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REPORT NO. EVT 31-87-1 (E)

MIL-STD-1660 TEST

OF

XM87 AND XM88 VOLCANO MINE PALLET

US ARMY
ARMAMENT
MUNITIONS
CHEMICAL COMMAND

US ARMY DEFENSE AMMUNITION
CENTER AND SCHOOL

EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV, has been tasked by the U.S. Army Armament Research, Development and Engineering Center (SMCAR-AEP), Picatinny Arsenal, NJ, to design, fabricate, and test a metal pallet for the PA113 Volcano Mine Cannister. This engineering report contains the results of the MIL-STD-1660 pallet testing sequence of the palletized PA113 Volcano Mine Cannister. As a result of these tests, recommendations to strengthen the pallet and modify the PA113 bundling procedure evolved.

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U.S. Army Defense Ammunition Center and School
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ABSTRACT

The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament Research, Development and Engineering Center (SMCAR-AEP), Picatinny Arsenal, NJ, to design, fabricate, and test a metal pallet for the PA113 Volcano Mine Cannister. This engineering report contains the results of the MIL-STD-1660 pallet testing sequence of the palletized PA113 Volcano Mine Cannister. As a result of these tests, recommendations to strengthen the pallet and modify the PA113 bundling procedure evolved.

U. S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL

Evaluation Division

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PART I

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and school, Evaluation Division, was tasked by the U.S. Army Armament Research, Development and Engineering Center (SMCAR-AEP) to design, fabricate, and test a metal pallet for the PA113 Volcano mine cannister. The test procedure for evaluating the metal pallet is MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U. S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ.

C. OBJECTIVE. The objective of these tests is to assess the PA113 Volcano Mine Cannister Pallet capability to meet Army functional/operational requirements for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

PART II

ATTENDEES

A.C. McIntosh Test Engineer	U.S. Army Defense Ammunition Center and School Evaluation Division ATTN: SMCAC-DEV Savanna, IL 61074-9639 AV 585-8989

PART III

TEST PROCEDURES

The test procedures outlined in this section are extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads 8, April 1977. This standard identifies nine steps that a unitized load must undergo and pass to be considered acceptable. These tests are synopsized below:

1. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16-feet high for a period of one hour. This is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner: The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive force of a 16-foot high load.

2. REPETITIVE SHOCK TEST. The repetitive shock tests shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3-cycles per second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch feeler may be momentarily slid freely between every point on the specimen in contact with the platform at some instant during the cycle or a platform acceleration

achieves one plus or minus zero point one G. Midway into the testing period, the specimen shall be rotated 90-degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and if tested in more than one position, the total time shall be three hours.

3. EDGEWISE DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Drop (Rotational) Test is as follows: The specimen shall be placed on its bottom with one end of the base of the container supported on a sill nominally 6-inches high. The height of the sill shall be increased if necessary to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the dropped end is raised for the drops. The unsupported end of the container shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation:

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP FOR LEVEL 'A' PROTECTION
Pounds	Inches	Inches
600	72	36
3,000	no limit	24
no limit	no limit	12

4. FORKLIFTING TEST. This test shall be conducted by using procedures of Method 5011 of Federal Standard 101, Procedure 6.2, Lifting and Transporting by Forklift Truck. The forklift hazard course that will be used is shown in Figure 1.

The procedure for lifting and transporting by forklift truck test is as follows: The specimen shall be lifted clear of the ground by a forklift truck at one side of the specimen and transported on the forks in the level or back tilt position across the alternate hazard course. The forklift must carry the specimen over the hazard course in 23 seconds and then shall be brought to a stop. The specimen shall be carefully observed during the traverse and while the forklift is at a stop for any damage, evidence of the inadequacy, or deflection of the specimen that might cause damage or displacement of the contents. The specimen shall be then lowered onto the ground. The forklift shall be moved from the side to the end of the specimen. The forks shall be run under the specimen as far as possible and then operated to lift the end 6 inches. Observe the specimen, particularly in the vacinity of the ends of the forks and record observations. If the specimen can thus be lifted clear of the floor and transported on the forks over the same hazard course, record observation. If it cannot be thus lifted, report the length of forks used and state that the specimen could not be carried on the forklift truck at either end.

5. SLING COMPATIBILITY TEST. Unit loads utilizing special design for nonstandard pallets shall be lifted, slung, lowered, and otherwise handled as necessary using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

PART IV

TEST EQUIPMENT

1. TEST SPECIMEN

a.	Drawing Number:	
b.	Width:	59 in.
c.	Length:	28 in.
d.	Height:	38-15/16 in.
e.	Weight:	1875 lbs.

2. COMPRESSION TESTER

a.	Manufacturer:	Ormond Manufacturing
b.	Platform:	60 in. by 60 in.
c.	Compression Limit:	50,000 lbs.
d.	Tension Limit:	50,000 lbs.

3. TRANSPORTATION SIMULATOR

a.	Manufacturer:	Gaynes Laboratories
b.	Capacity:	6,000 lbs.
c.	Displacement:	1/2 in. amplitude
d.	Speed:	50 to 400 rpm.
e.	Platform:	5 ft. by 8 ft.

PART V

TEST RESULTS

1. STACKING TEST.

Pallet Weight - 1811 lbs.
Pallet Height - 38-1/2 in.
Test Load - 9038 lbs.

The subject pallet was loaded to 9500 pounds compression for a period of one hour. At the end of this period of time, the compressive load had decreased to 9100 pounds. When the compression load was removed and test specimen removed from the Compression Tester, no measurable deformation in the load was evident.

2. REPETITIVE SHOCK TEST.

Subject pallet successfully passed a longitudinal transportation simulation test for a 90-minute test period. Rotating the pallet 90 degrees and subjecting it to a second 90-minute period in the Transportation Simulator caused no damage to the pallet or strapping. In order to achieve a 1/16-in clearance between the pallet and the Transportation Simulator bed, the equipment was operated at 210 rpm.

3. EDGEWISE DROP TEST.

Each side of the pallet base was placed on a beam displacing it six inches above the floor. The opposite side was raised to a height of 24 inches above the floor and then dropped. This process was repeated in either a clockwise or counterclockwise direction on all four sides of the pallet.

When the PA113 pallet was dropped in the lateral orientation, it had a tendency to bounce after being dropped. The amount of energy stored in the load, the spring constant of the pallet, and the high center of mass of the containers, caused the pallet to bounce high enough to tip over in the opposite direction from which it was released. This problem did not occur when the pallet was dropped in the longitudinal direction.

In addition, the pallet warped enough to loosen up the unitizing straps, permitting the containers to become disengaged within the unit and break the bundling straps as shown in the unitization procedure.

4. FORKLIFTING TEST.

The Forklifting Test was accomplished while moving the pallet between test stations and a storage building over a gravel road. All forks were engaged in the fork pockets provided on the pallet. Fork positions along the longitudinal side of the pallet provided for stable movement from test station to test station. Fork positions along the lateral side of the pallet were very narrow and required the forklift operator to move the fork to a narrower spacing. The narrow tine spacing and the high center of mass on the pallet makes the load unstable.

5. SLING COMPATIBILITY TEST.

The Sling Compatibility Test consisted of lifting the pallet from the hoisting attachment provisions with an included sling angle between 20 and 25 degrees. There were five lifts performed. The first lift was with all four hoisting provisions, the second with three, the third with two diagonal hoisting provisions, the fourth with two opposite diagonal hoisting provisions, and the fifth with one hoisting provision. The included angle was maintained, where possible, between 20 and 25 degrees. All hoisting attachment provisions maintained the test loads applied; however, metal deformation occurred in the top lifting attachment.

PART VI

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The PA113 Volcano Mine Cannister Pallet, as designed, is unsatisfactory for the following reasons. First, the pallet base is not strong enough to prevent excessive flexing in the unitization straps to maintain a solid load. Second, the hoisting provisions, where attached to the top lifting adapter, caused the metal to buckle when lifted by two slings. No metal deformation was experienced when hoisted from four points. Third, the bundling straps, as shown in the Volcano Mine Unitized Load drawing, do not provide load unity between the pallet base, top lifting adapter, and the top and bottom rows of containers.

2. RECOMMENDATIONS. The Volcano Mine Pallet successfully passed the compression and transportation tests. It did not survive the Edgewise Drop and Sling Compatibility Tests. It is recommended that the pallet and unitization procedure be redesigned. The redesign should include consideration of heavier gauge material in the pallet, pallet adapter, and top lifting adapter. Finally, it is recommended that a five-wide by four-high unitized configuration be investigated to reduce/eliminate the bounce on rebound from edgewise drops.

PART VII

PHOTOGRAPHS

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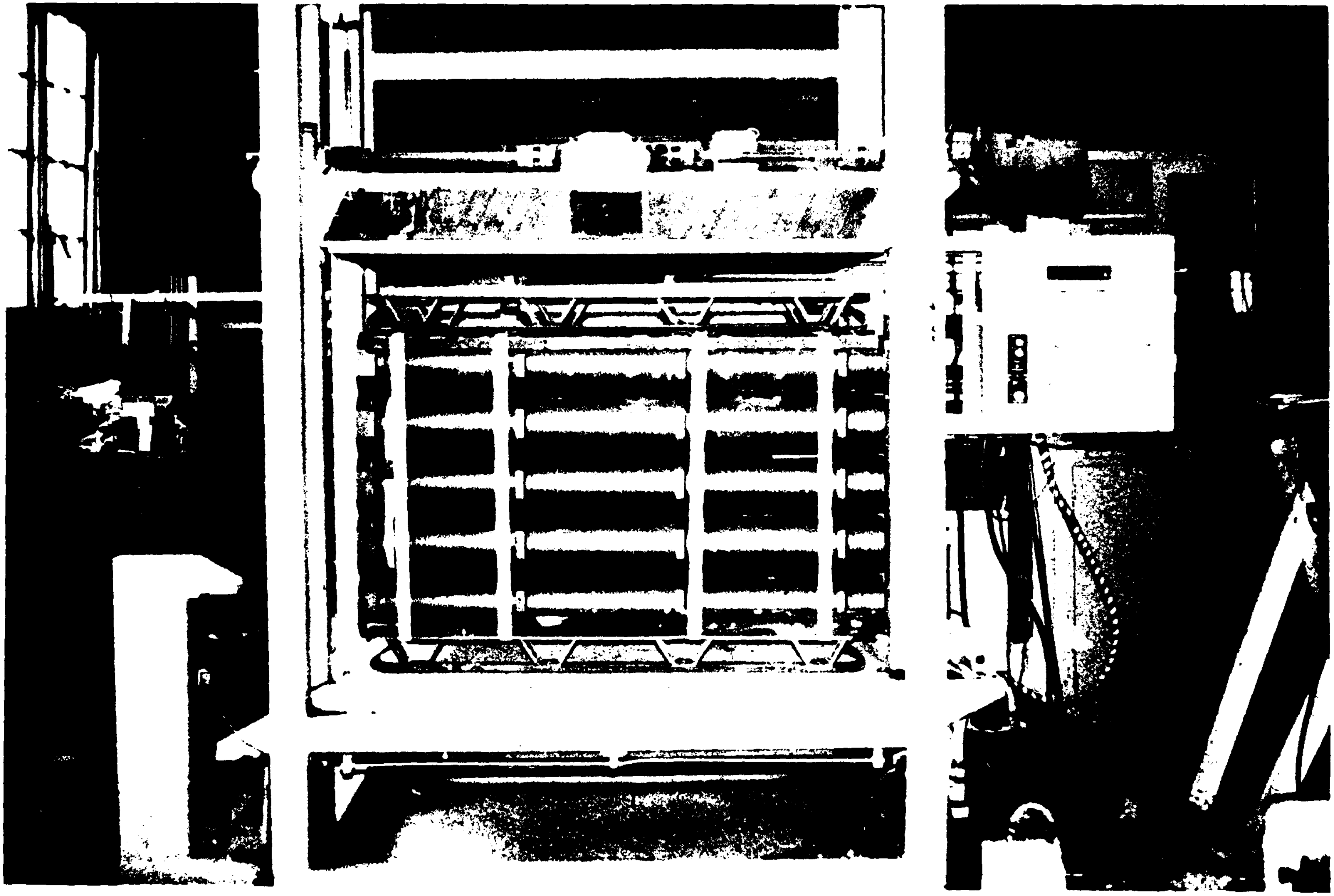

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Photo 1. This photo shows the PA113 Volcano Mine Pallet in the Compression Tester.

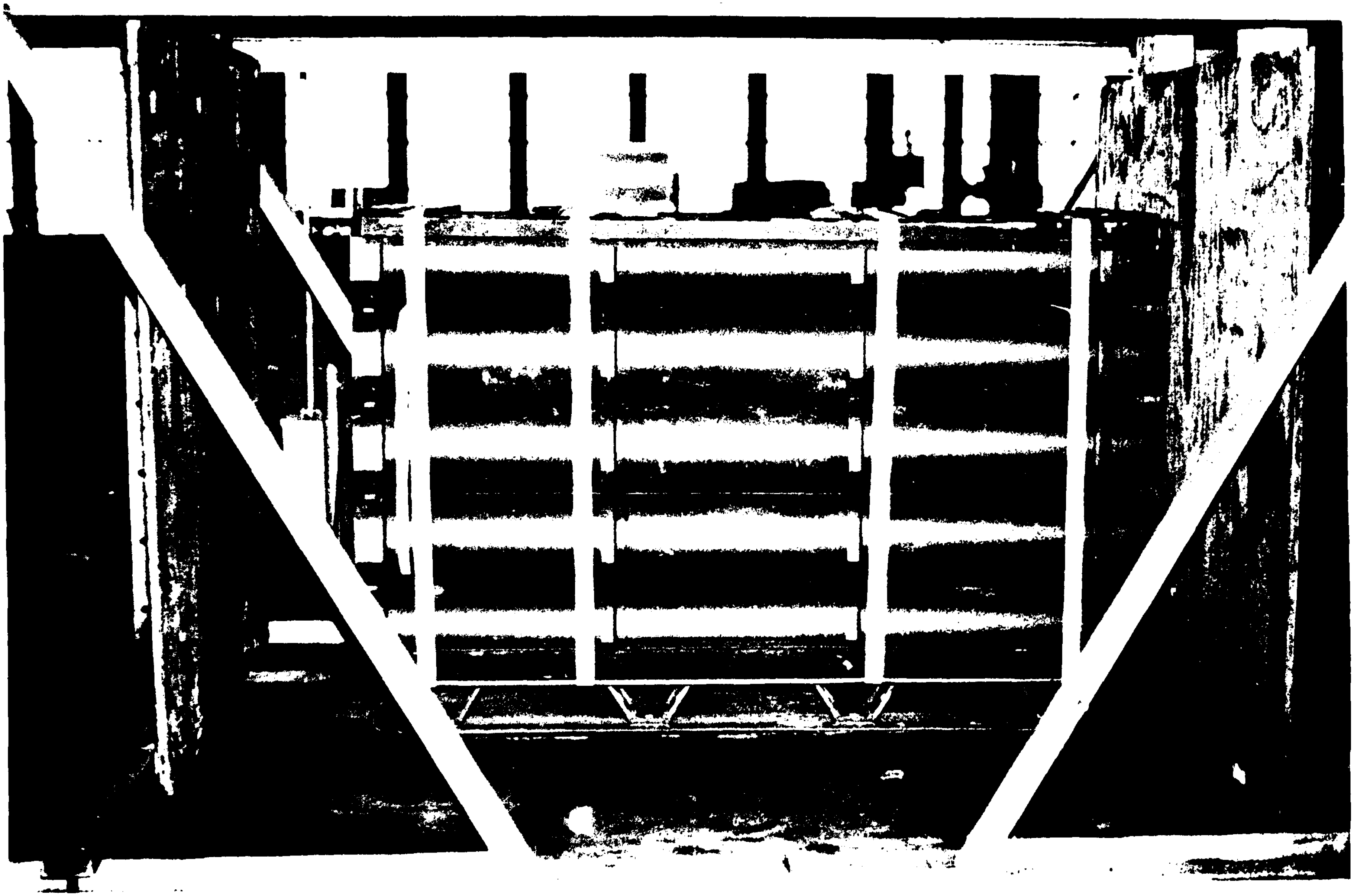

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Photo 2. This photo shows the Volcano Mine Pallet placed in the Transportation Simulator in the longitudinal orientation.

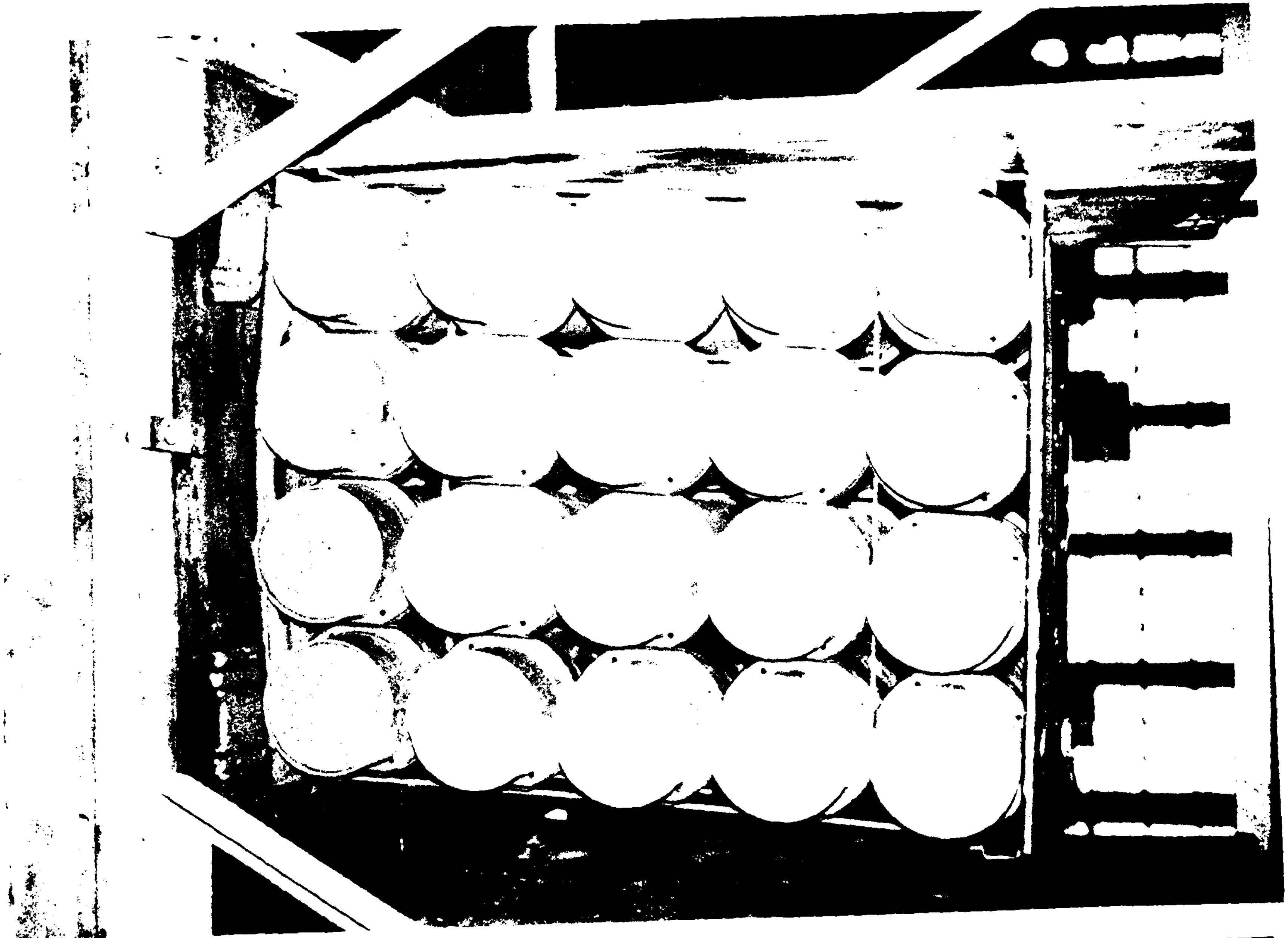

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Photo 3. This photo shows the Volcano Mine Pallet in the lateral orientation in the Transportation Simulator.

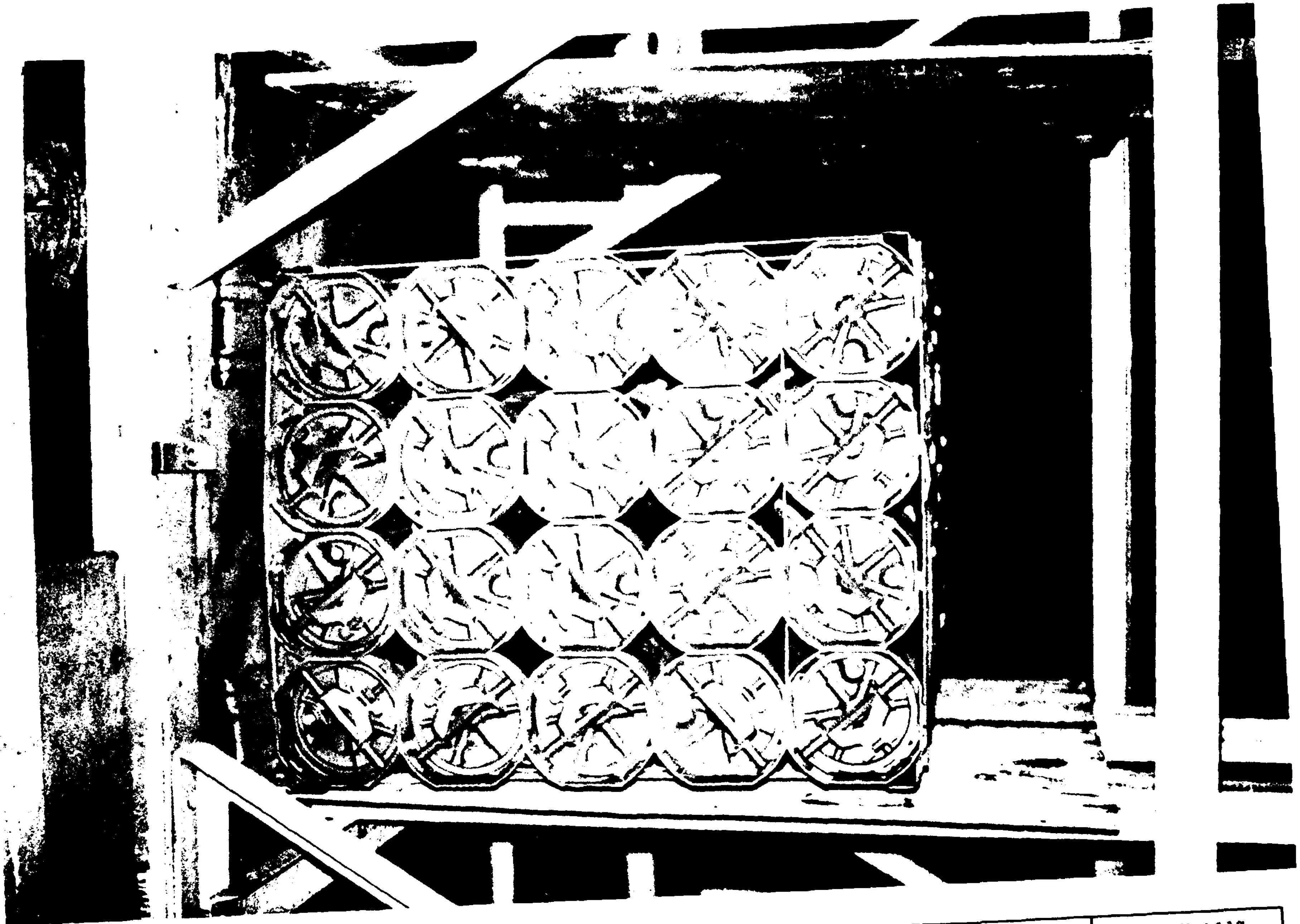

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Photo 4. This photo shows the Volcano Mine Pallet after 90 minutes of vibration in the Transportation Simulator. Note that the pallet base has bowed at the center.

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Photo 5. This photo shows the Volcano Mine Pallet raised 24 inches prior to dropping for the edgewise rotational drop test.

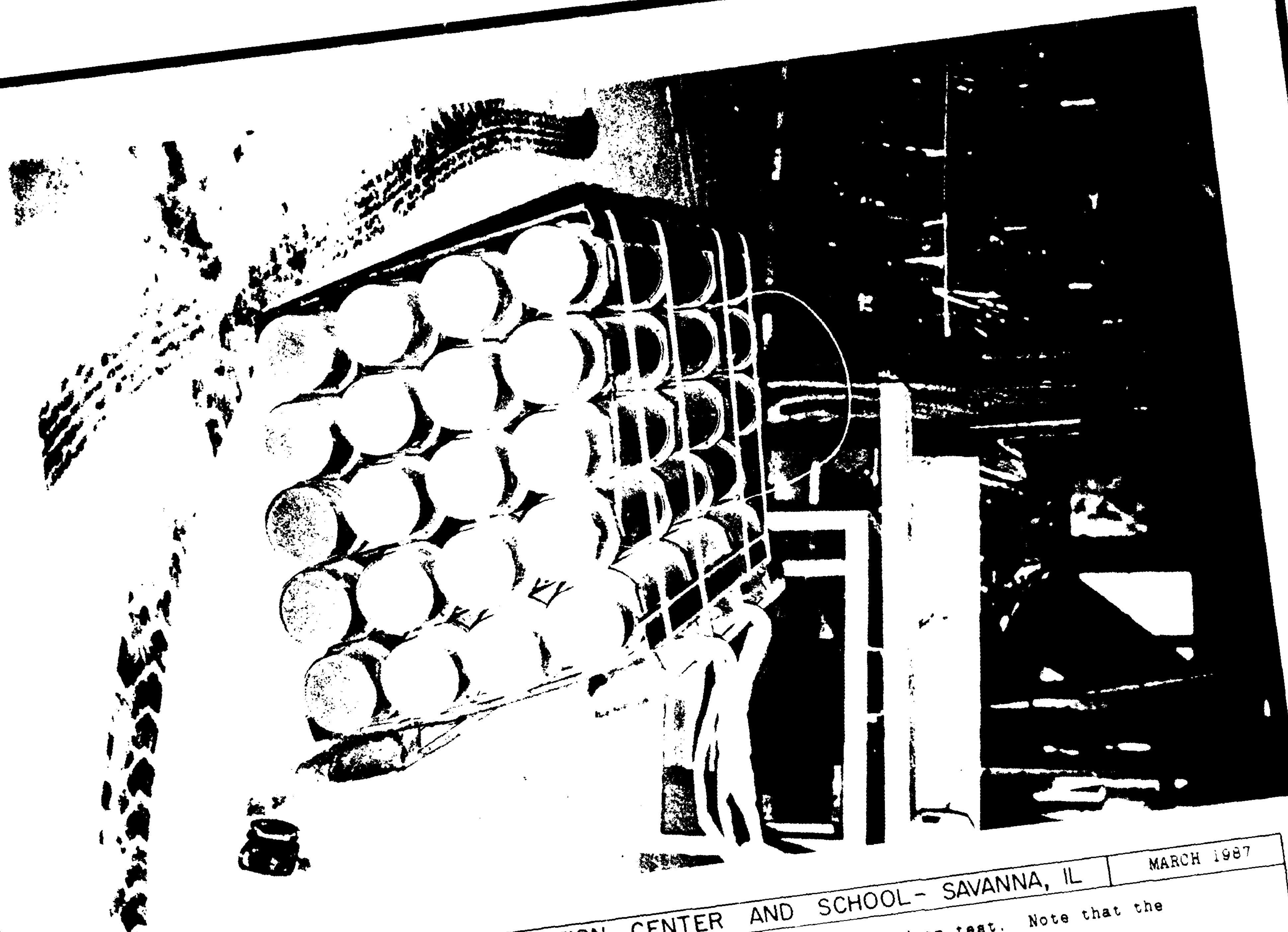

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Photo 6. This photo shows the Volcano Mine Pallet after the edgewise drop test. Note that the pallet has rolled over on its side and that the load has shifted.

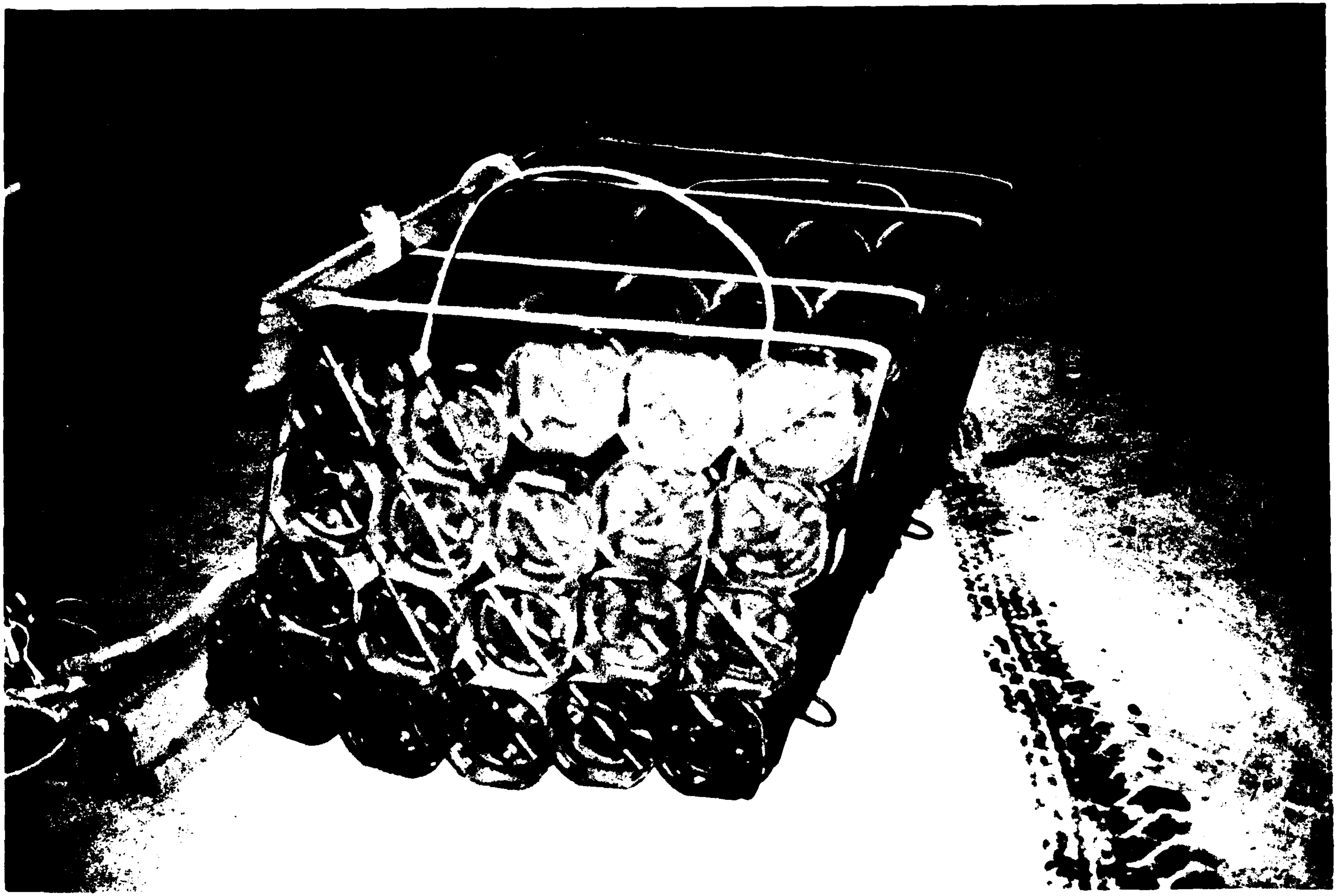

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Photo 7. This photo shows the Volcano Mine Pallet after the second drop. Note that one bundling strap has broken and that the pallet has bounced onto its side.

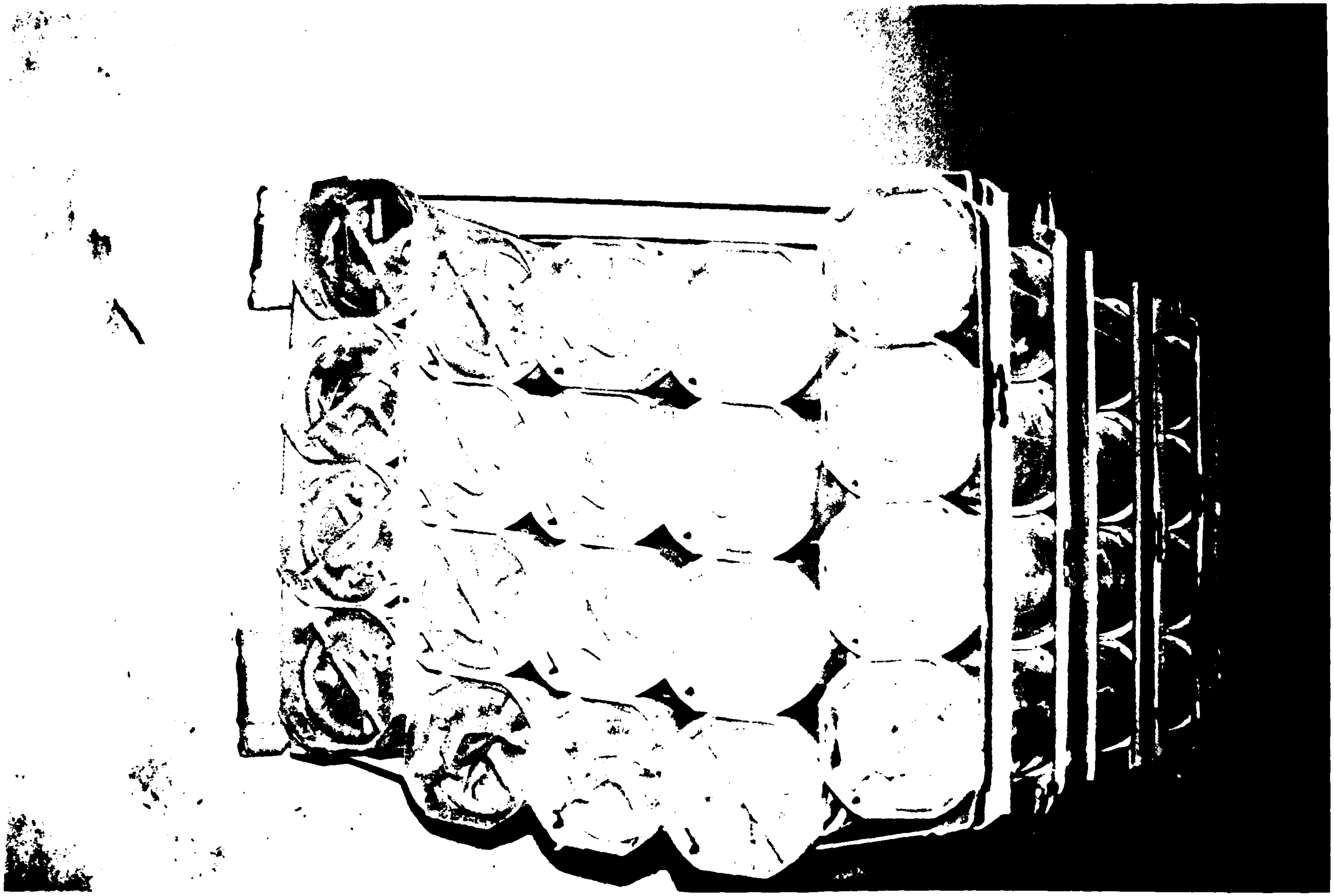

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Photo 8. This photo shows the Volcano Mine Pallet after several drops. Note that the bundling strap group has shifted from the original position. The original position within the bundling is shown by the upper and lower rows of canisters.

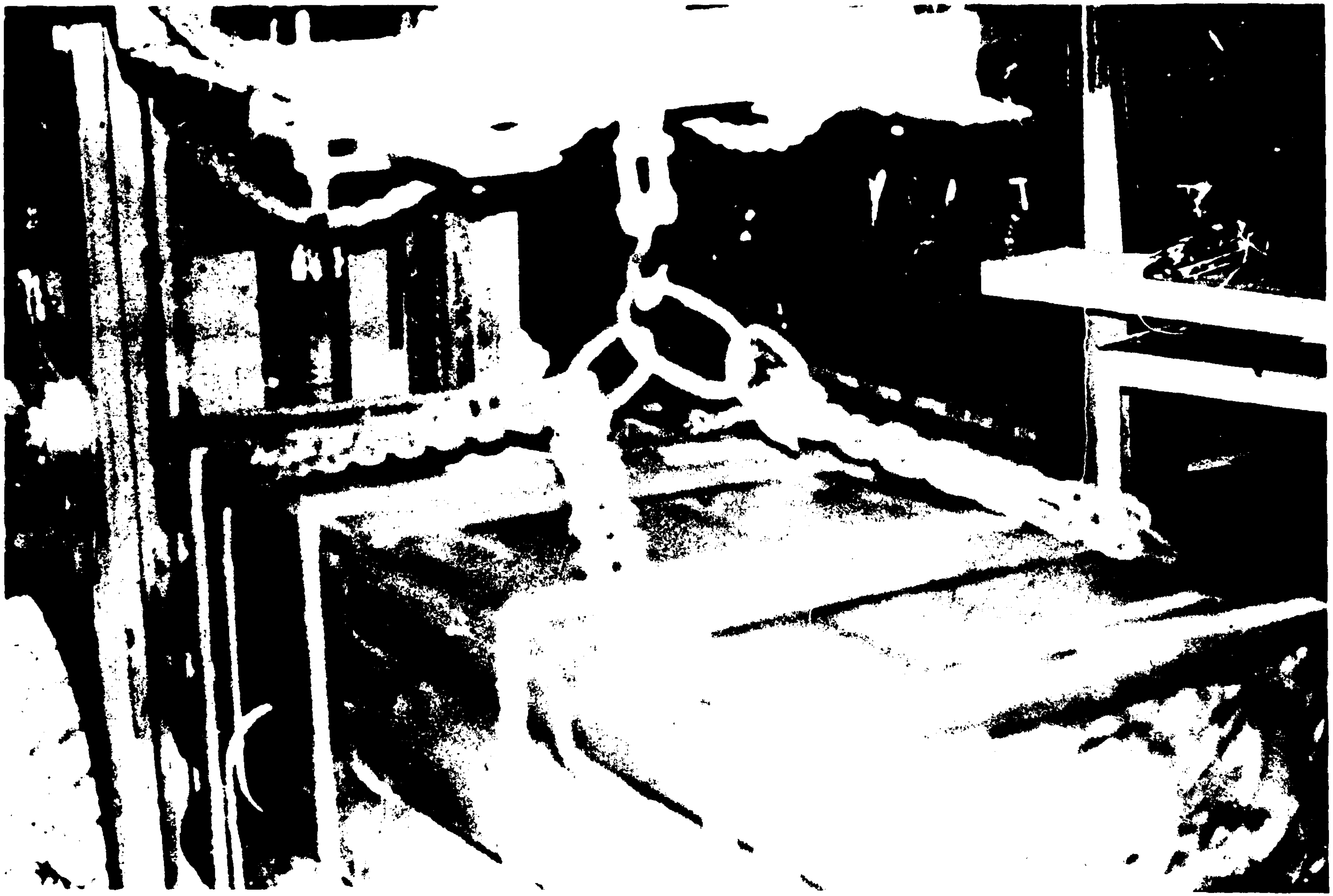

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Photo 9. This photo shows the Volcano Mine Pallet Adapter being lifted from four points by a sling.

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Photo 10. This photo shows the Volcano Mine Pallet being lifted from three points by a sling. Note the intruded angle is between 20 and 25 degrees.

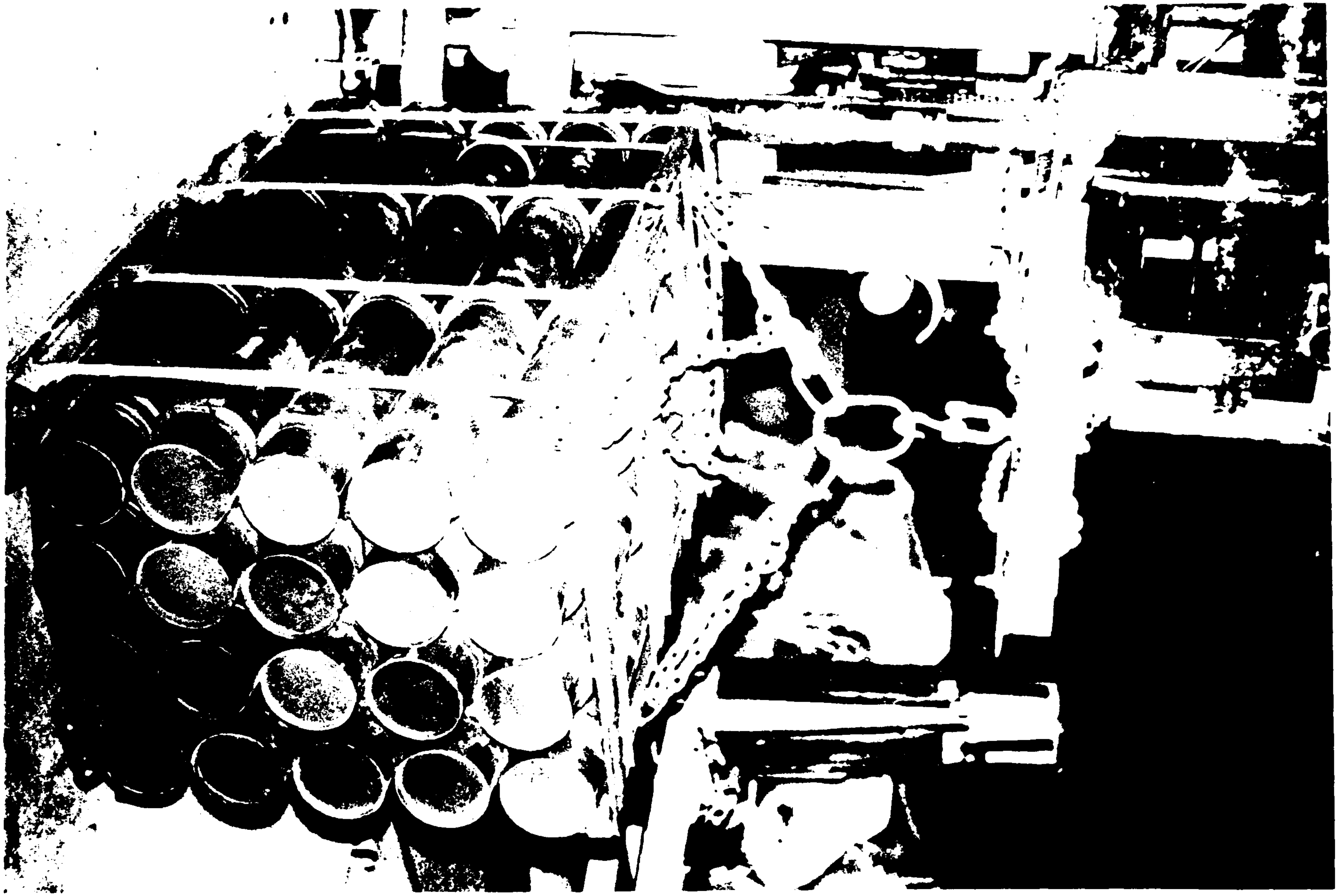

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Photo 11. This photo shows the Volcano Mine Pallet being lifted from two diagonal points by a sling with an intruded angle between 20 and 25 degrees.

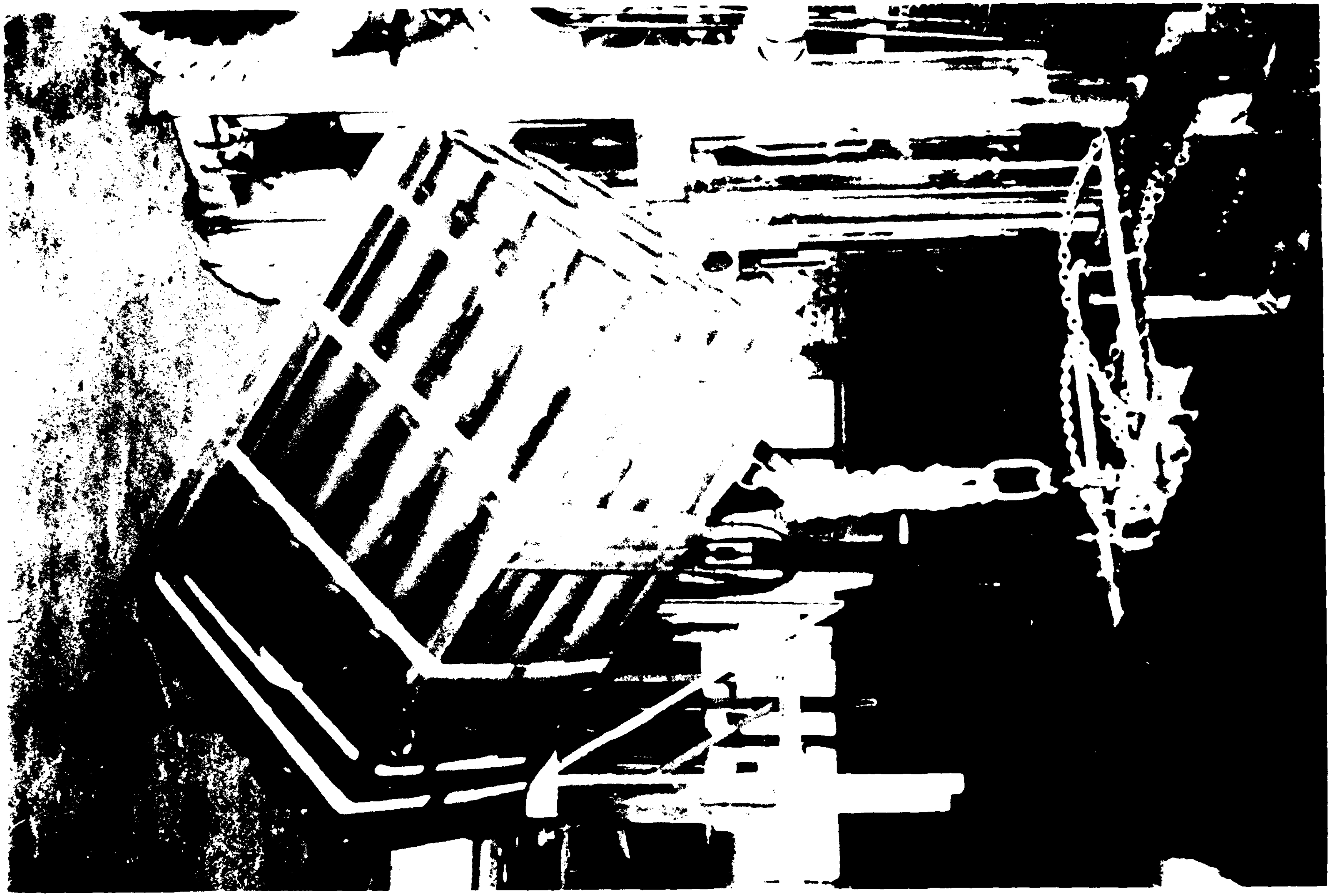

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Photo 12. This photo shows deformation in the Pallet Adapter of the Volcano Mine Pallet when being lifted by a sling. The connecting attachment or lifting eye was also deformed.

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Photo 13. This photo shows the Volcano Mine Pallet being lifted by a single slinging point. Note the modified bundling technique.