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XRD-113
Report Number

United States Atomic Energy Commission
Division of Technical Information

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(14) XRD-113

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BUREAU OF SHIPS GROUP

TECHNICAL INSPECTION REPORT.

(6) Operation Crossroads. U.S.S. Skate (SS305).

Classification (~~Restricted~~) (Changed to CONFIDENTIAL)
By Authority JOINT CHIEFS OF STAFF JCS 1795/36 DATED 15 APRIL 1949
By John Tulley Lt Col AFCWP Date 20 Jan 51

ATOMIC ENERGY ACT 1946
SPECIFIC RESTRICTED DATA CLEARANCE NOT REQUIRED
USE MILITARY CLASSIFICATION SAFEGUARDS

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GROUP 4
Downgraded at 3 year intervals; Declassified after 12 years

(12) 66p.

SUBMITTED:

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APPROVED:

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Captain, U.S.N.

USS SKATE (SS305)

(8)

(193600)

"This [redacted] is prohibited by law."

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Classification (Cancelled) [redacted] JOINT CHIEFS [redacted] DATED 15 APRIL 1949
By Authority of
By [redacted] 30 Jan 51

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Classification (~~Cancelled~~) (Changed to CONFIDENTIAL)
By Authority of JOINT CHIEFS OF STAFF JCS 1795/33 DATED 15 APRIL 1949
By John Galley Date Jan. 30, 1951
Lt Col. AFSWP

U.S.S. SKATE (SS305) 9c

SHIP CHARACTERISTICS

Building Yard: Mare Island Naval Shipyard.

Commissioned: 15 April 1943.

HULL

Heavy Hull Construction.
Length Overall: 311 feet 8 inches.
Length (between perpendiculars): 307 feet 0 inches.
Beam (extreme): 27 feet 3 inches.
Beam (molded): 27 feet 1 3/4 inches.
Height (lowest point of keel to top of periscope supports): 47 feet 2 inches.
Drafts (at time of test): Fwd. 15 feet 0 inches.
Aft. 15 feet 6 inches.
Standard Displacement: 1525 tons.
Displacement (at time of test): 1810 tons.

MAIN PROPULSION PLANT

Main Engines: Four Fairbanks-Morse, 9 cylinder, Type 38D8.
Auxiliary Engine: Fairbanks-Morse, 7 cylinder, Type 38D5.
Main Motors and Generators: Elliott.
Main Storage Battery: Exide.
Main Controls: Westinghouse.
Reduction Gears: Westinghouse.
Diesel Electric Drive.

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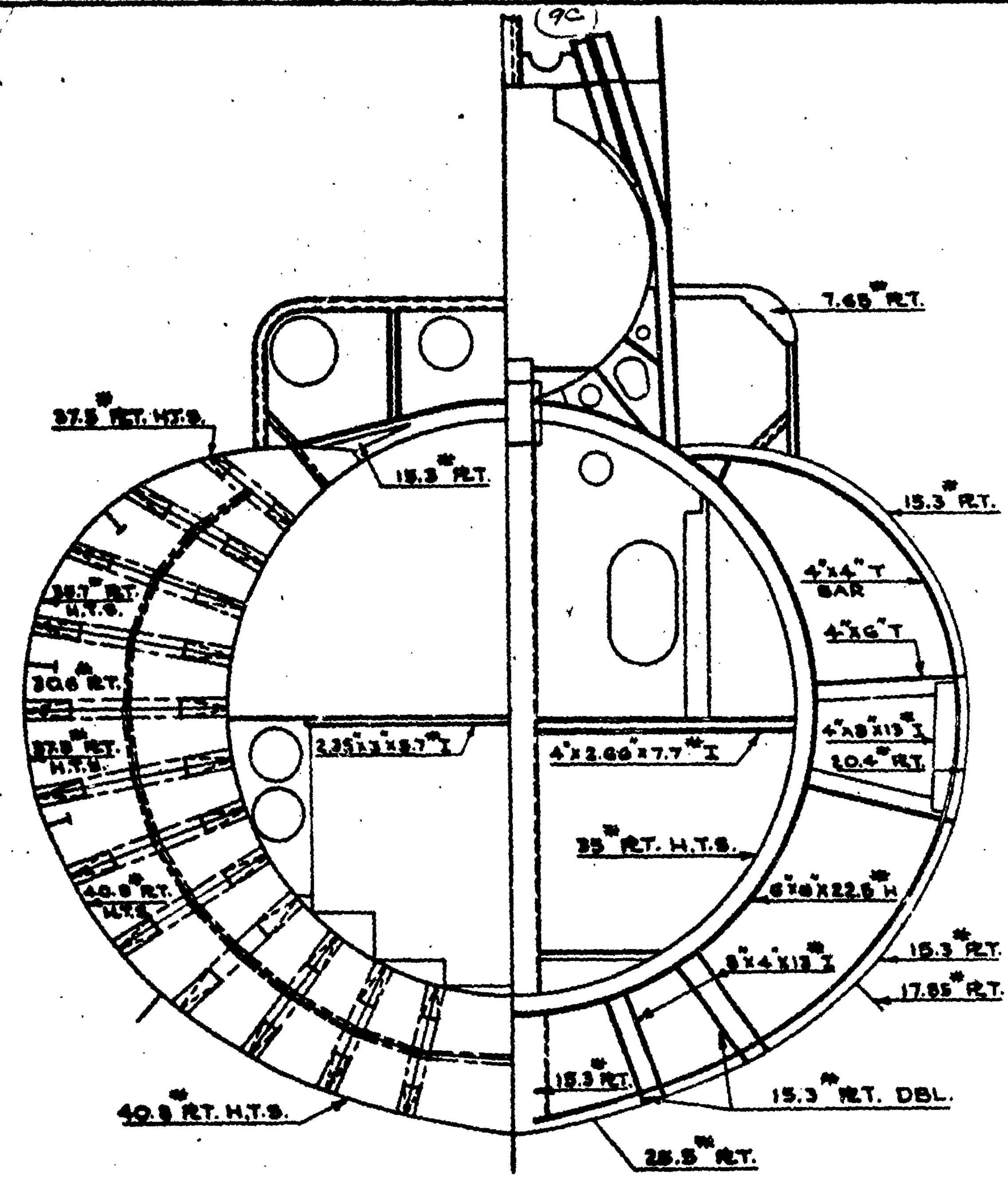
ATOMIC ENERGY ACT 1946

Classification (~~Cancelled~~) (Changed to CONFIDENTIAL)
By Authority of JOINT CHIEFS OF STAFF [illegible] DATED 15 APRIL 1949
By John [illegible] Date Jan. 30. 1951
Lt. Col. [illegible]



TYPICAL SECT. AT FR. 69
LOOKING AFT

TYPICAL SECT. AT FR. 53
LOOKING FORD.

CONFIDENTIAL

TEST B

SECRET

U.S.S. SKATE (SS 305)

RESTRICTED DATA

Classification (~~Cancelled~~) (Changed to CONFIDENTIAL)
By Authority of JOINT CHIEFS OF STAFF ... DATED 15 APRIL 1949
By John Tulley Date Jan. 30, 1951
AFSWP (9c)

TECHNICAL INSPECTION REPORT

OVERALL SUMMARY

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

The SKATE was on the surface for test B at a range of approximately 900 yards from the center of the burst. Draft and list after test were normal. There was no flooding except into safety tank through a leaking salvage air valve.

(b) Structural damage.

None.

(c) Other damage.

All main propulsion machinery has been tested and is operable as before test B.

The master gyro compass and its follow-up system were inoperable after the test.

Because of shattering of battery cell ventilation ducts, use of one battery was lost except for emergency.

The auxiliary gyro compass was found out of balance because of mercury spillage from the flotation bowl. The pickup pin which supplies power to rotors was bent.

II. Forces Evidenced and Effects Noted.

(a) Heat.

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No evidence.

(b) Fires and explosions.

No evidence.

(c) Shock.

There is evidence of some shock from below. The after battery sustained one cracked jar. Three cracked jar tops were found in each battery. About 50% of battery ventilation hard rubber ducts were broken in each battery tank. The appearance and location of the fractures as well as other evidence (loose and displaced battery wedges) indicates that the ducts were broken by an upward motion of the battery cells.

Shock caused the spillage of mercury from the auxiliary gyro compass and the bending of the pickup pin. The centering pin and the outer contact ring of the master gyro were bent. This was apparently caused by movement due to shock.

(d) Pressure.

The 'Coordinators Report on Air Blast and Water Shock, tests A and B' of 27 September 1946 indicates that the peak water pressure was approximately 1000 pounds per square inch, and the peak air pressure was approximately 6.6 pounds per square inch. Long base displacement gages located in the forward and after torpedo rooms showed that the hull was deflected toward the center axis as follows. None of these deflections exceed those which are normal at deep submergence:

	Horizontal Deflection	Vertical Deflection
Forward Torpedo Room	0.085	0.110
After Torpedo Room	0.100	0.120

(e) Any effect peculiar to the atom bomb.

The only effect noted peculiar to the atom bomb was radioactivity. The SKATE with the other submarine on the surface for test B was more radioactive than the submerged submarines and the inside of the pressure was above the radiological tolerance of 0.1 R/24 hours.

III. Effects of Damage.

(a) Effect on propulsion and ship control.

While the failure of the individual battery cell ventilation would not prevent the SKATE from discharging her batteries, it would make charging extremely hazardous as the hydrogen generated can not be effectively carried away without this ducting. Sufficient sections of ducting remain intact to equip one battery. Thus, by grouping all the intact sections in one tank, 50% of the ships submerged power can be utilized. Surfaced propulsion and ship control is not affected.

(b) Effect on gunnery and fire control.

The gyro follow-up system failure would necessitate feeding Own Ship's Course to the Torpedo Data Computer by hand.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Except for the effects of radioactivity it is considered that personnel and habitability would not have been affected by the test.

(e) Effect on fighting efficiency.

The fighting efficiency is reduced by loss of battery power for submerged operations. Temporary loss of Automatic Ship's Course feed to the Torpedo Data Computer would further reduce efficiency in a slight degree.

IV. General Summary of Observers' Impressions and Conclusions.

Except for the radiological phenomena experienced and except for the damage to the battery installation, this vessel was beyond the range of effectiveness of the bomb used in test B. The fact that no shock or other damage outside of the battery wells has been observed, leads to the conclusion that the battery cells may have been loosened by test A. However, such an effect was not noticed during the inspection after test A. For general views after test B see photographic section on pages 38 to 45.

V. Preliminary Recommendations.

The serious reduction in battery power resulting from shock damage to the ducting indicates the necessity for the following corrective measures:

(a) Redesign wedging and securing devices to prevent movement of battery cells.

(b) Fabricate ventilation ducts from a material more resistant to shock than the hard rubber ducts currently in use.

TECHNICAL INSPECTION REPORT

SECTION I - HULL

GENERAL SUMMARY OF HULL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

No flooding occurred except that 33,000 pounds of salt water flooded into safety tank as a result of venting through a leaky salvage air valve.

(b) Structural damage.

None.

(c) Other damage.

The operability of hull equipment is unaffected by the test except for the individual battery cell ventilation ducts. In the forward battery about 50% and in the after battery about 40% of the ducting is shattered, thus vitiating nearly all battery ventilation. No other ventilation is damaged.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

No evidence.

(c) Shock.

The breaking of the hard rubber individual battery cell ducts could have been caused by shock. However, the appearance and location of the fractures as well as other evidence (loose and displaced battery wedges) indicates that the ducts were broken by an upward motion of the battery cells. If this is true, shock was not the direct cause of damage to the ducts.

(d) Pressure.

The 'Coordinators Report on Air Blast and Water Shock, tests A and B' of 27 September 1946 indicates that the peak water pressure was approximately 1000 pounds per square inch, and the peak air pressure was approximately 6.6 pounds per square inch. Long base displacement gages located in the forward and after torpedo rooms showed that the hull was deflected toward the center axis as follows. None of these deflections exceed those which are normal at deep submergence:

	Horizontal Deflection	Vertical Deflection
Forward Torpedo Room	0.085	0.110
After Torpedo Room	0.100	0.120

(e) Effects apparently peculiar to the atom bomb.

Aside from radioactivity, no peculiar effects were noted.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

While the failure of the individual battery cell ventilation would not prevent the SKATE from discharging the batteries, it would make charging extremely hazardous as the hydrogen generated can not be effectively carried away without this ducting.

Sufficient sections of ducting remain intact to equip one battery. Thus, by grouping all the intact sections in one tank, 50% of the ship's submerged power can be utilized. Surfaced propulsion and ship control is not affected.

(b) Effect on gunnery and fire control.

No comment..

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Except for the effects of radioactivity it is considered that personnel and habitability would not have been affected by the test.

(e) Total effect on fighting efficiency.

The longitudinal strength, buoyancy, stability, watertight integrity and seaworthiness of the vessel and the operability of hull equipment were not affected by the test. The fighting efficiency is reduced about 15% by the inability to utilize power from both batteries simultaneously.

IV. General Summary of Observers' Impressions and Conclusions.

Except for the radiological phenomena experienced and except for the damage to the battery installation, this vessel was beyond the range of effectiveness of the bomb used in test B. The fact that no shock or other damage outside of the battery wells has been observed, leads to the conslusion that the battery cells may have been loosened by test A. However, such an effect was not noticed during the inspection after test A.

V. Preliminary Recommendations.

The peculiarly localized nature of the damage suffered by the SKATE in test B highlights a serious weakness. The damage is actually minor in nature, being confined almost solely to the individual battery cell ventilation, yet 50% of the ships submerged power is incapacitated. Had the ventilation ducts been fabricated from some pliable material it is probable that they would still be intact. With wartime advance in plastics available, there should be no difficulty in replacing the brittle hard rubber ducts with some tough, pliable material capable of absorbing considerable motion of the cells without failure, yet retaining the other desirable characteristics. For any future battery installations in submarines, it is recommended that such material be utilized for individual cell ventilation ducts.

DETAILED DESCRIPTION OF HULL DAMAGE

A. General Description of Hull Damage.

No damage except as covered in Item M.

B. Superstructure.

No damage.

C. Turrets, Guns and Directors.

No damage.

D. Torpedo Mounts, Depth Charge Gear.

No damage.

E. Weather Deck.

No damage.

F. Exterior Hull.

No damage.

G. Interior Compartments (above w.l.).

No damage.

H. Armor Decks and Miscellaneous Armor.

Not applicable.

I. Interior Compartments (below w.l.).

No damage.

J. Underwater Hull.

No damage.

No damage.

L. Flooding.

None.

M. Ventilation.

None of the ventilation system is damaged except the individual battery cell ducting. In the forward battery about 50% and in the after battery about 40% of the cell ventilation ducts are broken. The majority of the damage is confined to the two outboard rows of cells in each battery. These rows are closest to the deck above. Nearly all the failures occurred at the Tee connection where each riser joints into the common main. Such damage can be explained by assuming an upward movement of the cells until the ventilation duct main struck the deck above (in the case of the outboard rows of cells), or until the rigidity of the duct mains applied an appreciable resisting force to hold the top of the risers down. In the rows other than outboard, which could hardly have moved far enough to strike the deck above, such motion would have to be either very sudden, causing shock loading on the ducts, or would have to be relative motion between the adjacent cells. The concept of relative or successive motion of the cells is difficult to accept, yet is strengthened by the fact that numerous wooden wedges were found projecting above the cell tops, two to four inches, a phenomenon that can also be explained by relative motion of the adjacent cells. Excessive rolling or pitching might cause certain cells, whose wedges were slightly looser than others, to move 'up', yet the maximum roll is believed to have been only 16 degrees and other items in the ship do not indicate excessive roll. For photographs of the damage see Photographic Section, pages 47 to 53.

While the nature of the cause of the damage appears to be undeterminate, the remedy is clear. Construct the individual cell ventilation ducts of some tough, pliable material capable of absorbing sudden relative motion rather than of brittle hard rubber.

N. Ship Control.

No damage.

O. Fire Control.

No damage.

P. Ammunition Behavior.

No damage.

Q. Ammunition Handling.

No damage.

R. Strength.

No damage.

S. Miscellaneous.

No comment.

T. Coverings.

No damage.

U. Welding and Rivetting.

No damage.

TECHNICAL INSPECTION REPORT

SECTION - MACHINERY

GENERAL SUMMARY OF MACHINERY DAMAGE

I. **Target Condition After Test.**

(a) Drafts after test; list; general areas of flooding, sources.

The SKATE was on the surface for test B. Draft and list after test were normal. There was no flooding.

(b) Structural damage.

None observed from test B.

(c) Other damage.

All machinery has been tested and is operable as before test B.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence of heat was noted.

(b) Fires and explosions.

No evidence of fires nor explosions was noted.

(c) Shock.

There is evidence of some shock from below. The after battery sustained one cracked jar. Four cracked jar tops were found in the forward battery and three cracked jar tops were found in the after battery. About 50% of battery ventilation hard rubber ducts were broken in each battery tank. The master gyro compass was made inoperable due to shock. No damage from shock occurred to machinery.

(d) Pressure.

No evidence of unusual pressure was noted.

(e) Effects apparently peculiar to the atom bomb.

The only effect noted peculiar to the atom bomb was radioactivity. The SKATE, along with the other submarine on the surface, was more radioactive than the submerged submarines and the inside of the pressure hull was above radiological tolerance.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

None.

(b) Effect on gunnery and fire control.

None.

(c) Effect on watertight integrity and stability.

None.

(d) Effect on personnel and habitability.

Habitability unaffected. Radiological effect on personnel is beyond the writers ability to estimate and a matter for the radiological experts. Personnel injuries may have occurred as a result of shock.

(e) Total effect on fighting efficiency.

Shock damage to battery ventilation is not considered to have reduced fighting efficiency although the overcoming of the damage would have placed an increased work load on ship's force. Shock damage to master gyro compass slightly reduced fighting efficiency in that Own Ship's Head would have had to be introduced into Data Computer by hand.

IV. General Summary of Observers' Impressions and Conclusions.

No damage was sustained by the SKATE to machinery as a result of test B. The SKATE apparently suffered an appreciable shock from below.

V. Preliminary Recommendations.

A redesign of wedging and securing of main storage batteries to prevent movement upward against heavy shock from below should be undertaken.

DETAILED DESCRIPTION OF MACHINERY DAMAGE

A. General Description of Machinery Damage.

(a) Overall condition.

Above radiological tolerance for continuous exposure inside and topside but otherwise undamaged.

(b) Areas of major damage.

Undamaged.

(c) Primary cause of damage in each area of major damage.

Undamaged.

(d) Effect of target test on overall operation of machinery plant.

None. All machinery operable, tested and in same condition as before target test.

B. Boilers.

Not applicable.

C. Blowers.

Not applicable.

D. Fuel Oil Equipment.

No damage.

E. Boiler Feedwater Equipment.

Not applicable.

F. Main Propulsion Machinery.

No damage.

G. Reduction Gears.

No damage.

H. Shafting and Bearings.

No damage.

I. Lubrication System.

No damage.

J. Condensers and Air Ejectors.

Not applicable.

K. Pumps.

No damage.

L. Aux. Generators (Turbines and Gears).

Discussed under Item F.

M. Propellers.

No damage.

N. Distilling Plant.

No damage.

O. Refrigeration Plant.

No damage.

P. Winches, Windlasses and Capstans.

No damage.

Q. Steering Engine.

No damage.

R. Elevators, Ammunition Hoists, etc.

Not applicable.

S. Ventilation (Machinery).

No damage.

T. Compressed Air Plant.

No damage.

U. Diesels (Generators and Boats).

Not applicable. See Item F.

V. Piping Systems.

No damage.

W. Hydraulic System.

No damage.

X. Navigational Instruments.

No damage.

Y. Periscopes.

No damage.

Z. Radar and Sonar.

No damage.

AA. Miscellaneous.

None.

SECTION III - ELECTRICAL

GENERAL SUMMARY OF ELECTRICAL DAMAGE

I. Target Condition After Test.

(a) Drafts after test; list; general areas of flooding, sources.

Not observed.

(b) Structural damage.

There was no structural damage which contributed to electrical damage.

(c) Damage.

The significant electrical damage was confined to the propelling storage batteries, the master gyro compass and its follow-up system, and the auxiliary gyro compass. The shattering of battery vent ducts rendered both batteries inoperable, except in emergencies, until temporary repairs were effected in one battery well so as to permit operating this battery. The gyro compass equipment was rendered inoperable until temporary repairs were effected to restore operation of the master gyro compass and its follow-up system.

II. Forces Evidenced and Effects Noted.

(a) Heat.

No evidence.

(b) Fires and explosions.

None.

(c) Shock.

Shock was the cause of all electrical damage except the derangement to the master gyro follow-up system. Shock damage consisted essentially of mercury spillage from the auxiliary gyro compass, bending of pins in both gyro compasses, extensive shattering of battery vent ducts, failure of battery tie-rods, displacement of battery cells and wedges, and the cracking of battery cell tops. One battery jar was also cracked. Cell breather caps and deck plating in the battery compartments were dislodged.

Maximum shock damage occurred in the battery wells and was due to underwater shock impulses which apparently exerted maximum force in a vertical direction. Most of the damage to battery vent ducts was probably caused indirectly by impact from dislodged cells and from contact with hull structure.

(d) Pressure.

There was no evidence of pressure damage.

(e) Any effects apparently peculiar to the atom bomb.

None other than radioactivity.

III. Effects of Damage.

(a) Effect on machinery, electrical and ship control.

There was no effect on surface propulsion or ship control. The damage to the battery vent ducts would make charging of batteries extremely hazardous as the hydrogen generated could not be effectively carried away without the duct work. Sufficient lengths of undamaged vent ducts remained in both battery wells to restore the vent ductwork in one battery well. Thus, by grouping all the intact lengths of ducts in one well, fifty percent of the ship's propelling battery capacity could be utilized when submerged.

(b) Effect on gunnery and fire control.

Automatic feed of Own Ship's Course to the torpedo data computer was temporarily inoperable.

(c) Effect on watertight integrity and stability.

None from an electrical standpoint.

(d) Effect on personnel and habitability.

None.

(e) Effect on fighting efficiency.

The fighting efficiency of this ship would be reduced by the inability to use both propelling batteries when submerged. The temporary loss of automatic feed of Own Ship's Course to the torpedo data computer would also have impaired fighting efficiency somewhat.

IV. General Summary of Observers' Impressions and Conclusions.

This ship was located on the surface at a distance sufficiently close to the atom bomb to experience appreciable damage to its propelling batteries and vent ductwork as a result of the underwater shock impulses. With the exception of gyro compass equipment, other electrical equipment was not affected.

V. Preliminary Recommendations.

The methods of securing propelling batteries in the wells and the battery duct installation should be improved to prevent displacement and damage due to shock. A material more shock resistant than hard rubber should be employed for battery vent ducts, if practicable.

The sensitive relay coil for the master gyro compass follow-up system should be designed to withstand increased voltage and current. Consideration should be given revising the follow-up circuits so that failure of the sensitive relay coil will not de-energize the gyro follow-up system.

DETAILED DESCRIPTION OF ELECTRICAL DAMAGE

A. General Description of Electrical Damage.

(a) Overall Condition.

All electrical equipment not damaged or inoperable prior to test B was intact and operable with the exception of the master gyro compass and its follow-up system, the auxiliary gyro compass, the propelling batteries and the battery vent duct work. Partial or complete repairs of damaged equipment could be effected by the ship's crew.

(b) Areas of major damage.

The two battery wells were the areas of major electrical damage.

(c) Primary causes of damage in each area of major damage.

The primary cause of electrical damage was shock transmitted through the water.

(d) Effect of target test on overall operation of electrical plant.

1. Electrical propulsion.

No effect. Operable.

2. Main storage batteries.

Operability reduced primarily due to damage to battery ventilation duct work.

3. Auxiliary power.

Operable.

4. Communications.

Operable except as impaired in test A.

5. Fire control circuits.

Operable except for loss of feed of Own Ship's Course to the torpedo data computer caused by a derangement to the master gyro compass follow-up system, and damage suffered in test A.

6. Lighting.

Operable except for damage suffered in test A.

7. Ventilation.

Operable except for battery ventilation.

(e). Types of equipment most affected.

The propelling batteries and gyro compass equipment were the types of electrical equipment affected.

B. Electrical Propulsion Rotating Equipment.

No damage.

C. Electric Propulsion Control Equipment.

No damage.

D. Generators - Ships Service.

Not applicable.

E. Generators - Emergency.

Not applicable.

F. **Switchboards,** Distribution and Transfer Panels.

No damage in test B.

G. **Wiring, Wiring Equipment and Wireways.**

No damage in test B.

H. **Transformers.**

No damage.

I. Submarine Propelling Batteries.

Both batteries were fully charged and on open circuit during the test. Damage experienced during test A had been repaired by the ship's crew.

The damage suffered by the propelling batteries in test B was caused by underwater shock, which apparently acted with maximum force in a vertical direction. The shock was sufficient magnitude to displace cells vertically but not sufficient to break lighting fixtures secured to the overhead in the battery wells.

Analysis of electrolyte samples removed from two cells in each battery after the test was made by Pearl Harbor Naval Shipyard. This analysis revealed significant change attributable to the atom bomb.

In order to evalute more completely the damage to the cells, and to determine if the battery tank lining or the tank itself was damaged, ten cells were removed. These ten (Nos. 17A through 23A, 58A and 67A) comprised two groups of adjacent cells in the after battery, so chosen as to include the most seriously damaged cells, and also to permit inspection of the tank in those areas where damage to the rubber or steel would be most likely to have occurred. None was pulled in the forward battery as it was considered that the condition of the after battery was representative of the two locations.

Damage suffered by the propelling batteries is detailed below.

Forward Battery.

(a) Jars.

The tops of cells 11, 12, 26 and 27 were cracked. There was no evidence that any of the jars were cracked. Cells 34, 35 and 36 were permanently displaced about one-fourth inch higher than other cells. However, many of the other cells apparently had moved upward and then settled in their original positions. There was no evidence that any cell plates had moved with respect to the jars in which they were contained. Cells 38 and 39 were warped.

(b) Covers.

Practically all cell breather caps were dislodged except in those rows in the center covered with deck plates. Some of the deck plates over the two center rows of cells were displaced and those over cells 44 to 46 and over cells 66 and 67 were broken. Damage in the later instance was apparently from impact with the ion exchanger, as shown in photograph on page 46.

(c) Wedges and strongbacks.

Nine tie-rods were damaged. The damage varied, but included nuts stripping off, and tie-rods shearing, bending or pulling through the longitudinal channels. In other cases the tie-rods were bent by the upward motion of the wedges and the nuts and washers pulled through the holes in the strongbacks. This damage was not localized. A broken tie-rod is shown in photograph on page 47. Photograph on page 56 shows a typical tie-rod after a failure of the latter variety. It appears that an increase in the scantlings of the tie-rods is in order.

The wedges along the inboard side of the port and starboard second rows of cells were found loose and many extended to as much as four inches above the cell tops. These wedges were displaced higher, in general, on the port side than on the starboard side. Practically all other wedges were loose. Displaced wedges are shown in photographs on pages 50 to 53.

The two lengths of angle iron between cells 27 and 28 and between 34 and 35 were deformed.

(d) Busbars and cell connections.

Busbar connections were deformed between cells 36 and 37, and between cells 89 and 90.

(e) Acid spillage.

A quantity of acid spilled from each cell when breather caps were dislodged.

(f) Ventilation duct work.

The main vent duct running longitudinally along the overhead at the centerline of the well and the forward transverse duct were not damaged. The after transverse duct was pulled loose at the soft rubber joint located on the starboard side, but was not otherwise damaged. The vertical ducts were not damaged; however, many were displaced and one riser, located on the starboard side forward near cell 68, were completely dislodged. The above conditions are shown in photographs on pages 47, 48 and 49.

The vertical risers referred to above connect to the cell ducts running fore and aft along each row of cells by means of Tee sections. These Tee sections shattered on the port side forward, on the starboard side forward between the two inboard rows of cells, and on the port and starboard sides aft at the outboard rows of cells. This breakage was confined to the Tee sections and is shown in photographs on pages 47 and 51.

The cell ducts running fore and aft along each row of cells connect the individual cells by means of 'goosenecks' were shattered all along the outboard rows of cells. Those in the forward port corner appeared more completely shattered, although the damage was extensive along the starboard outboard row of cells also. The longitudinal cell ducts for the center two rows of cells were broken in several locations at the Tee section joints, and 'goosenecks' connecting to the ducts were loosened. However, about 90 percent of the damage to the cell ducts was confined to the outboard ducts. These conditions are shown in photographs on pages 47 to 51.

The collar on cell 63 'gooseneck' was broken.

After Battery.

(a) Jars.

The tops of cells 20, 25 and 64 were cracked. The jar for cell 17 was cracked and would not hold electrolyte. None of the cells were permanently displaced, although many of them apparently had moved upward and then had settled in their original positions. There was no evidence that any cell plates had moved with respect to the jars in which they were contained.

The outsides of the jars of the ten cells pulled were carefully examined. The cells were then steamed and the elements pulled for inspection of the connection, plates, separators and active materials. In all cells the separators and positive grids were in excellent condition. There was only 1/2 to 5/8 inch of sediment in the bottom of the jars, a normal amount for a battery having 17 cycles. The only damage found was in the laminated rubber jars of cells 17A, 22A and 58A. When the cells were thrown upward, a small shipfitters bolt, (about 1/2" x 1 3/4") rolled under cell number 17A. The remains of the bolt are shown in photograph on page 57 and the hole it punched in the bottom of the jar is shown in photograph on page 54. In addition, the jar of this cell was cracked at one top corner and is shown in photograph on page 55 one bottom corner, shown in photograph on page 59 and had an almost continuous crack around all four sides about 1/2 inch from the bottom. Cell 22A had a 4 inch crack in the bottom corner, see photograph on page 58 and cell 58A had cracks in the top and bottom corners similar to those in 17A.

(b) Covers.

Many cell breather caps were dislodged and deck plates over the two center rows of cells were displaced. The deck plate over cell 80 was broken.

(c) Wedges and strongbacks.

Some wedges moved upward, although not as high as in the forward well. Displaced wedges were higher on the port side than on the starboard side. Practically all other other wedges were loose. Displaced wedges are shown in photographs on pages 50 to 53.

(d) Busbars and cell connections.

A total of seven cell busbar connections were deformed.

(e) Acid spillage.

A quantity of acid spilled from most of the cells when the breather caps were dislodged.

(f) Ventilation duct work.

The main centerline and the forward and after transverse ducts, all of which are secured to the overhead, were not damaged. However, one section of the forward transverse duct on the port side was dislodged and had dropped on the deck plating without breaking. Another section of the after transverse duct on the port side was dislodged and had dropped on the outboard row of cells. The vertical ducts or risers which connect to the transverse ducts were not damaged, but a few were slightly displaced. The Tee sections which connect the outboard risers to the transverse ducts were shattered. The above conditions are shown in photographs on pages 52 and 53.

The Tee sections which connect the risers with the cell ducts running fore and aft were shattered at the outboard cell ducts. The outboard rows of cell ducts were almost completely shattered. No shattering and only slight damage, such as loosening of 'goosenecks', occurred along the other rows of cell ducts.

The ion exchanger was broken at the top.

The two groups of cells pulled were located in the forward starboard corner and the forward center section of the after battery tank. After removal, the rubber lining in each location was carefully examined visually but no signs of damage were found. The steel below the rubber was not distorted. The outside of the pressure hull in way of both battery tanks was also inspected without finding any evidence of distortion. From this it is concluded that the battery cells were thrown upward by a general motion of the hull or by the transmission of the shock force through the hull without local deflections of the structure.

Comments.

The damage suffered in the forward battery well was more severe than in the after well, but in each well the damage was similar in nature.

The cracked cell tops probably were caused by the fact that the rigid busbar connections tended to resist the movement of the cells under shock. On the other hand, it is possible that the busbar connections may also have held the cell plates from being displaced out of their jars.

The most extensive damage to cell ducts occurred in the outboard rows where the clearance to the overhead is only four to five inches. Shattering of these ducts was apparently due to impact with the overhead as the ducts were jarred upward by the cells.

The ship's crew, with the assistance of the tender USS FULTON, collected sufficient lengths of unbroken vent duct work from both battery wells to repair the vent system in one battery well.

Recommendations.

Supplementing the recommendations noted in test A Technical Inspection Report for the USS SKATE, the following additional recommendations are considered warranted on the basis of the additional data obtained from test B:

1. The method of securing battery jars should be improved to prevent displacement of the jars and wedges under shock and possible displacement of cell plates from the jars.

2. The use of more flexible intercell connections should be considered with a view toward preventing the cracking of cell tops.

3. Battery vent duct work should be secured more sturdily to prevent dislodgement under shock.

4. A material more shock resistant than hard rubber should be employed for battery vent ducts, if practicable.

J. Portable Batteries.

Not applicable.

K. Motors, Motor-Generator Sets and Motor Controllers.

No damage in test B.

L. Lighting Equipment.

No damage in test B.

M. Searchlights.

The 12'' searchlight had been removed prior to test A and placed inside the conning tower.

N. Degaussing Equipment.

Not applicable.

O. Gyro Compass Equipment.

(a) Master.

Shock caused the centering pin and the outer contact ring of the master gyro compass to bend. After the ship's force had effected repairs and the compass operated it was discovered that the gyro follow-up system would not function. The trouble was found to be due to an open circuit in the coil of the sensitive relay which actuates a gyro alarm circuit. The compass is an Arma Mark VII, Model 3 unit. The relay is Arma part No. 50377-2, with name plate data: Ward Leonard, 8.06 volts, D-C Catalogue No. 251-40.

Visual inspection revealed no evidence of shock damage to the relay. It is believed that the relay coil failed due to an over voltage or over-current in the follow-up circuits, possibly caused by moisture grounds. When the relay coil was by-passed, the follow-up system operated but without the gyro alarm functioning. A similar failure occurred on two other submarines after test B.

Recommendations.

The sensitive relay coil should be given to revising the follow-up circuits so that failure of the sensitive relay coil will not de-enertize the gyro follow-up system.

(b) Repeaters.

No damage in test B.

(c) DRT and DRA.

No damage in test B.

(d) Auxiliary.

The auxiliary gyro compass was found to be out of balance because of mercury spillage from the flotation bow. The pick-up pin was bent. This type of Arma compass is susceptible to mercury spillage under shock as similar failures have occurred on other target submarines in test A and B. However, it is understood that this compass is now .bsolete.

P. Sound Powered Telephones.

No damage.

Q. Ship's Service Telephones.

Not applicable.

R. Announcing Systems.

No damage in test B.

S. Telegraphs.

No damage.

T. Indicating Systems.

No damage.

U. I.C. and A.C.O. Switchboards.

No damage.

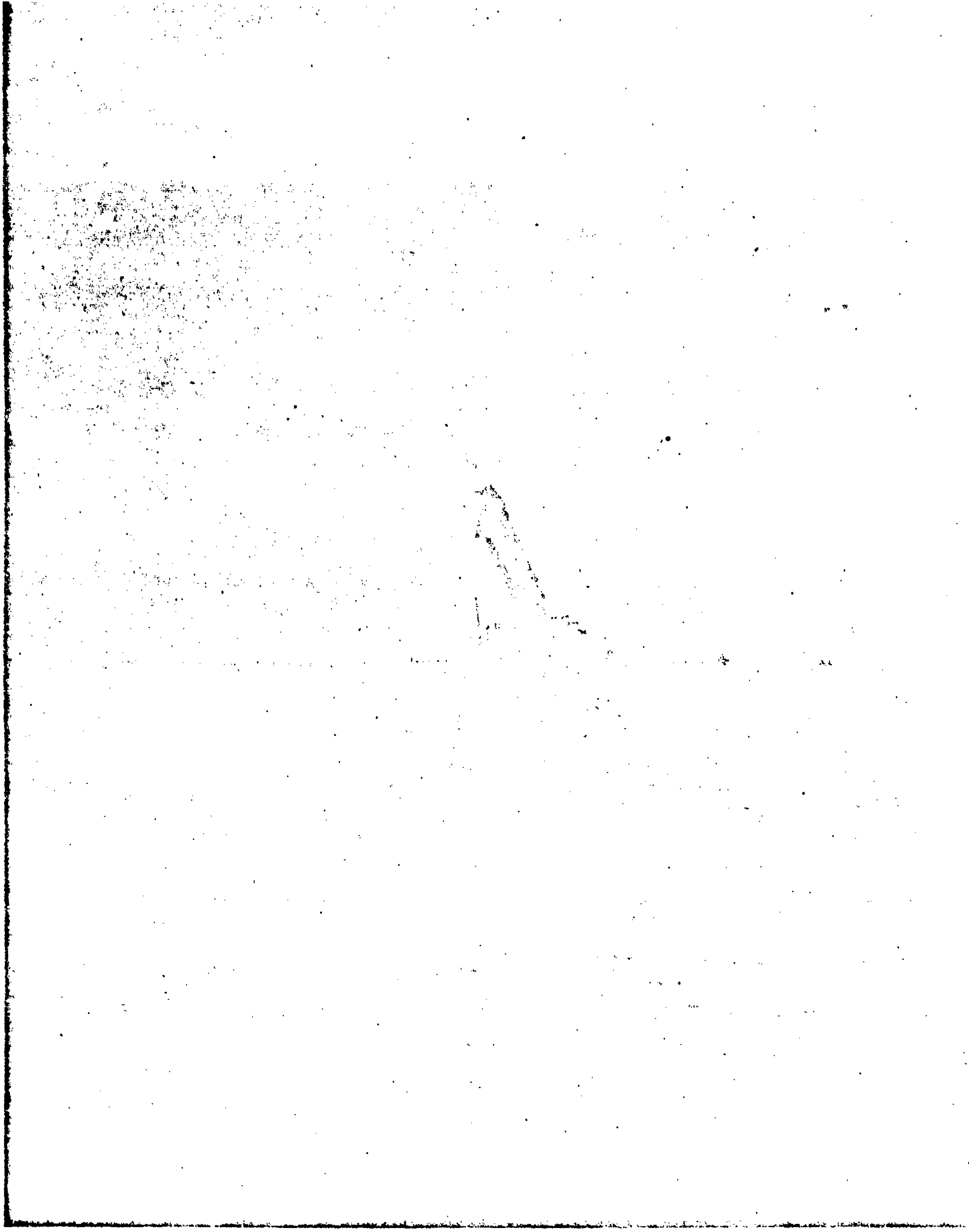
U. F.C. Switchboards.

No damage.

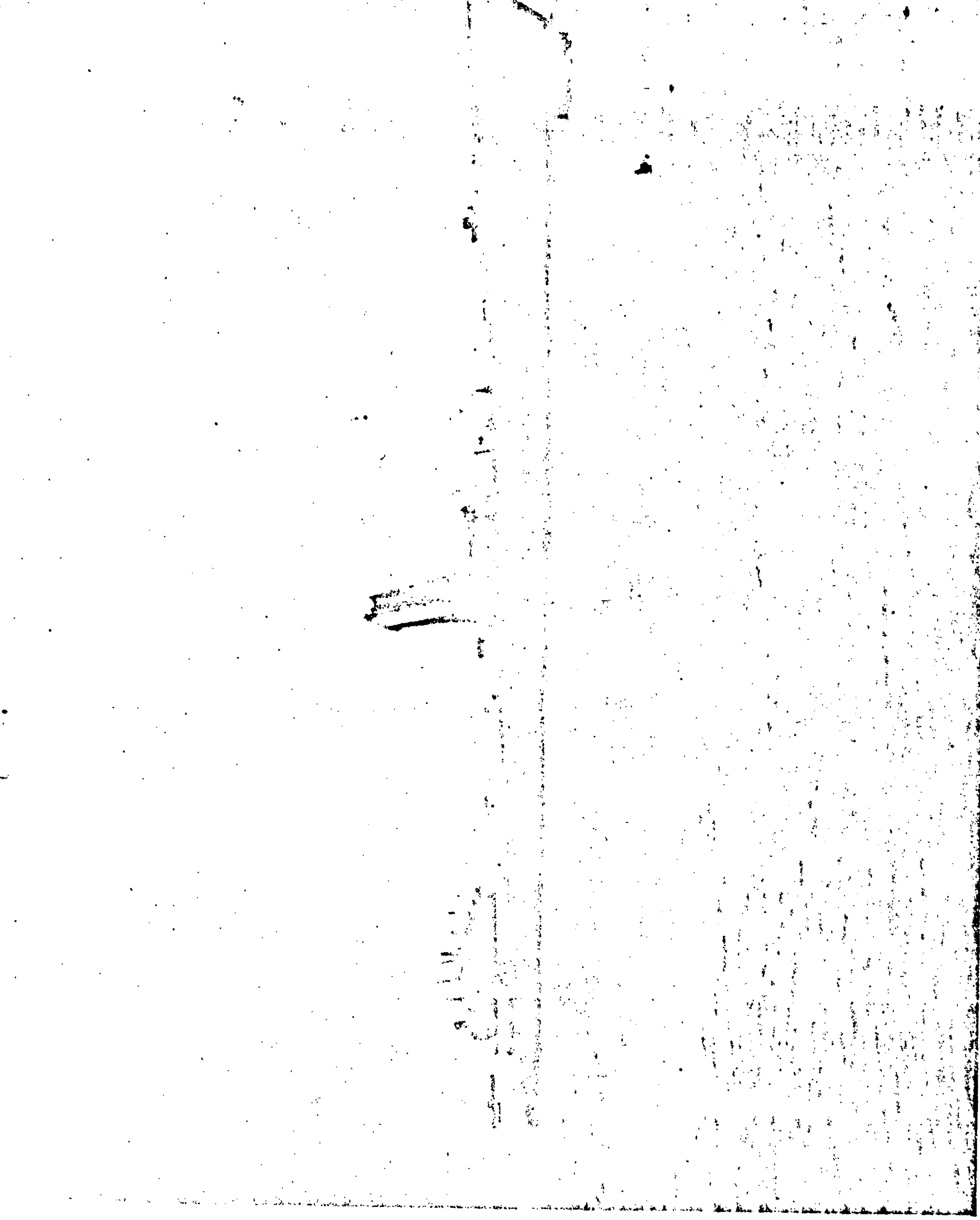
SECTION IV

PHOTOGRAPHS

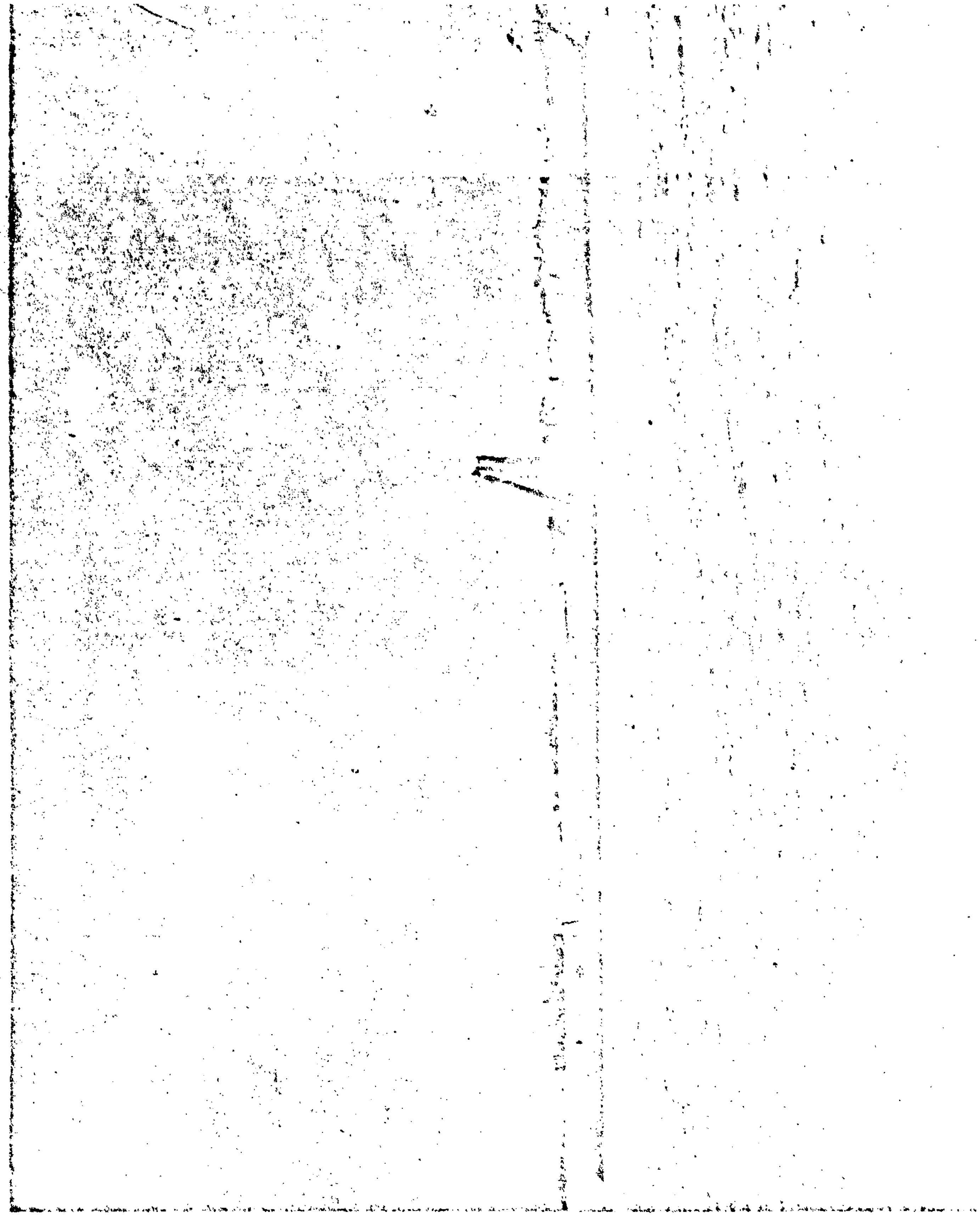
TEST BAKER



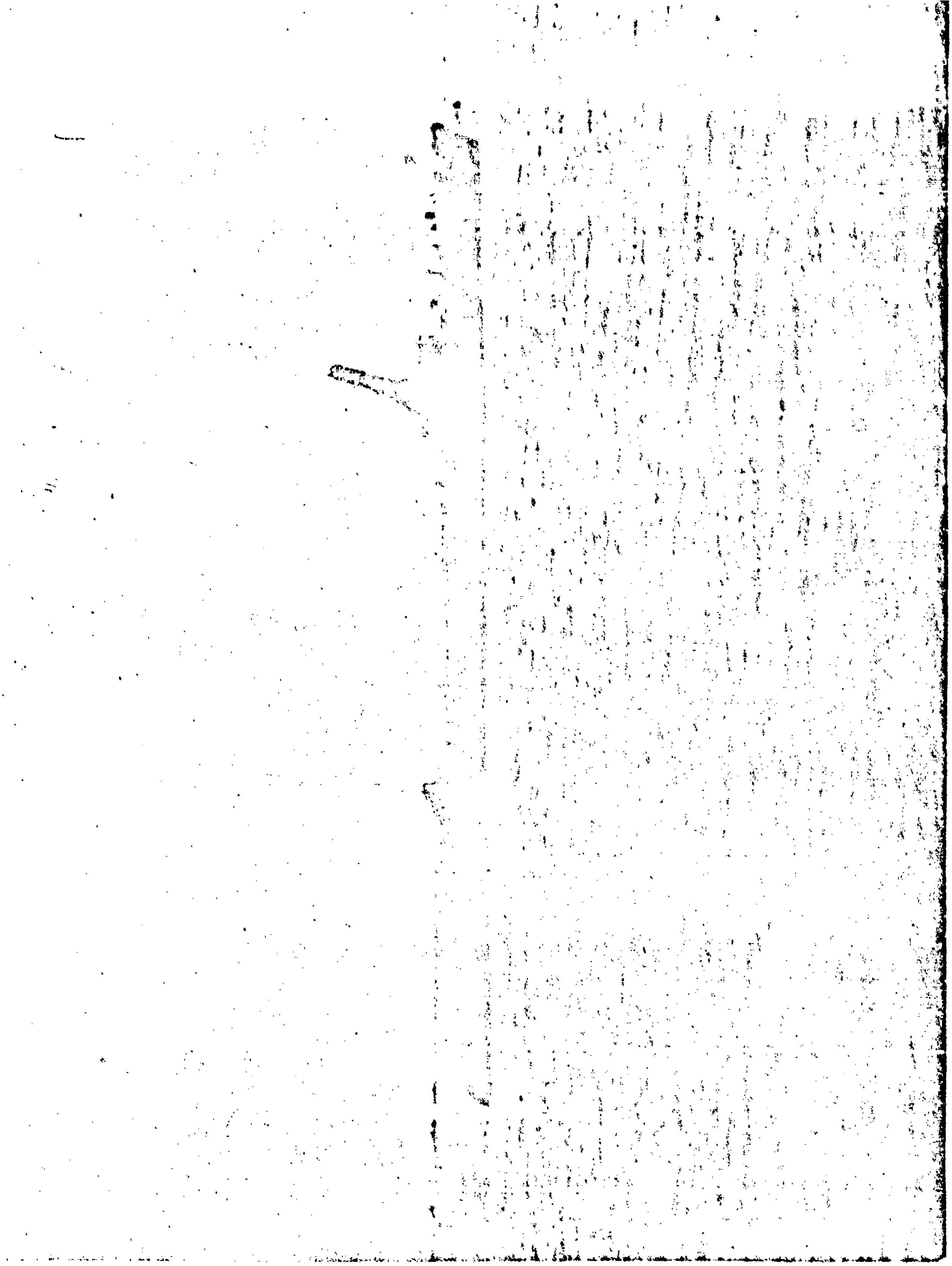
AB-CR-227-290-44. General view from ahead.



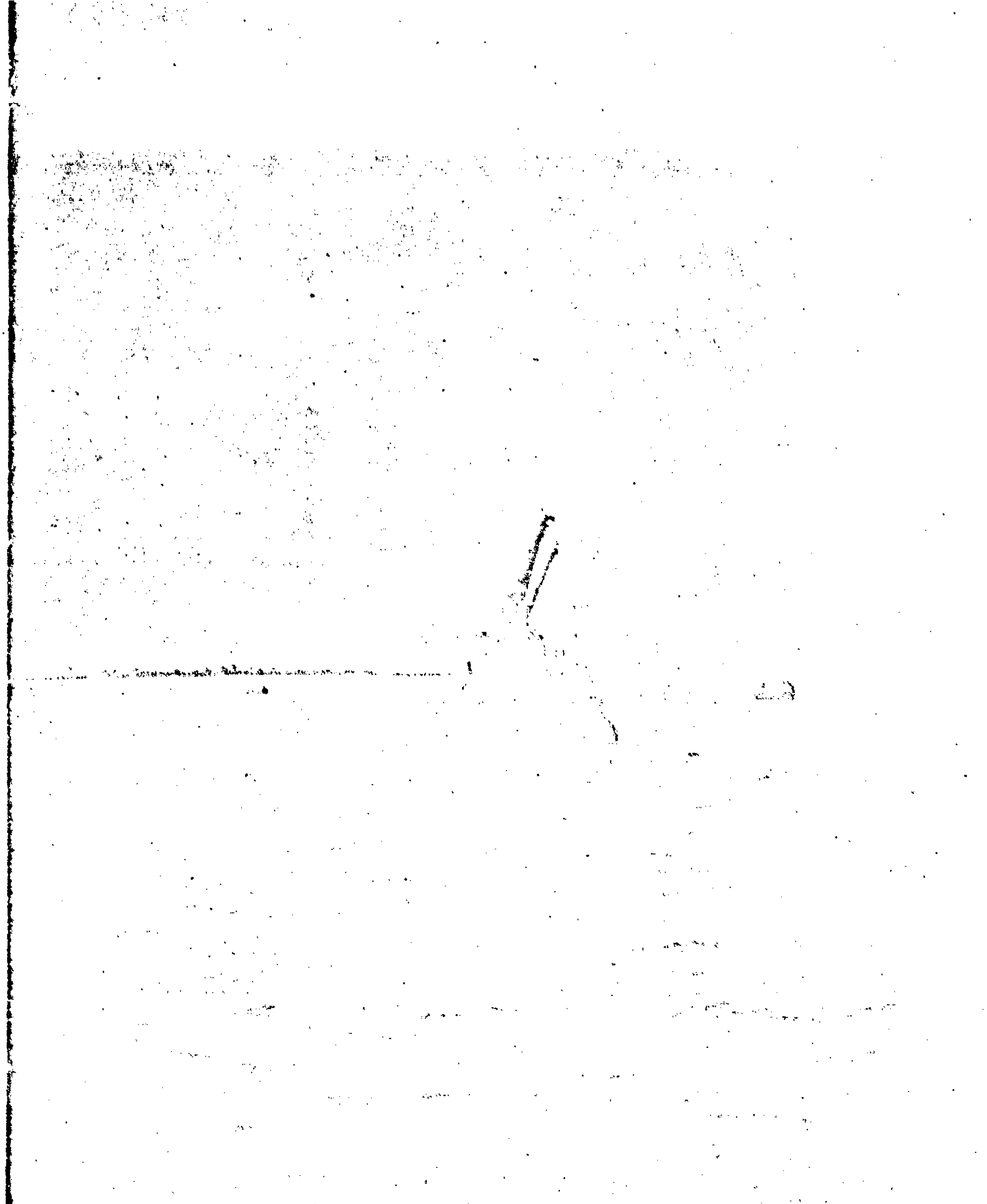
AB-CR-227-290-45. General view from starboard bow.



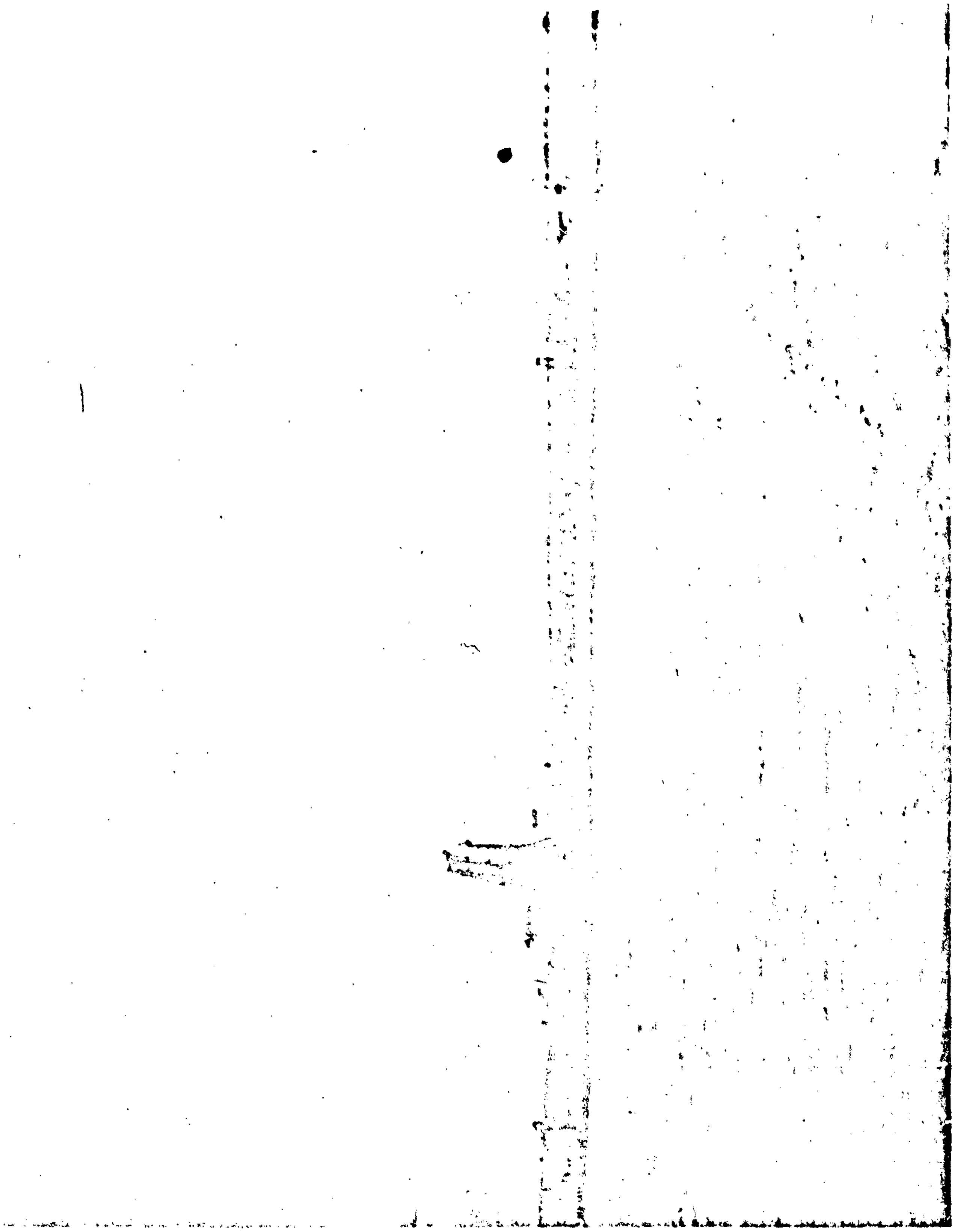
AB-CR-227-290-46. General view from starboard beam.



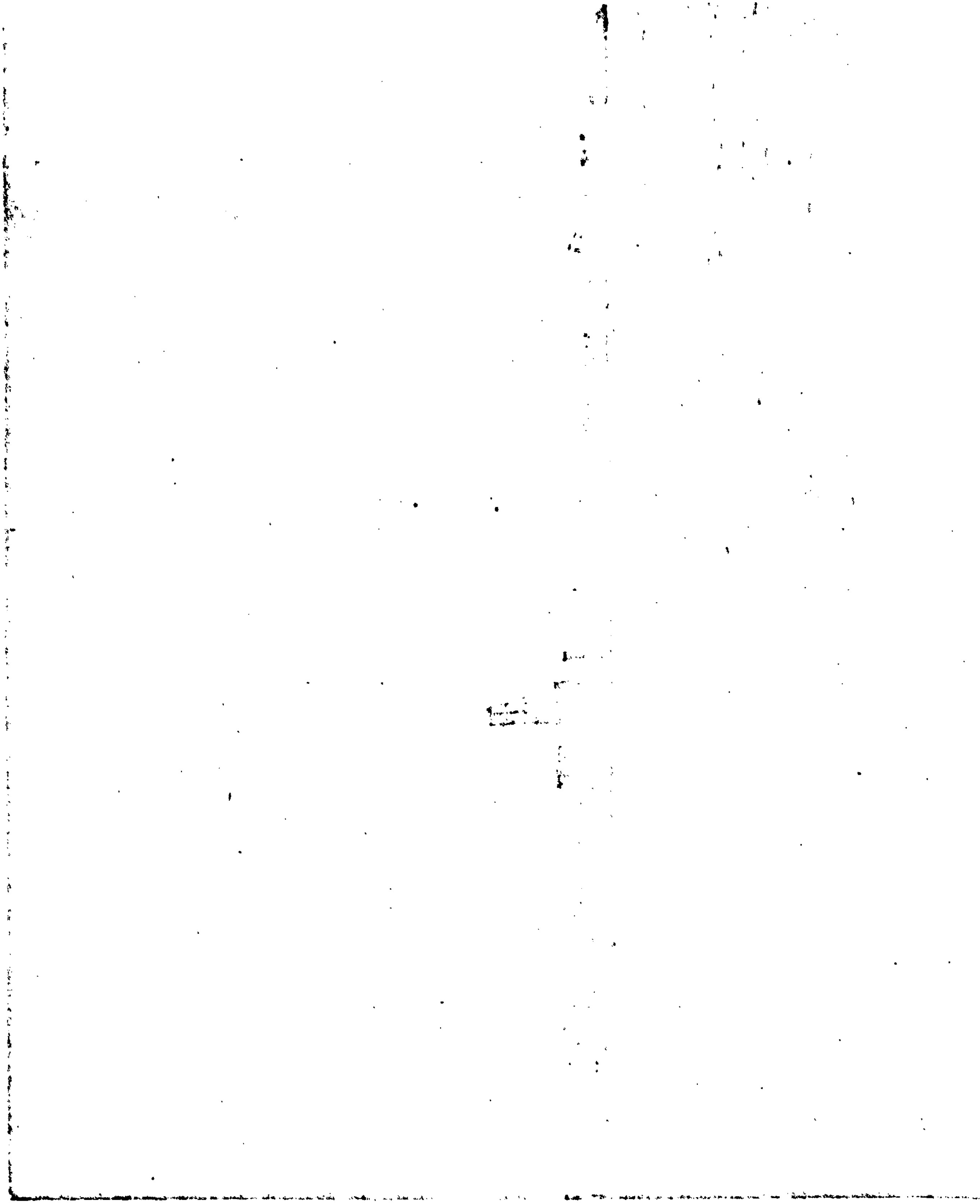
AB-CR-227-290-47. General view from starboard quarter.



AB-CR-227-290-40. General view from astern.

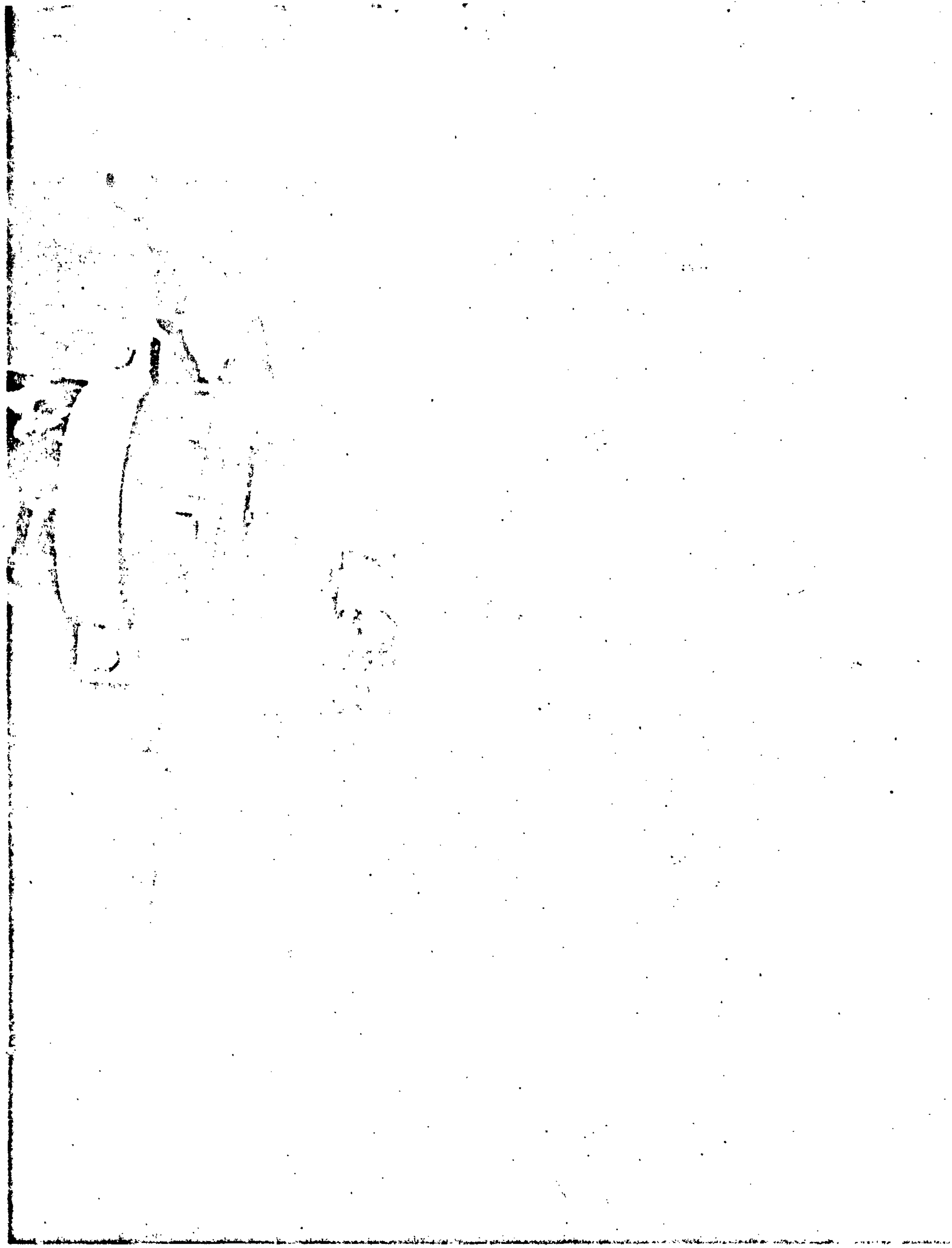


AB-CR-227-290-41. General view from port quarter.

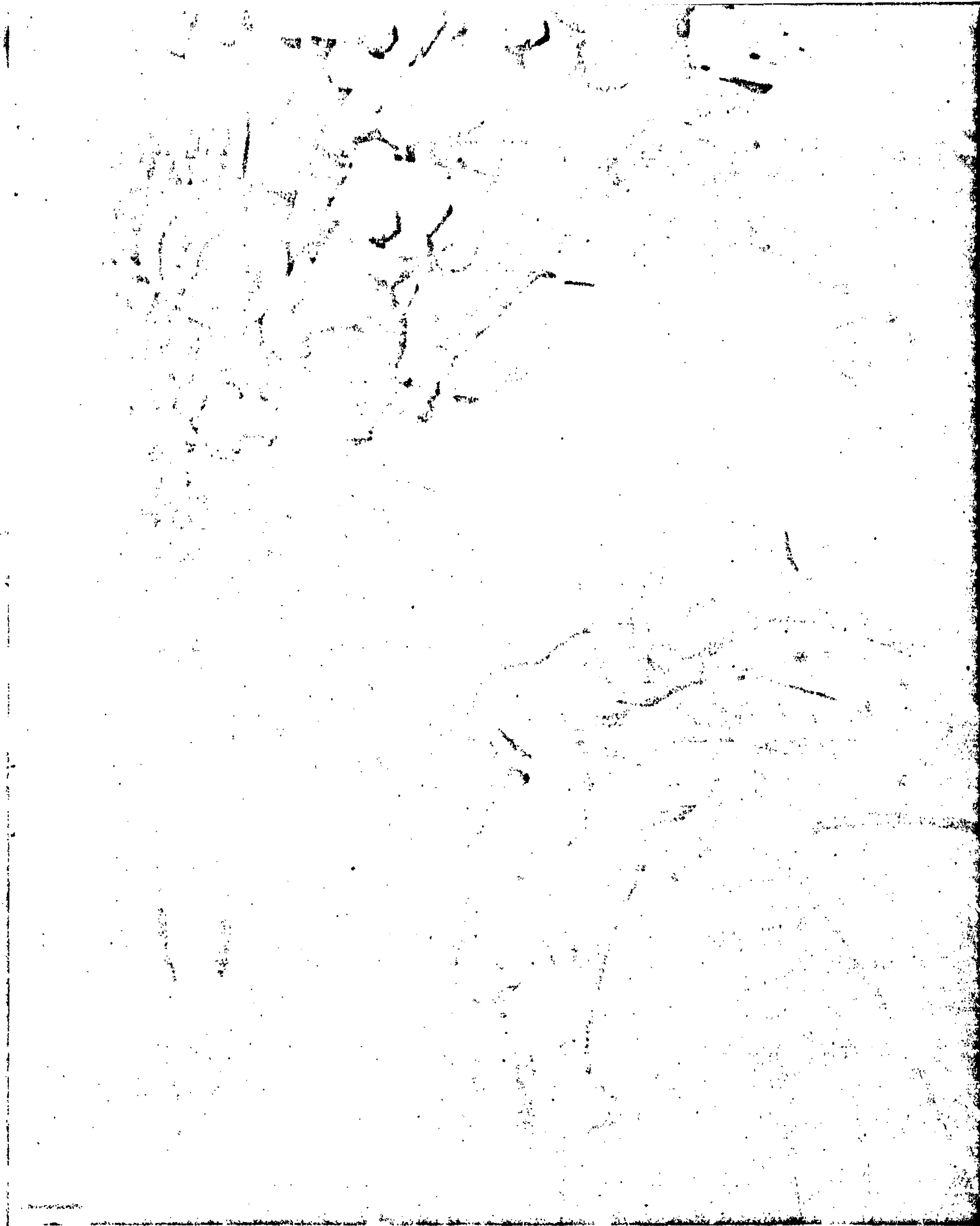


AB-CR-227-290-42. General view from port beam.

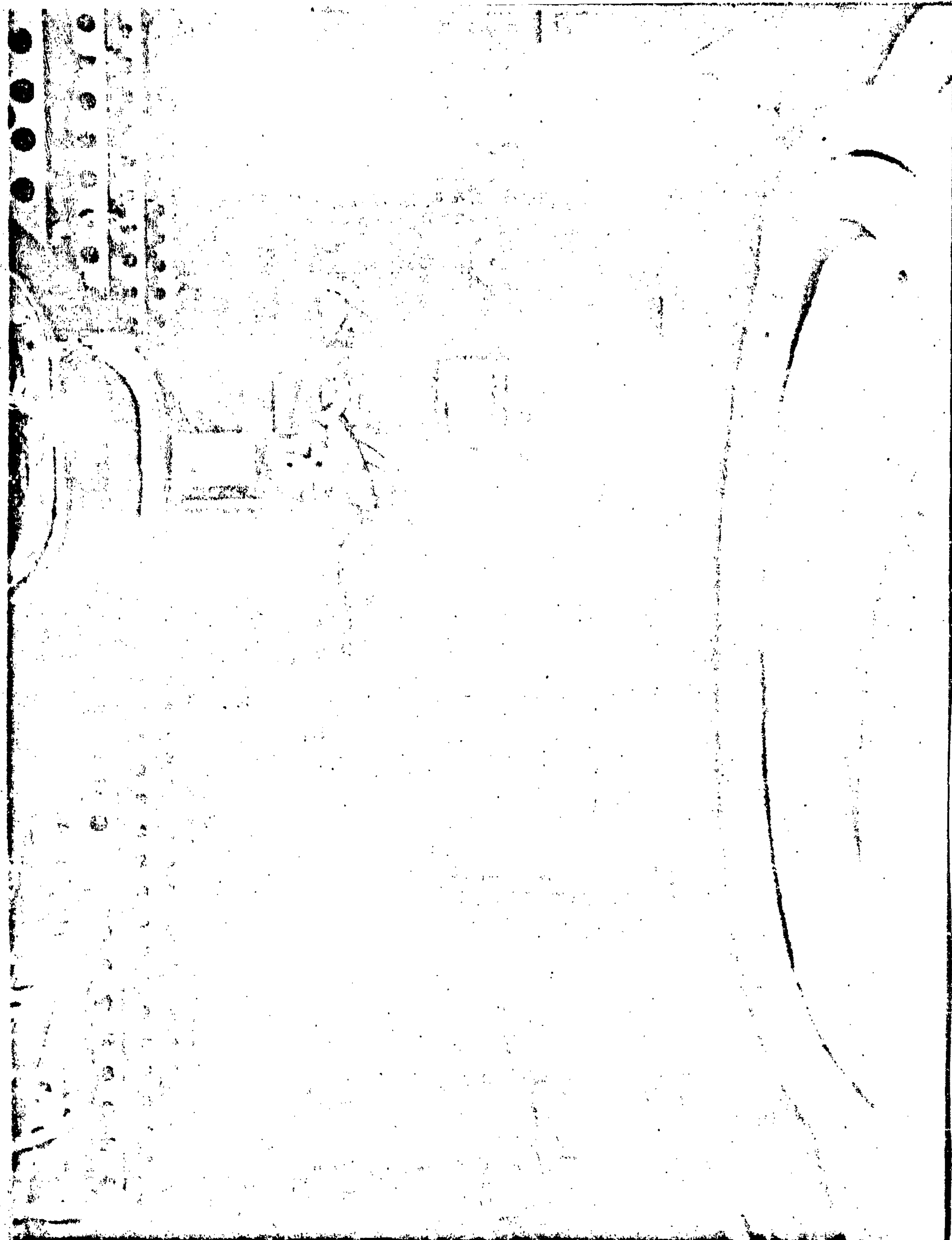
AB-CR-227-290-43. General view from port bow.



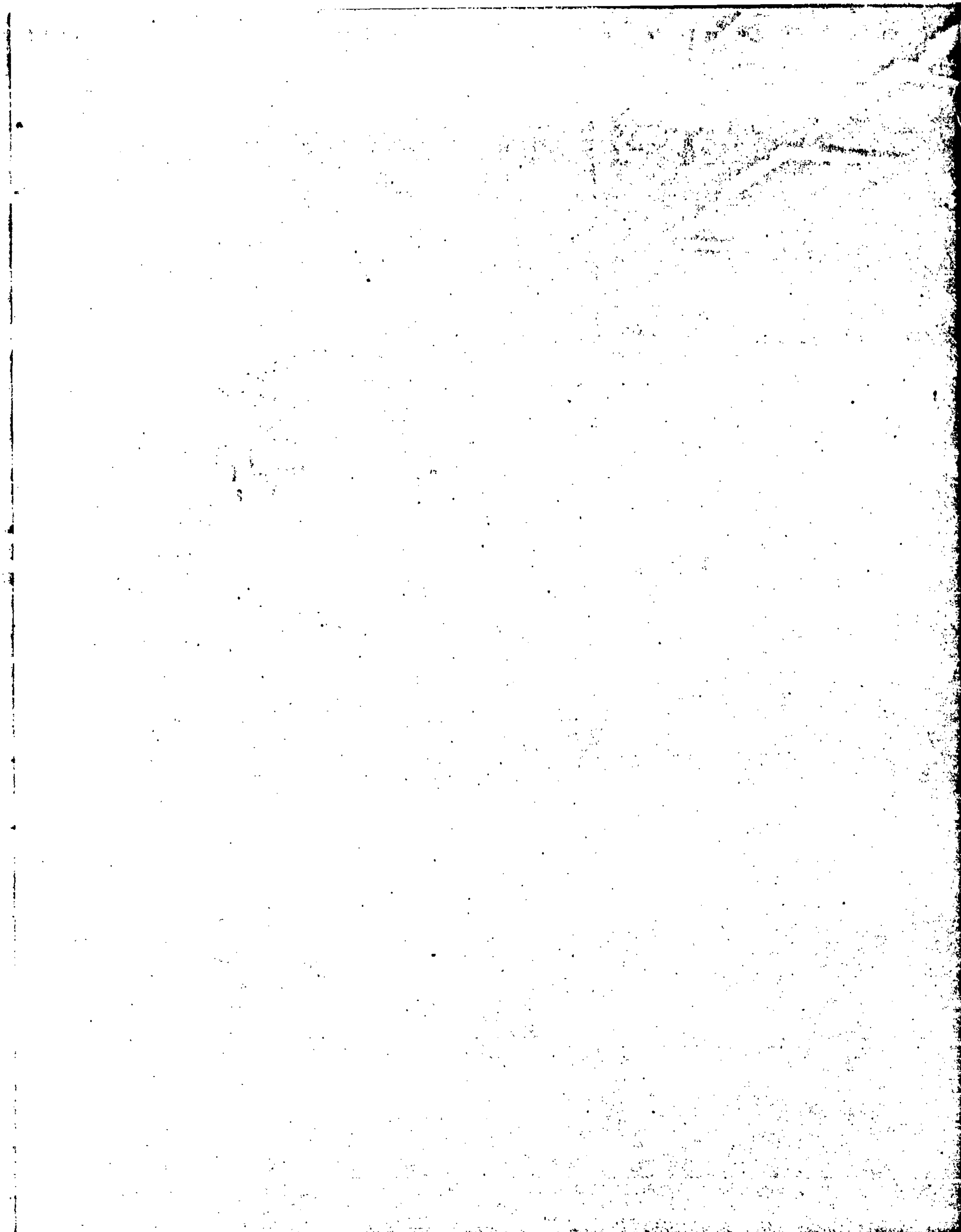
AB-CR-655-2188-8. Cracked deck platforms in forward battery tank.



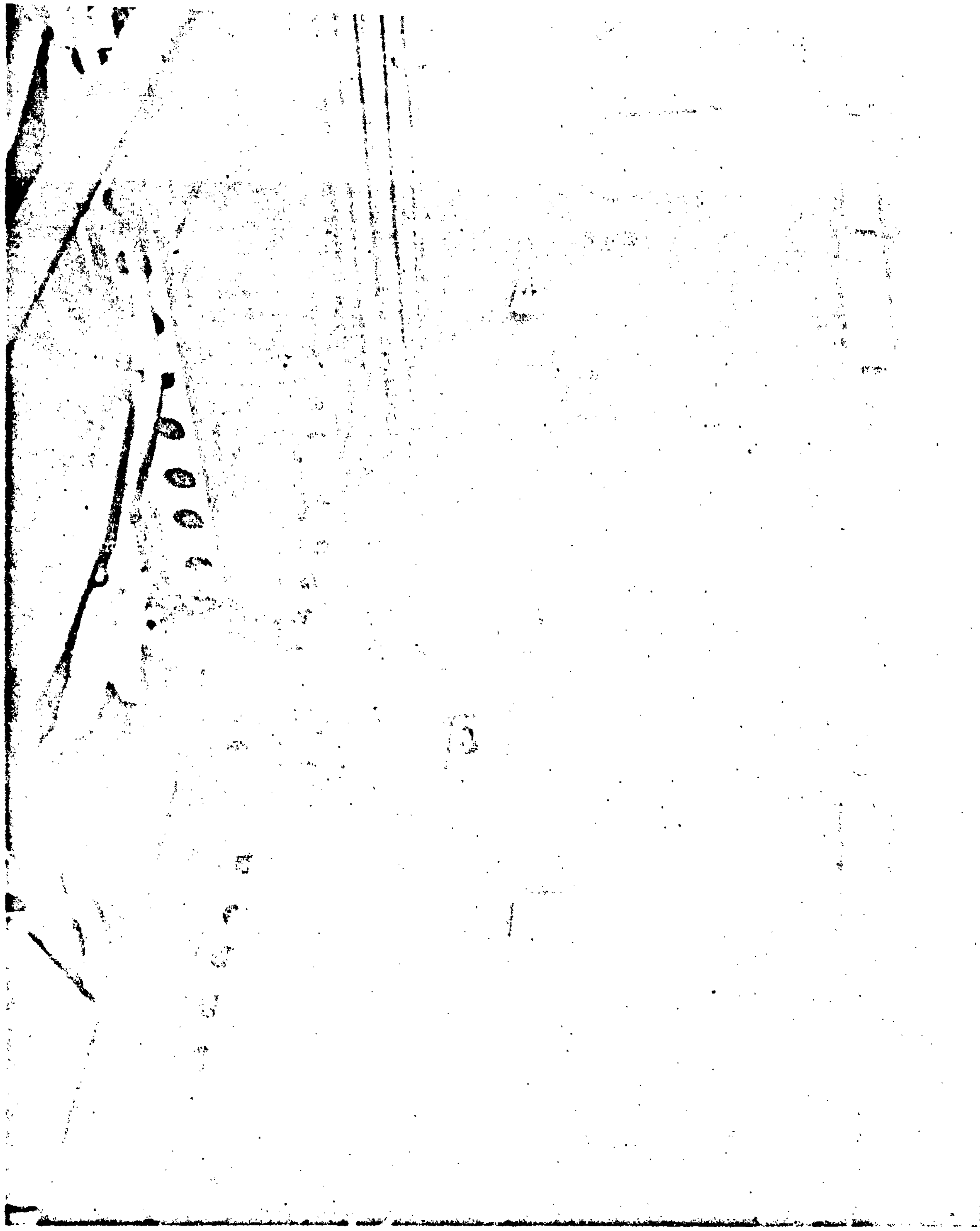
AB-CR-65-2188-3. Damage to vent ducts and a broken tie rod.



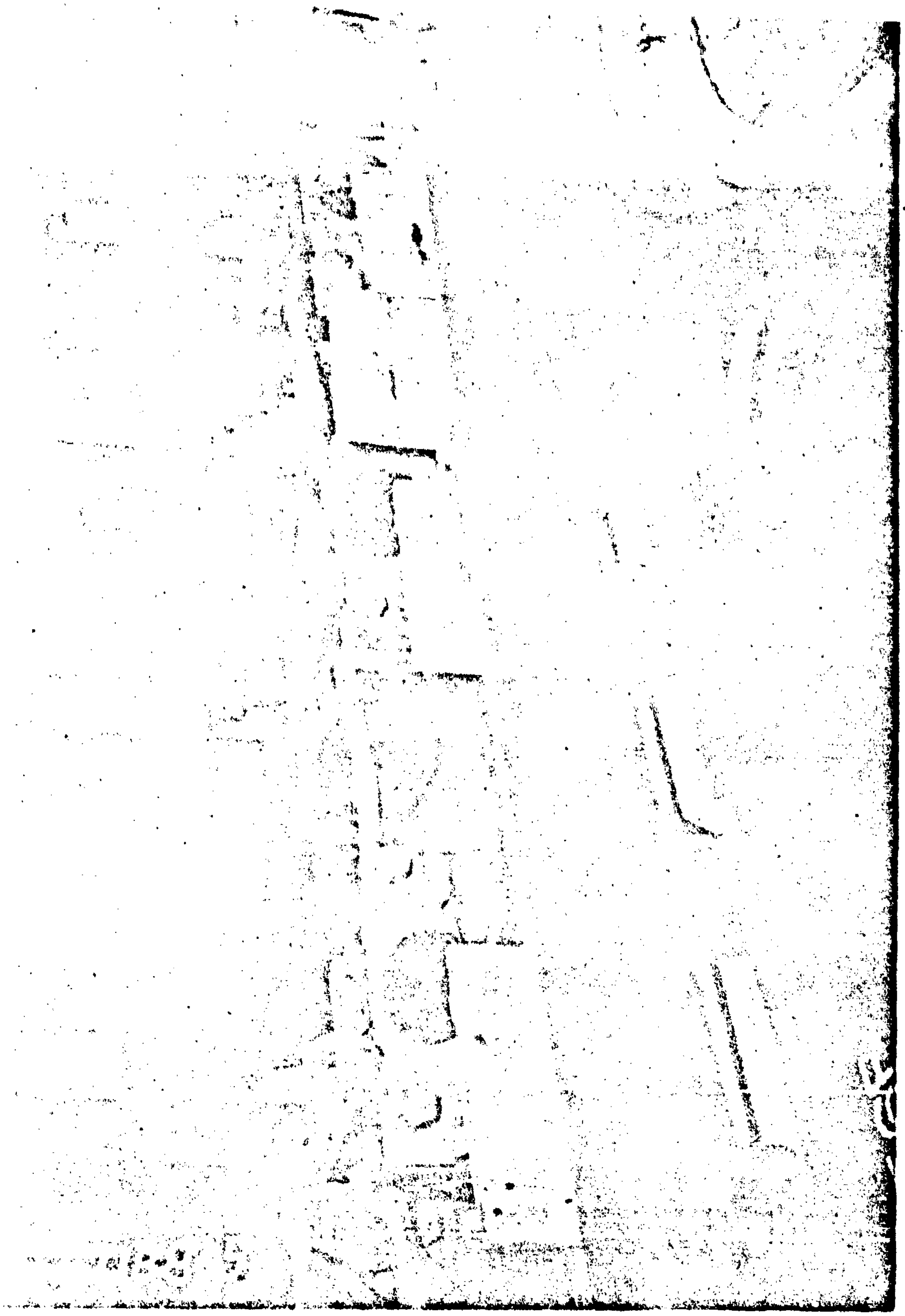
AB-CR-65-2188-1. Forward battery tank, general view.



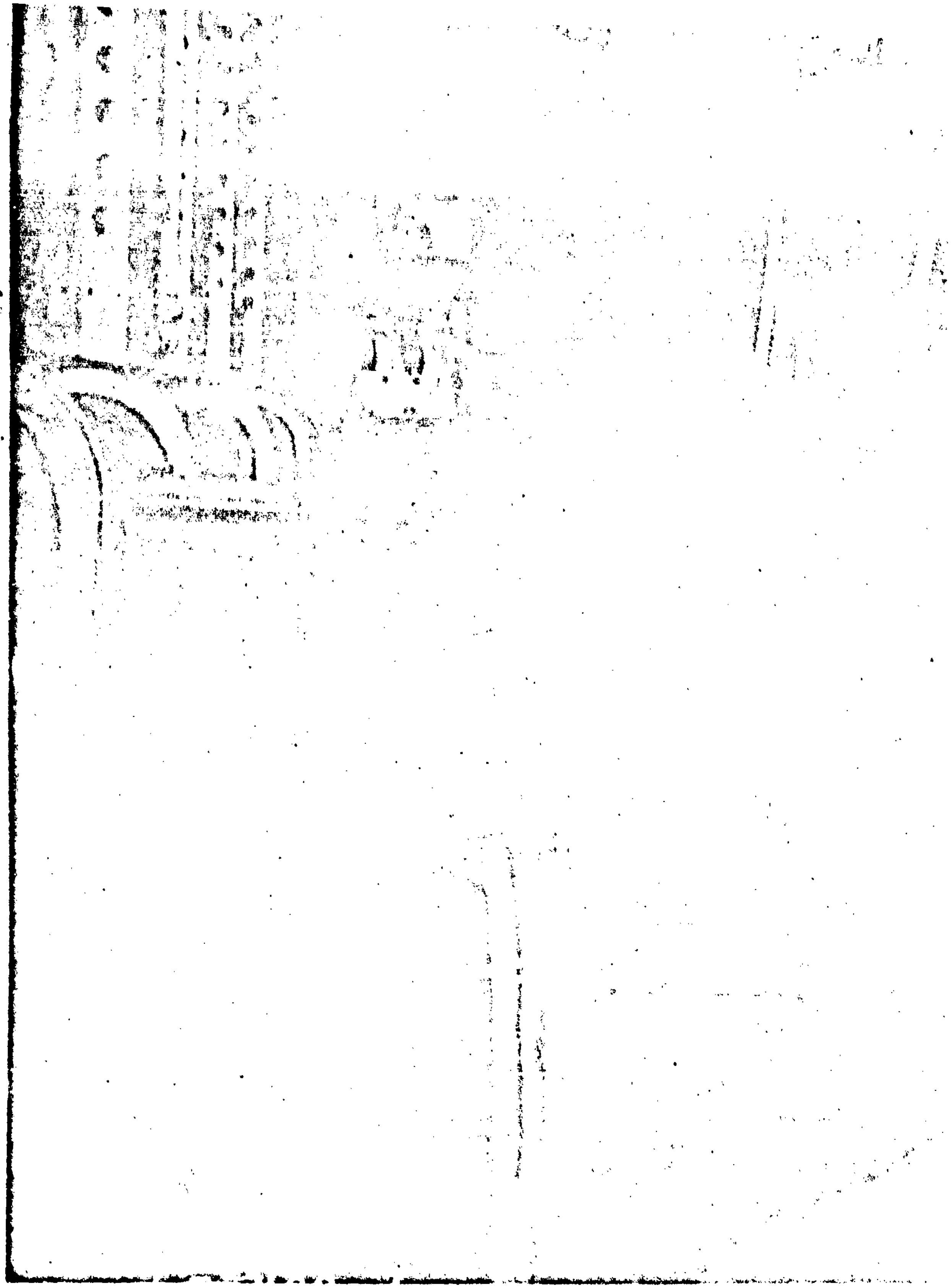
AB-CR-65-2188-2. Forward battery tank, general view.



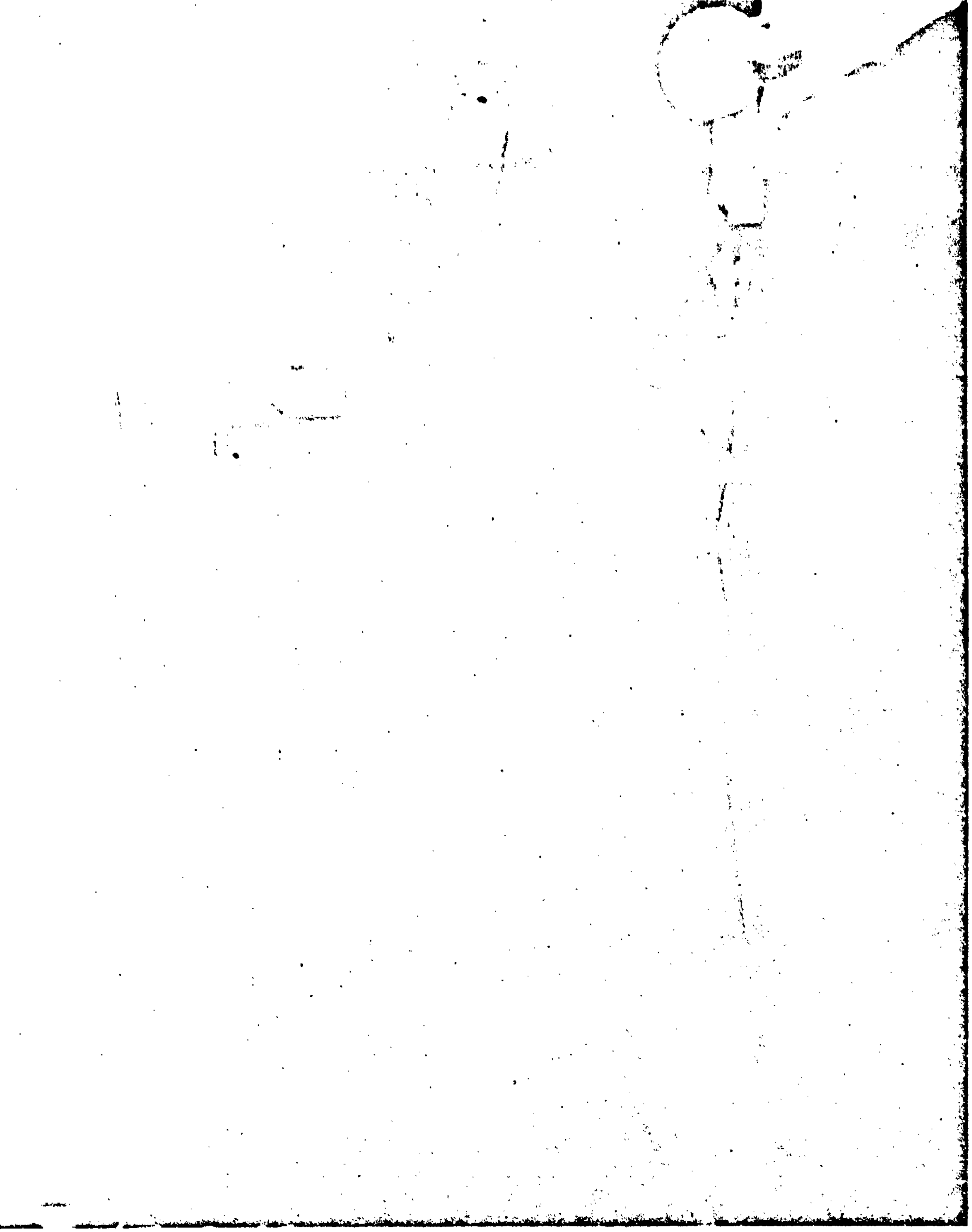
AB-CR-2188-4. Forward battery tank showing broken vent ducts outboard and raised wedges.



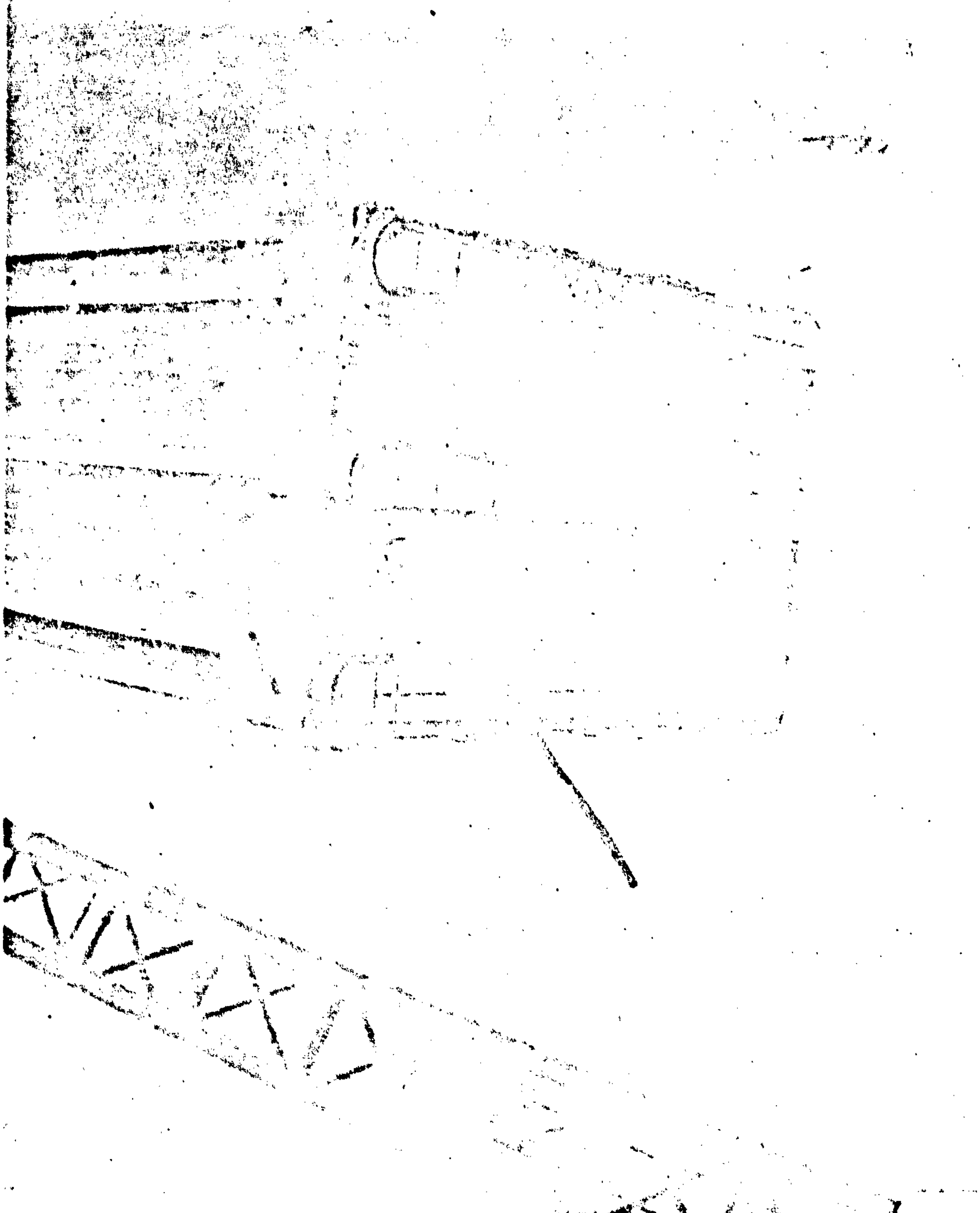
AB-CR-65-2188-5. Forward battery tank showing damaged battery ventilation ducts and raised wedges.



AB-CR-65-2188-6. View in after battery tank showing damage and raised wedges.

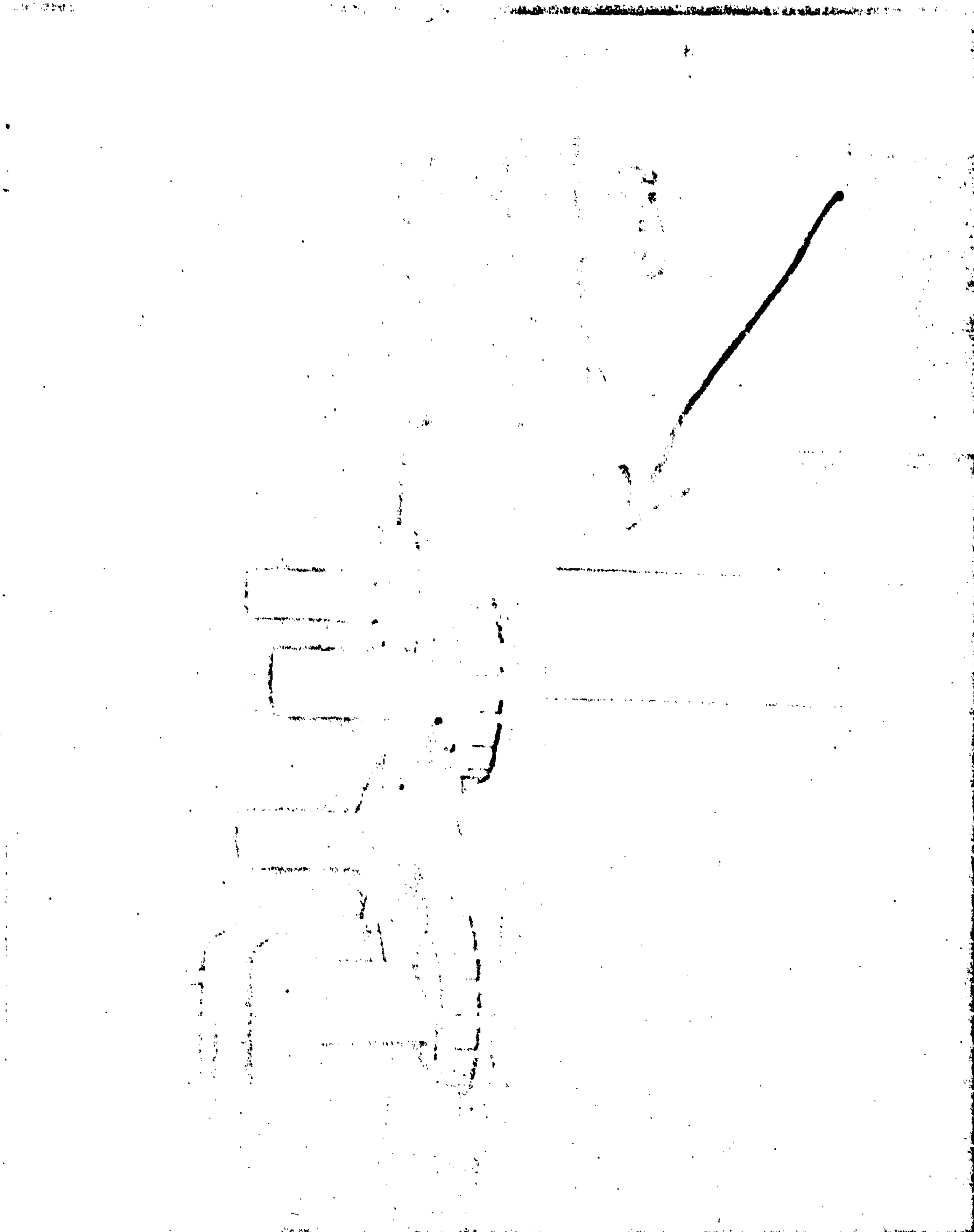


AB-CR-65-2188-7. View in after battery tank showing damage and raised wedges.

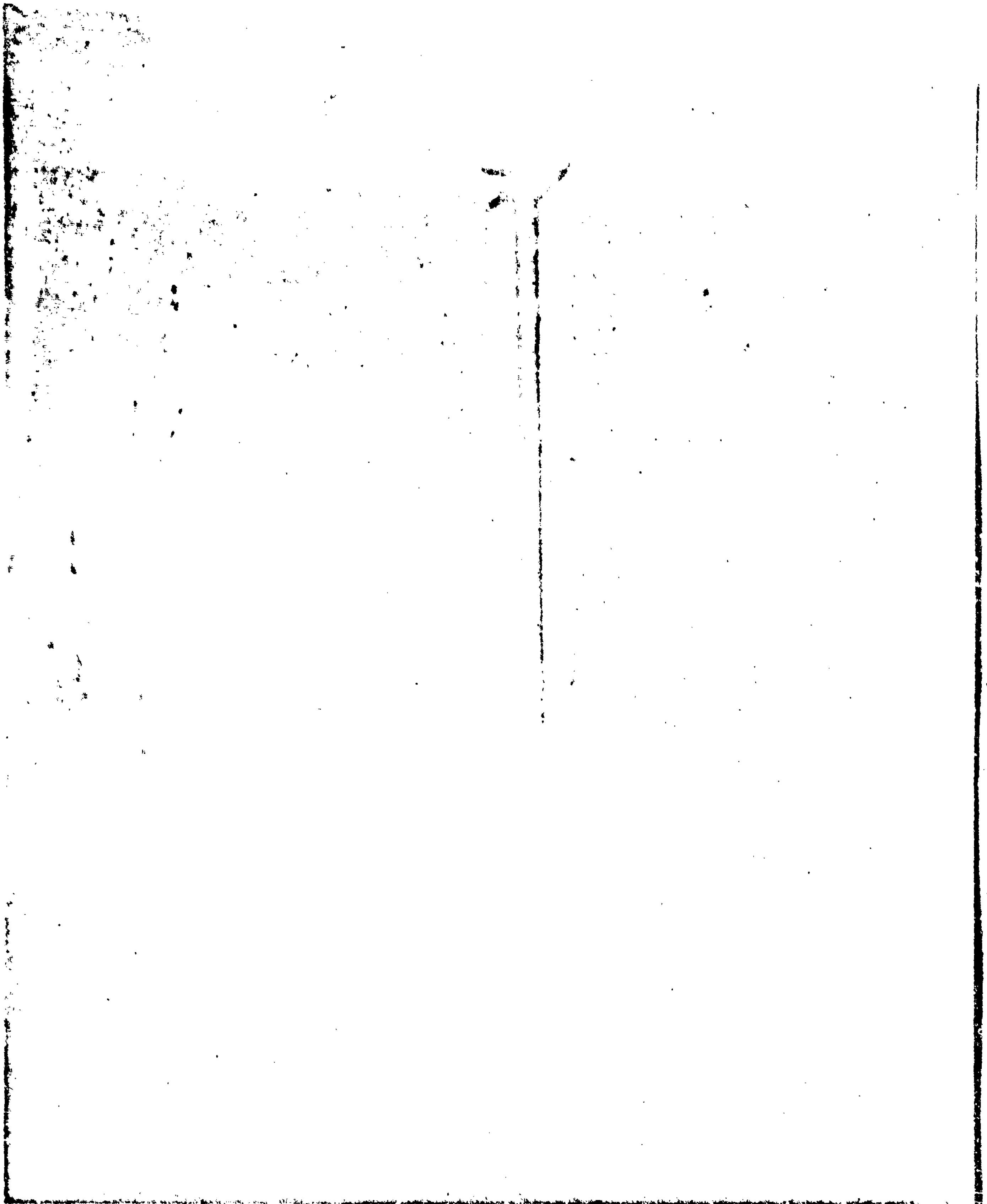


AB-CR-MIK-6504-1. Hole in bottom of # 17A cell caused by bolt.

4787

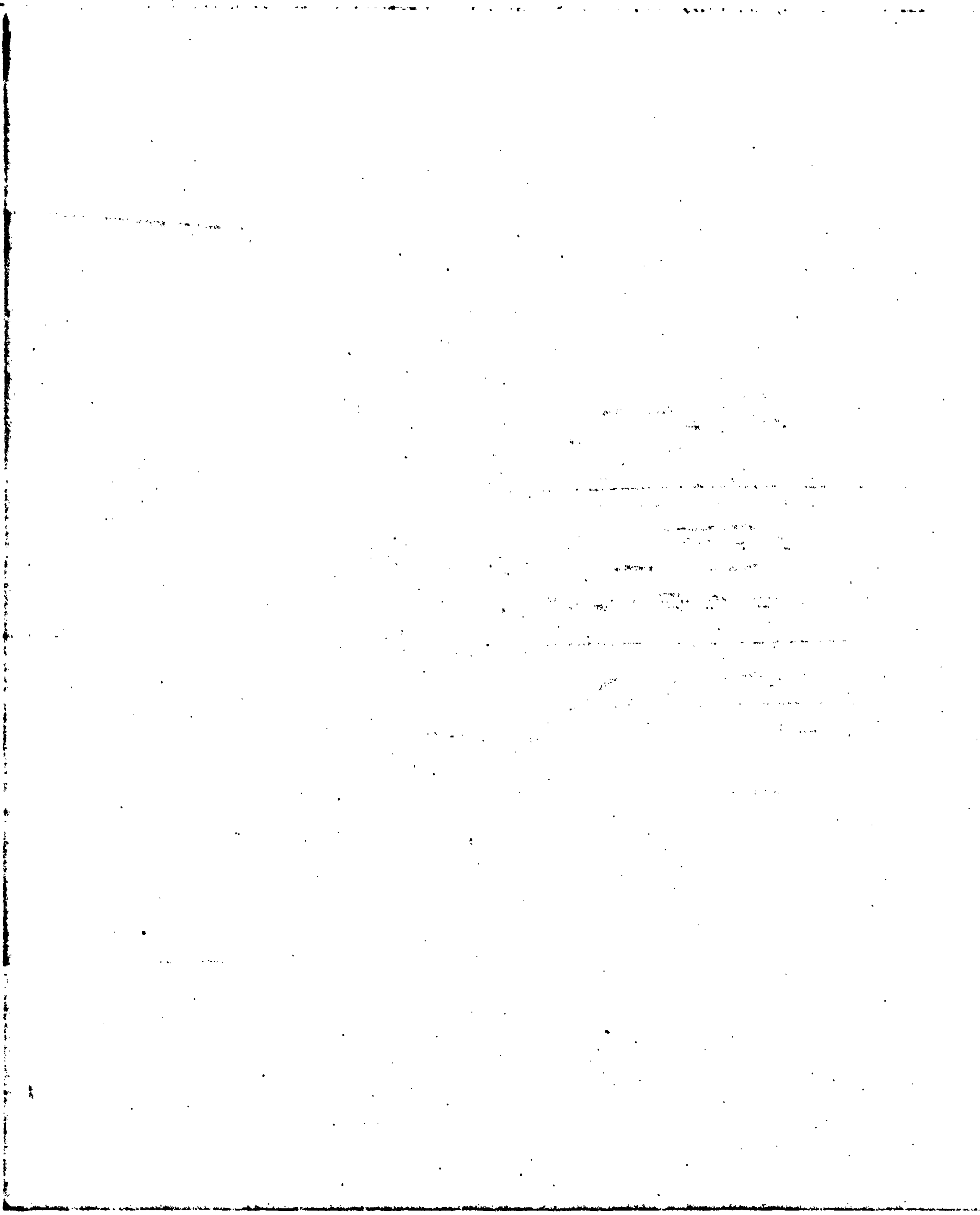


AE-CR-MIK-6504-2. #17A cell. Crack in top corner of case.

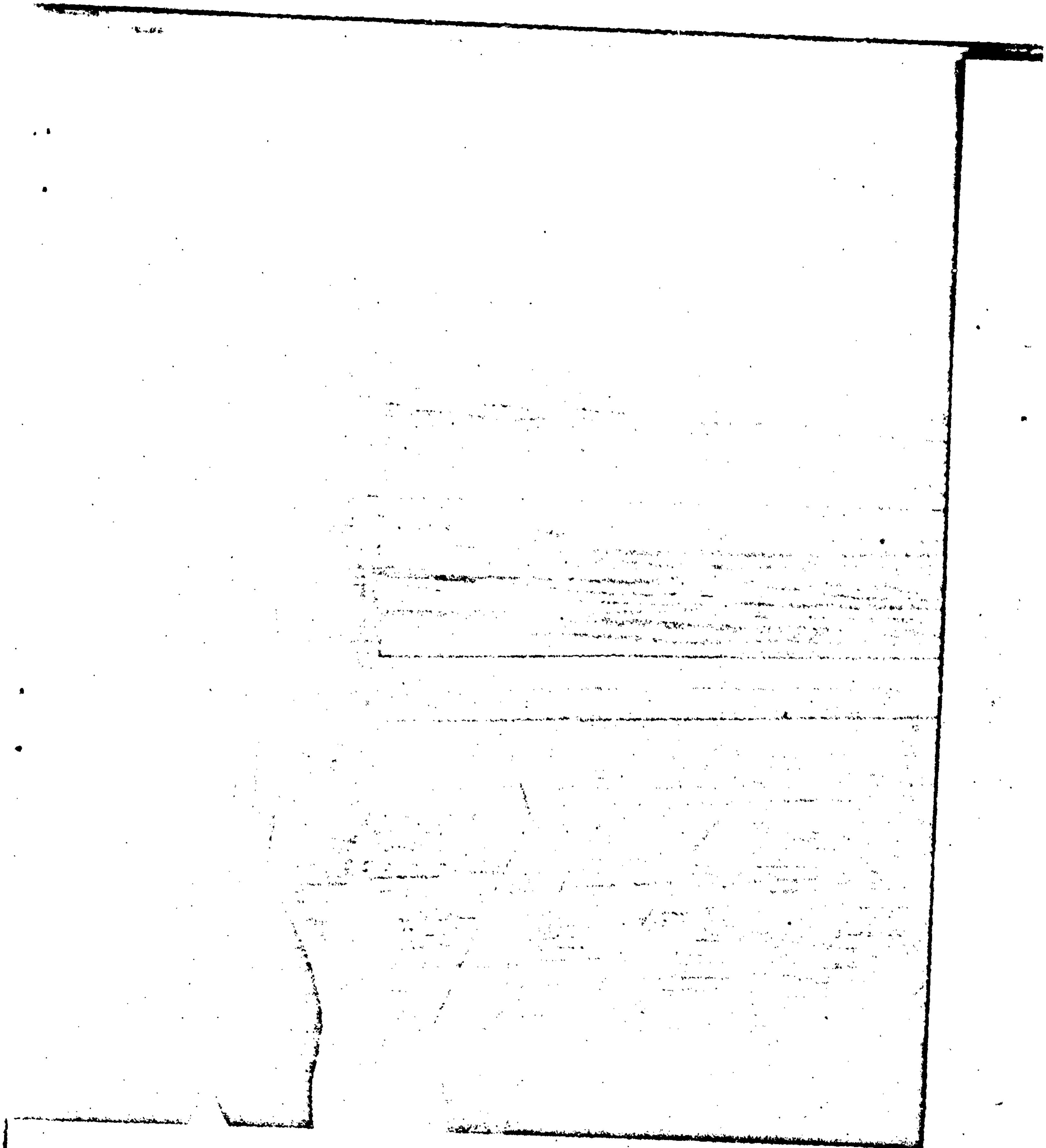


AB-CR-MIK-6504-6. Tie Rod from outboard stbd. row in after battery. Showing typical effect on tie rods caused by upward movement of wedges.

AB-CR-MIK-6504-7. Shipfitters bolt found under cell 17A upon removal of cells.



AB-CR-MIG-6506-6. Cell 58A showing cracked jar.



AB-CR-MIG-6506-7. Cell 17A showing 12 inch crack on lower corner.

APPENDIX

COMMANDING OFFICER'S REPORT

TEST BAKER

REPORT NO. 11 - PART I

GENERAL CONDITION OF VESSEL BEFORE TEST B

A. Name -- U.S.S. SKATE (SS305).

B. Type -- Submarine - Heavy hull.

C. Location in target array -- approximately 1000 yards southwest of the center of berth 161.

D. General discussion of material condition.

(a) Mooring -- On the surface, moored fore and aft to buoys on heading approximately 090°T with sixty-five fathoms of anchor chain from hawse pipe to forward buoy and 1 1/4" wire from the towing padeye to a cylindrical float aft which was anchored with a large concrete block. In addition there was a submarine type anchor underfoot with 105 fathoms of chain leading through the bullnose to the forward towing padeye. The excess chain between the bullnose and this anchor was stopped up in four 15 fathom bights.

(b) Topside condition -- The superstructure was badly mangled in test A. Prior to test B, most of the wreckage was cut away. A catwalk was built along the starboard side. The foundation and deck for a new bridge was installed. The bent periscope shears and the exposed main induction piping were strengthened by welded straps.

(c) Below decks condition -- All machinery was in good operating condition, and the ship was completely seaworthy.

(d) Rig for A-Bomb -- Ship was rigged in accordance with a bill prepared on the basis of general outline in Submarine Supplement to 'Instructions to Target Vessels for Tests and Observations by Ship's Force'.

GENERAL SUMMARY

I. **Target** Condition After Test.

(a) The draft did not increase appreciably. It remained approximately 15' forward and 15' 6'' aft. There was no list and no evidence of flooding.

(b) Structural damage -- None from Test B.

(c) Operability -- Test B caused no apparent damage to machinery, ship control, fire control, gunnery or electronics gear. The ventilation system in the battery wells was rendered inoperable. Several battery cell tops and one jar were cracked.

(d) There was no evidence of heat or fire. Majority of personnel on board would have been casualties from being injured by the shock of the explosion or from the radioactivity following it.

II. Forces Evidenced and Effects Noted.

(a) Heat -- None.

(b) Shock -- In general objects not firmly secured were thrown forward. There was no apparent effect on the hull or machinery.

(c) Fires and explosions -- None.

(d) Pressure -- The hull was compressed as indicated by the displacement gauges.

(e) Effects peculiar to the atom bomb -- None except radioactivity.

III. Results of Test on Target.

(a) Effects on propulsion and ship control -- None.

(b) Effect on gunnery and fire control -- None.

(c) Effect on watertight integrity and stability -- None.

(d) Effect on personnel and habitability -- Radioactivity precluded even the boarding by a working party until BAKER plus eleven. Even at the date of this report, three weeks after the explosion, working parties are permitted to stay aboard only for a few hours at a time.

(e) Total effect on fighting efficiency -- From a material standpoint, damage to the battery ventilation system has made it temporarily dangerous to charge the battery. There was no apparent damage to torpedoes or tubes.

IV. General Summary.

In Test BAKER the SKATE received a terrific jolt from broad on her port bow. This apparently moved her bow to starboard and up, resulting in a small roll and a quick pitching motion. The only damage of importance was to the main storage batteries which were pitched up out of position, demolishing the individual cell ventilation system and cracking several cells. This casualty would prevent safe submerged operation even if no other damge had been sustained.

V. Recommendations.

None.

SECTION I - HULL

L. Flooding.

There was no general flooding.

Safety tank was rigged as a main ballast tank with the floods open, main, emergency, and inboard vents shut. When the SKATE was reboarded on 9 August, safety tank had flooded to 33,000 pounds. It was discovered that there is a slow leak through the valve in the salvage air line.

M. Ventilation.

(a) Condition and causes of damage to:

1. Hull and battery ventilation system outboard-- No damage from Test B.

2. Engine induction system -- No damage from Test B.

3. Ventilation system inboard -- Intact except in battery wells. About 75% of the ventilation ducts in each battery well were broken. The batteries apparently were thrown up about one foot causing ducts to be broken against the overhead.

(b) Constructive criticism of design or construction -- The tie rods between rack members should be of heavier design.

SECTION II - MACHINERY

N. Distilling Plant.

No damage to No. 2 distilling plant.

No. 1 seems to be clogged, apparently by loose scale caused by the shock of the bomb explosion.

SECTION III - ELECTRICAL

I. Submarine Propelling Batteries.

(a) Jars -- Forward battery - Cells 11, 12, 23, and 27 cracked but electrolyte still in cells; 38 and 39 warped.

After battery - Cells 23, 25, and 64 cracked but electrolyte still in cells; cell 17 cracked and dry.

(b) Covers -- All covers knocked off. Three covers missing.

(c) Wedges and strongbacks -- Wedges were raised about a foot. Strongbacks were deformed and loose.

(d) Busbars and cell connections -- Generally bent.

(e) Acid spillage -- Considerable.

O Gyro Compass Equipment.

(a) Master -- Before Test B, the sensitive element was out of balance due to mercury missing from the oscillating bowl. The vacuum in the south rotor was down to 15". After the test, it was found that the centering pin and the outer contact rigg were bent, probably result of shock. Also a break was found in the sensitive relay coil in the follow up system. The gyro appeared to operate normally when the above mentioned troubles were remedied.

(b) Auxiliary -- Before Test B, mercury was missing from the flotation bowl. After the test, it was found that the pick-up pin which supplies power to the rotors was bent. The gyro appeared to operate normally after it was cleaned, the pin straightened and the mercury replaced.

(c) Repeaters -- No damage.

(d) DRT's and DRAI -- No apparent damage.

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SECTION IV - ELECTRONICS

L. Communication Transmitters (Radio).

The TBL second intermediate power amplifier tuning step functions erratically probably due to shock. No further evidence of damage from Test B. The transmitter is operable.

M. Sonar Echo Ranging and Listening Equipment.

The WCA driver is inoperative due to shock. The plate cap sockets were knocked off the oscillator (807) and the power (838) tubes. One filament in 838 was broken. Leads in the plate circuit of 807 oscillator plate supply were broken by shock. The driver will not key due to a broken lead in the keying circuit. The projector electrical circuits have normal readings.

All other components of the sonar gear appear to operate normally.

Classification (cancelled) (Changed to CONFIDENTIAL)
By Authority of JOINT CHIEFS OF STAFF JCS 1735/33 DATED 15 APRIL 1949
By John Gulley Date Jan. 30, 1951
Lt. Col. AFSWP
9c

RESTRICTED DATA
ATOMIC ENERGY ACT - 1946
SPECIFIC RESTRICTED DATA CLEARANCE REQUIRED IN ADDITION TO
THE MILITARY CLASSIFICATION SAFEGUARDS

CONFIDENTIAL

CONFIDENTIAL

Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC 18 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush (Security)

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency has declassified the following reports:

AD-366588	XRD-203-Section 12
AD-366589	XRD-200-Section 9
AD-366590	XRD-204-Section 13
AD-366591	XRD-183
AD-366586	XRD-201-Section 10
AD-367487	XRD-131-Volume 2
AD-367516	XRD-143
AD-367493	XRD-142
AD-801410L	XRD-138
AD-376831L	XRD-83
AD-366759	XRD-80
AD-376830L	XRD-79
AD-376828L	XRD-76
AD-367464	XRD-106
AD-801404L	XRD-105-Volume 1
AD-367459	XRD-100

TRC 18 April 1997

Subject: Declassification of Reports

AD-367491	XRD-134-Volume 2
AD-367479	XRD-123
AD-367478	XRD-122
AD-367481	XRD-125
AD-367500	XRD-159-Volume 2
AD-367499	XRD-160-Volume 3
AD-367498	XRD-161-Volume 4
AD-367512	XRD-147
AD-367511	XRD-148
AD-367465	XRD-107
AD-366733	XRD-43
AD-367477	XRD-121
AD-367476	XRD-120
AD-367467	XRD-109-Volume 1
AD-367475	XRD-119
AD-367474	XRD-118
AD-367473	XRD-117
AD-367472	XRD-116
AD-367471	XRD-115
AD-367466	XRD-108
AD-801405L	XRD-113
AD-367470	XRD-112
AD-367469	XRD-111

TRC 18 April 1997

Subject: Declassification of Reports

AD-801406L ✓ XRD-114

In addition, all of the cited reports are now **approved for public release; distribution statement "A" now applies.**

Ardith Jarrett
ARDITH JARRETT
Chief, Technical Resource Center