT INSPECTED AND THE PIPE WAS HYDROSTATICALLY TESTED DURING PRIMARY SYSTEM HYDRO LICENSEE IS PERFORMING A DYNAMIC ANALYSIS AS PART OF THE 10 CFR 50.59 EVALUATION.	REVIEW REPORT AND F PER MC 2515.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NRR

MAY 16 1983

MEMORANDUM FOR: Paul Wu, Chemical Technology Section
Chemical Engineering Branch, DE

THRU: Ralph Meyer, Section Leader, Reactor Fuels Section
Core Performance Branch, DSI

FROM: Michael Tokar, Reactor Fuels Section
Core Performance Branch, DSI

SUBJECT: PRAIRIE ISLAND SPENT FUEL POOL FUEL ASSEMBLY DEGRADATION (TAC 49353)

At an April 20, 1983, work session of the group that was established to develop a staff position on the issue of the fuel assembly nozzle failure in the Prairie Island spent fuel pool (TAC 49353), you asked me to look into the safety aspects of a potential nozzle separation in an operating reactor core. The safety concern centered on the fact that at the present time there remains a possibility that the fuel assembly nozzle degradation in Prairie Island could be the result of in-reactor processes rather than the spent fuel pool environment. Specifically, the question was "could a severance occur during reactor operation, and if so, what would be the safety issues? For example, would control rod insertion be impaired?" I have had some informal discussions with Westinghouse licensing personnel on this matter, and it is my understanding that W did a safety analysis for the Prairie Island licensee, Northern States Power Company, that addressed the potential consequence of a fuel assembly nozzle separation in an operating core. That analysis, which to my knowledge has not been submitted to NRC, addressed control rod insertion and fuel coolability concerns.

In their analysis W reportedly determined that alignment between the guide tube, nozzle and grids would be retained and that loose parts would also not be a problem in the event of a separated nozzle. Alignment would be retained because (a) the Zircaloy thimble tubes will remain engaged within the sleeve portion on the top nozzle, (b) the fuel rods will maintain grid position and alignment, (c) core pins will remain engaged within the top nozzle, (d) holddown springs will maintain axial positions, and (e) grids of adjacent fuel assemblies (containing thimble plugs) will provide additional lateral support. With regard to loose parts, W says that (a) each portion of a failed sleeve would remain firmly attached to the grid and nozzle (also, each portion would be held on the Zircaloy thimble tube by the presence of the grid and nozzle), (b) any postulated grains of material freed by intergranular corrosion will not affect control rod (RCC) insertion and, (c) effects of postulated debris are already bounded by the analysis of Salem grid damage. W thus has concluded that control rod insertion would not be affected by a separated fuel assembly nozzle.

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With regard to potential coolable geometry effects, W says that (a) there is no predicted increase in the potential physical deformation of a fuel assembly as a result of a separated nozzle, (b) lateral loads at a grid sleeve failure area are all within the strength of the Zircaloy thimble tubes acting alone (i.e., alignment would be maintained with no flow blockage), (c) loads (grid impacts) are primarily absorbed by center grids, and (d) postulated loose parts are not significant enough to affect coolable geometry. Hence, W concludes that coolable geometry will not be affected by a nozzle separation.

In summary, I have at your request taken an informal, preliminary look at the potential safety issues that might exist as a result of fuel assembly nozzle separations such as the one at Prairie Island (but occurring in-core, not in the spent fuel pool). Based on discussions with W, there appears (from a W analysis) to be no problem associated with prevention of control rod insertions or flow blockages. Thus, with regard to the order of magnitude of safety concern associated with a potential nozzle separation (i.e., thimble sleeve failure in-core), there would appear to be little concern, based on what I have heard informally from Westinghouse. Of course, I have not actually reviewed any analyses, but we can at least use this information as an indication of the degree of urgency that NRC should assign to this issue. In my view, the information we have to date in no way enables us to recommend fuel assembly design or manufacturing and quality control changes, as questioned in your recent draft memorandum (copy attached), nor is there reason to think that any changes are needed at this point.

Michael Tokar

Michael Tokar, Reactor Fuels Section
Core Performance Branch, DSI

cc: C. Berlinger
V. Benaroya
D. DiIanni
C. McCracken

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

(4)

JUN 24 1983

MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: C. J. Heltemes, Jr., Director
Office for Analysis and Evaluation
of Operational Data

SUBJECT: POTENTIAL CONTAMINATION OF THE SPENT FUEL POOL AND PRIMARY REACTOR SYSTEM

A recently completed Engineering Evaluation Report on the above subject is enclosed. Our evaluation concluded that two separate events at the same plant site, which involved cracking of fuel assembly nozzles in the spent fuel pool and in piping from the boric acid storage tank to the safety injection system, are indicative of degradation that resulted from contamination of the systems. Since the postulated sources of contamination were a contaminated batch of boric acid or resin intrusion due to the recycling system, the issue is potentially generic to PWR's.

Some important aspects are that: (1) this type of contamination was not anticipated, (2) the water chemistry monitoring programs for the spent fuel pool and the primary reactor system do not analyze for sulfates, and (3) an unsuspecting licensee could inadvertently place a plant in a condition that may result in significant degradation of safety related equipment. We believe it would be prudent for NRR to consider establishment of requirements to include monitoring for sulfur contaminants in the water chemistry programs for the primary reactor system and the spent fuel pool.

C. J. Heltemes, Jr., Director
Office for Analysis and Evaluation
of Operational Data

cc: R. C. DeYoung, IE
T. E. Murley, Region I
J. P. O'Reilly, Region II
J. G. Keppler, Region III
J. T. Collins, Region IV
J. B. Martin, Region V
E. L. Jordan, IE

(Without enclosure — see FOIA-84-251 Appendix A, No. 8)

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