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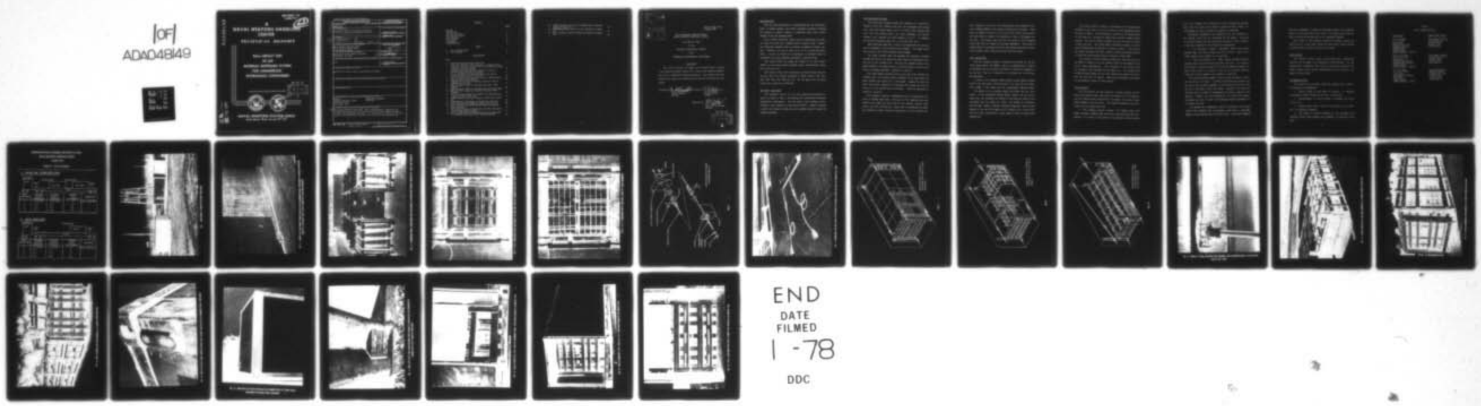

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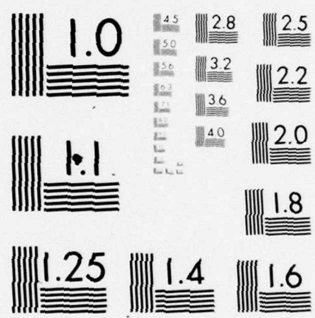

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NWHC REPORT 7749
3 AUGUST 1977

A NAVAL WEAPONS HANDLING CENTER

TECHNICAL REPORT

RAIL IMPACT TEST OF AN INTERNAL RESTRAINT SYSTEM FOR COMMERCIAL INTERMODAL CONTAINERS

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NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey 07722

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This report describes rail impact tests conducted upon a concept of an Internal Restraint System Kit to secure three different ammunition loads in commercial intermodal containers. The results of the tests indicate this concept can satisfactorily restrain the load within the containers.

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NAVAL WEAPONS HANDLING CENTER

RAIL IMPACT TEST OF AN INTERNAL RESTRAINT SYSTEM FOR COMMERCIAL INTERMODAL CONTAINERS

ABSTRACT

This report describes rail impact tests conducted upon a concept of an Internal Restraint System Kit to secure three different ammunition loads in commercial intermodal containers. The results of the tests indicate this concept can satisfactorily restrain the load within the containers.

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INTRODUCTION

With the rapid introduction of containerships into the US Merchant Fleet, it became apparent that future emergency situations requiring the shipment of military supplies in commercial hulls, would require adaption to the new shipping modes.

Due to safety restrictions, cargo restraint requirements for explosive items are much more stringent than for general cargo. Commercial intermodal containers have no internal dunnaging (restraint) systems. Therefore, the use of these containers for transporting ammunition; as would be required in an emergency, is dependent upon the availability of an easily installed, inexpensive, restraint system.

This report details the design and testing of one such system, IRSKIT, by the Naval Weapons Handling Center, Naval Weapons Station Earle, Colts Neck, NJ.

This system evolved from observations and data derived from prior concepts which are formally described in NWHC Reports 7516, 7537, 7565, 7590, 7613, 7645, 7695 and 7711. The rail impact tests described herein were conducted on 18 May 1977.

THE TEST CONTAINER

The containers used in this test were commercial intermodal containers as listed in Table I and meeting ISO (International Standards Organization) requirements. The test loads of inert ordnance corresponding to each container are also listed in Table I. Figures 1 through 5 depict the container loading area and container interiors during the stuffing operations.

THE RESTRAINT SYSTEM

The loads were restrained within the containers by a system consisting of four 5/8" diameter steel wire rope assemblies with swaged eyes, four steel anchor blocks, four 1" x 8 UNC x 48" threaded steel rods, four steel backup plates, two swivel assemblies, and screws, washers, nuts, shackles and pins (Figures 6 and 7). In addition, two structural aluminum angles 8"L x 12 lb x 85" were used.

Each structural angle has a series of predrilled holes for the purpose of attachment to the restraint cable assembly. The single bottom hole is used for the bottom restraint cable assembly.

The upper restraint cable and threaded rod assembly is installed through the hole of the upper five holes which lies immediately above the level of the ordnance load. This was the uppermost hole for the 105mm Ordnance; the middle hole for the MK 82 Bombs; and the lowest hole for the 155mm Projectiles. [Figures 8, 9 and 10]

The swivel fitting provides the nut at the end of the threaded rod assembly with a flat bearing surface regardless of the angle which the cable assembly may assume due to load height. [Figure 11]. Wood end gates, and various components of dunnaging and bracing were used as required for the specific load and container. These are illustrated in Figures 12, 13 and 14.

The containers required a modification prior to loading which consisted of drilling eight holes. Four pairs of 7/8" diameter holes were drilled at the upper and lower ends of the container vertical corner posts at the front (closed) end. These were to accommodate the terminal connections (anchor blocks and backup plates) of the restraint system, [Figures 15, 16 and 17]. The backup plates were designed to present a minimal addition to the exterior envelope of the container. Those shown in Figures 15 and 16 are for use on flat exterior corner posts. The plate shown in Figure 17 is installed on a type of corrugated corner post. The backup plate fits into the recess in the corrugated section and does not change the container dimensions. Both types of backup plates are fabricated from the same material and both are identical in length, width, thickness and hole size and spacing.

TEST PROCEDURE

The test containers loaded as indicated were placed on a 90 foot TTCX railway flatcar, SN 976080. This car is equipped with a cushioned drawhead and has tie-down provisions to secure ISO containers to the car bed. This car is referred to as the impact car in the following description.

A string of five stationary empty boxcars coupled together without slack in the draft gears, and with brakes "set" was used as a buffer. Total weight of the buffer cars was approximately 260,000 pounds.

The impact car was propelled toward the buffer cars by a locomotive. At the approximate desired impact velocity, the car was released from the locomotive and allowed to roll freely for about 75 feet and impact into the buffer car string. The official test procedure, MIL-STD-1325, "Railcar Loading of Hazardous Materials" calls for three impacts on one end of the impact car at velocities of 4, 6 and 8 mph. The car is then reversed and a single impact is made at 8 mph on the opposite end.

The actual velocity of impact is determined by two microswitches installed at each end of an 11 foot section of track immediately before the point of impact. The microswitches, actuated by the leading wheels of the impact car, activated an elapsed time recorder reading in milliseconds. The feet per second readings are then converted to velocity in miles per hour. The actual impact velocities and buffer car movements resulting from the impacts are listed in Table II. The doors of the loaded containers had been secured in their fully opened position in order that load movement could be observed on each impact.

The containers with the 105mm and 155mm test loads were placed on the flatcar as shown in the test syllabus (Table II) and Figures 18 and 19 and tested simultaneously. After completion of that series, those two containers were unloaded from the impact car. The container with the MK 82 Bombs (Figure 20) was then loaded on the flatcar and underwent the same series of impacts. High speed photography was utilized for recording the 8 mph ("A" End) impacts.

TEST RESULTS

The TTCX flatcar, the ISO Containers, restraint systems, and test loads were inspected after each impact for damage or loss of integrity. The four impacts which constituted the rail impact test results in negligible shifting of the test loads. The following summarizes the observations of each container/test load:

a. The aluminum exterior container, CTI 261469, packed with 155mm Projectiles remained tight and secure during and after the tests. However, as a result of the impacts in the direction toward the open end of the container the vertical line of rivets securing the aluminum skin to the rear corner posts sheared, causing the skin to ripple. No other damage was noted on either the container or projectiles.

Subsequent investigation has established that the installation of the restraint system was not responsible for this damage. This mode of container damage has been frequently observed on other containers of this type regardless of the internal load configuration.

b. The fiberglass container, SNC-49834, packed with 105mm, remained tight and secure during and after the tests. There was no visible damage to the container or the unit loads.

c. The steel container, CTI 041689, packed with MK 82 Bombs, remained tight and secure during and after the tests. As a result of the bearing of transverse beams in the forward bulkhead assembly, the corner posts bowed to a depth of 1 inch in the horizontal direction. There was no other damage to the container or unit loads.

The above mentioned damage occurred during the impacts towards the closed end at 8.8 mph. It should be noted that the restraint system has no load carrying capability in the direction towards the closed end due to the usage of wire rope cables. Therefore, the closed end structure must be capable of withstanding the forces of impact in that direction. However, the forces imparted to the closed end during a rail impact test were in excess of the applicable design requirements for a container end wall.

An identical test configuration with the exception of the forward (closed end) bulkhead was subsequently tested with no discernible damage to the closed end wall and corner posts. The forward bulkhead had been redesigned to present the maximum bearing of the bulkhead against the wall panel and corner posts. The initial design had only about one-third the bearing area as the redesigned bulkhead.

The testing of this bulkhead consisted of impacts towards the closed end at 4, 6 and 8 mph; towards the open end at 8 mph, followed by another impact towards the closed end at 8 mph.

CONCLUSIONS

The internal restraint system as described herein, satisfactorily withstood the rail impact test requirements of MIL-STD-1325. The test configurations encompassed three levels of load density and three different container types thereby demonstrating that this concept is not limited by these factors.

RECOMMENDATIONS

The system has successfully passed the required tests, however, the following are recommended:

a. Further testing in other modes of transport; i.e. shipboard trial shipment, TOFC (Trailer On Flat Car), over the road.

b. Instrumentation in future testing to determine load levels, stresses, etc.

c. Design studies and/or tests for the purpose of cost reduction or to facilitate installation.

d. The design of forward bulkheads for the corrugated steel containers which would minimize the possibility of bowing the corner posts.

TABLE I

TEST CONFIGURATIONS

CONTAINER	INERT TEST LOADS
CTI S/N 261469 8' x 8' x 20' Steel Frame, Aluminum Panel Ext., Plywood Panel Int., Aluminum Roof, Wood Flooring, Weight (Empty): 4000 lb.	Army 155mm Projectile 8 Proj/Unit Load 42 Unit Loads @ 800 lb. Unit Total 33600 lb.
NWHC SNC-49834 8' x 8' - 6" x 20' Steel Frame, Fiberglass Reinforced Plywood Walls and Roof, Wood Flooring Weight (Empty): 4350 lb.	Army 105mm Projectile 30 Proj/Unit Load 20 Unit Loads @ 1910 lb. Unit Total 38200 lb.
CTI S/N 041689 8' x 8' x 6" x 20' Steel Frame, Corrugated Steel Walls, Steel Roof, Wood Flooring Weight (Empty): 5140 lb.	Navy MK 82 Bombs (MHU/122 Pallets) 6 Bombs/Unit Load 12 Unit Loads @ 3000 lb. Unit Total 36000 lb.

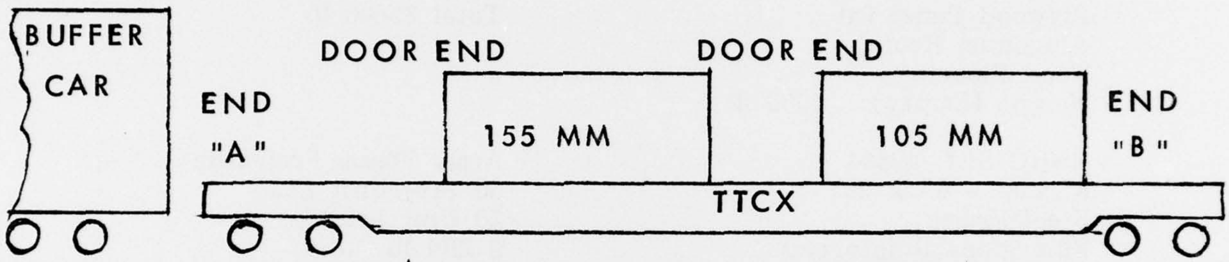
DEMONSTRATION OF INTERNAL RESTRAINT SYSTEM

NAVAL WEAPONS HANDLING CENTER

18 MAY 1977

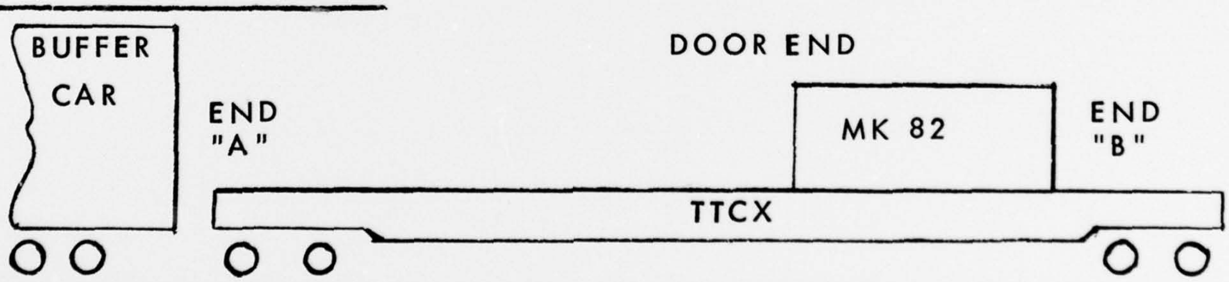
TABLE II - TEST SYLLABUS

A. 105 MM AND 155 MM INERT LOADS



END IMPACTED	DESIRED IMPACT VELOCITY	ACTUAL IMPACT VELOCITY	BUFFER CAR MOVEMENT	REMARKS
A	4.0 MPH	4.75 MPH	7"	NO DAMAGE
A	6.0	6.4	14"	"
A	8.0	8.8	35"	"
B	8.0	8.8	37"	"

B. MK 82 INERT LOADS



END IMPACTED	DESIRED IMPACT VELOCITY	ACTUAL IMPACT VELOCITY	BUFFER CAR MOVEMENT	REMARKS
A	4.0 MPH	4.4 MPH	4"	NO DAMAGE
A	6.0	6.6	8"	"
A	8.0	8.8	17"	"
B	8.0	8.8	28"	"

FIG. 1 CONTAINERS DURING STUFFING OPERATION

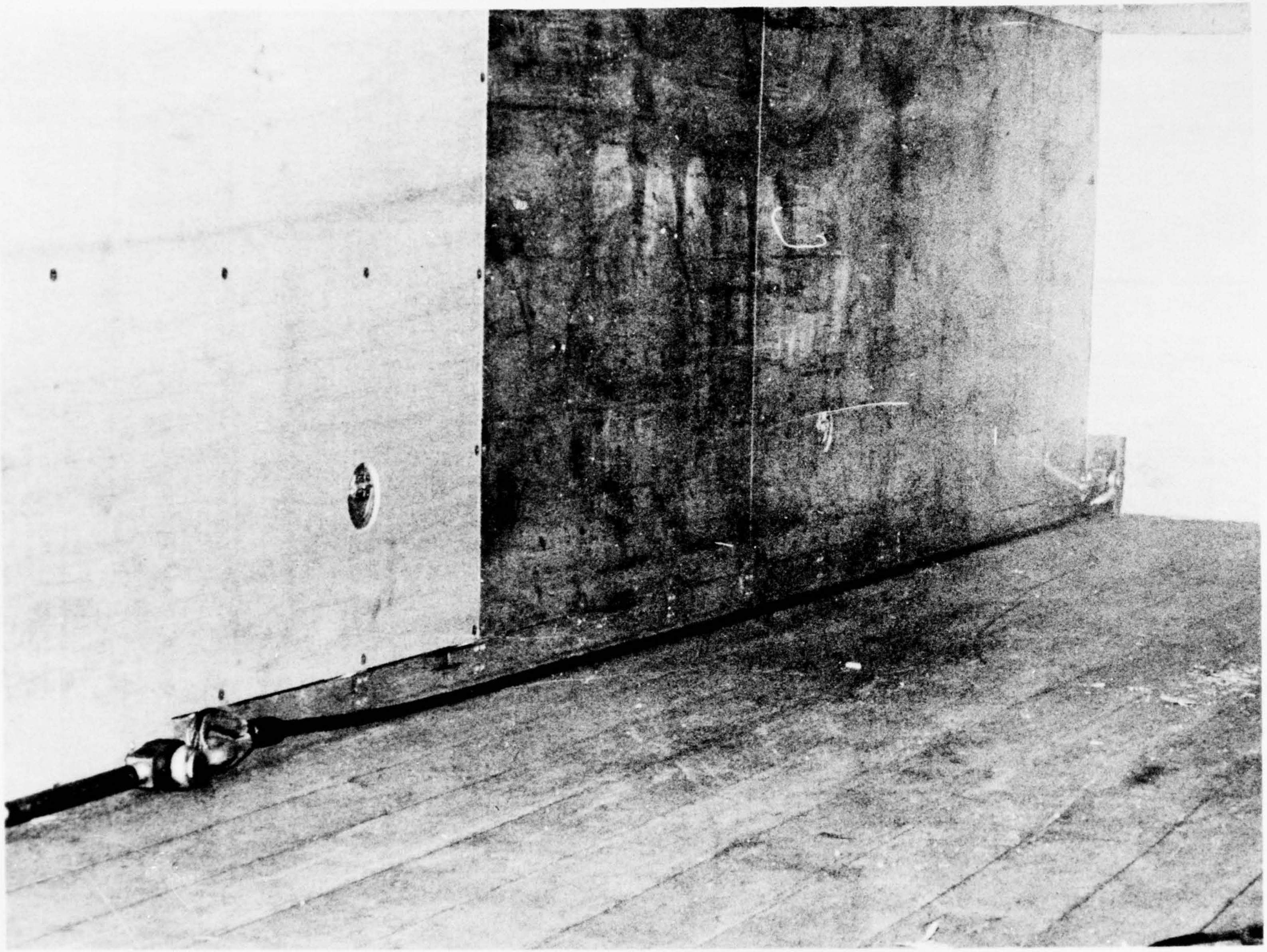


FIG. 2 LOWER LEFT RESTRAINT CABLE INSTALLED IN ALUMINUM PANEL CONTAINER (PLYWOOD INTERIOR) PRIOR TO 'STUFFING' WITH 155mm PROJECTILE LOAD AND DUNNAGE

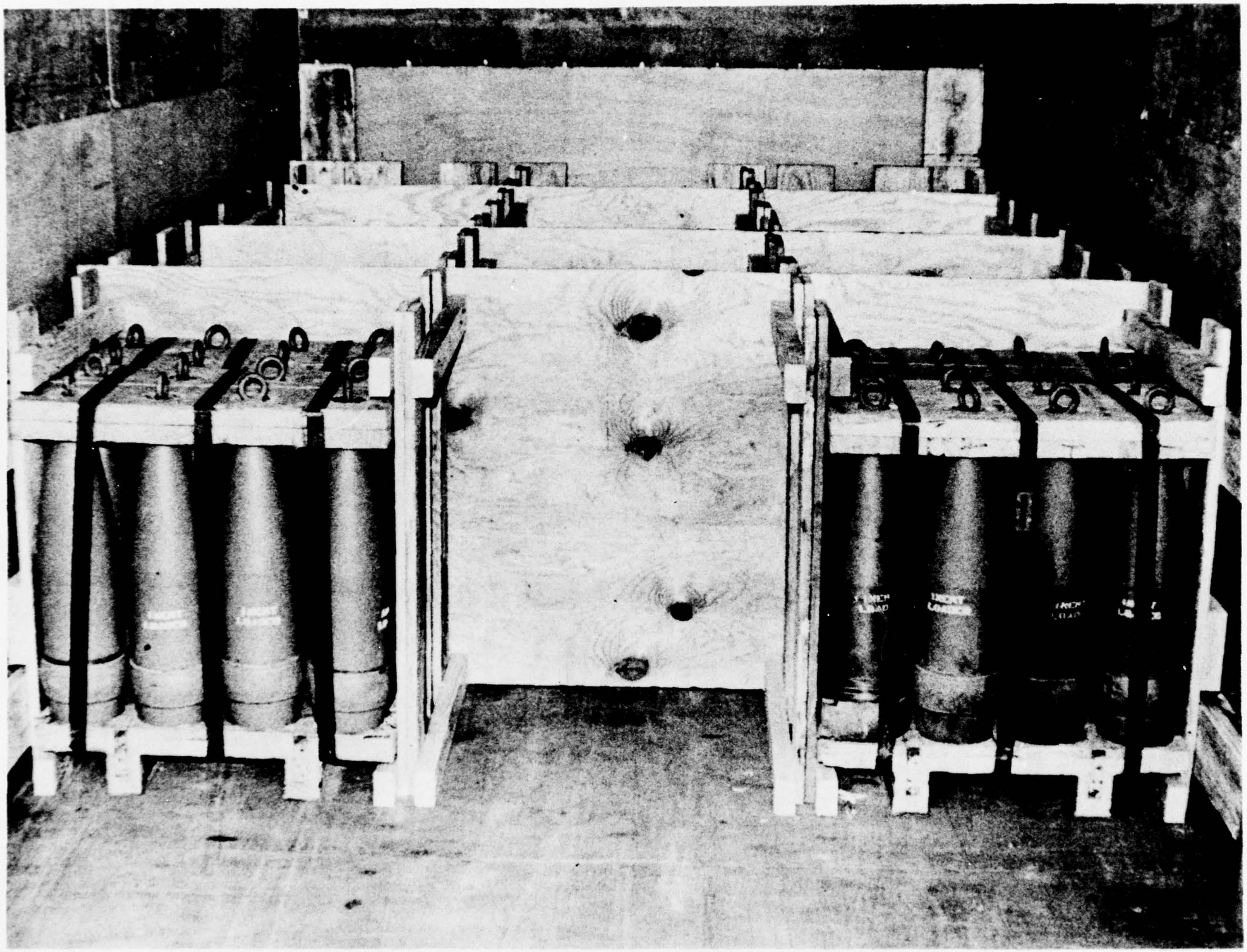


FIG. 3 ALUMINUM PANEL CONTAINER WITH RESTRAINT SYSTEM AND PARTIAL PROJECTILE LOAD AND DUNNAGE

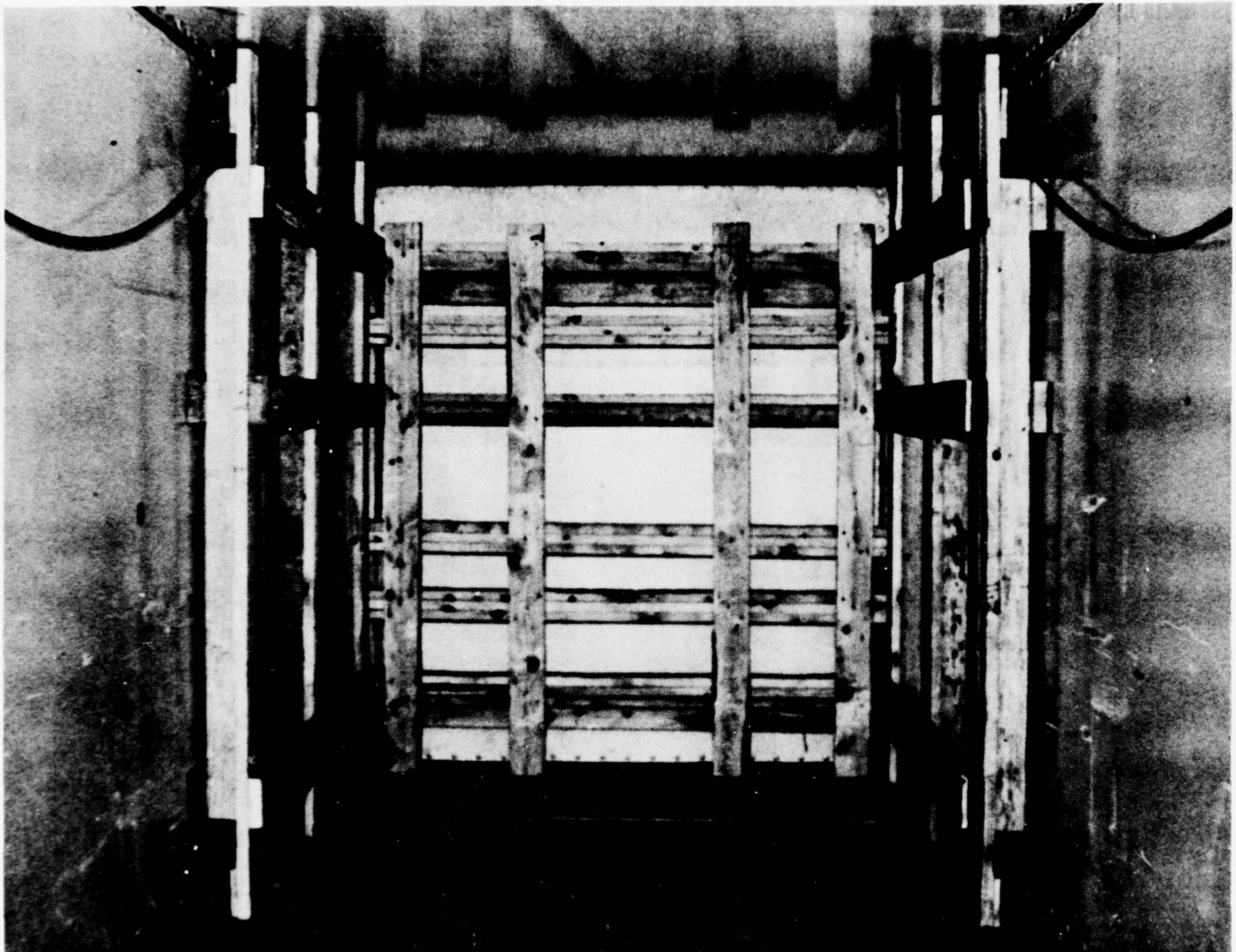


FIG. 4 F.R.P. CONTAINER WITH RESTRAINT SYSTEM AND PARTIAL DUNNAGE INSTALLED PRIOR TO 'STUFFING'

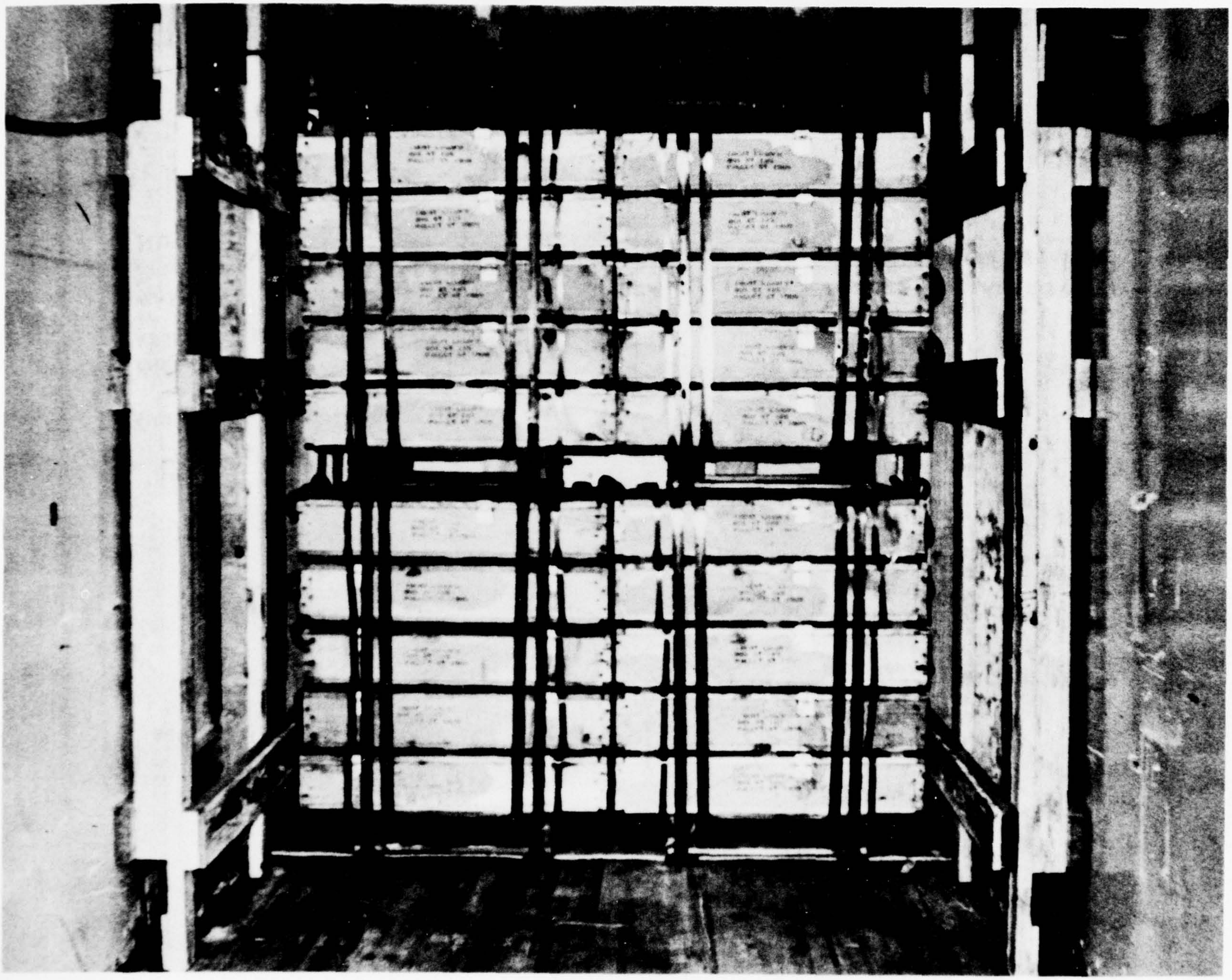
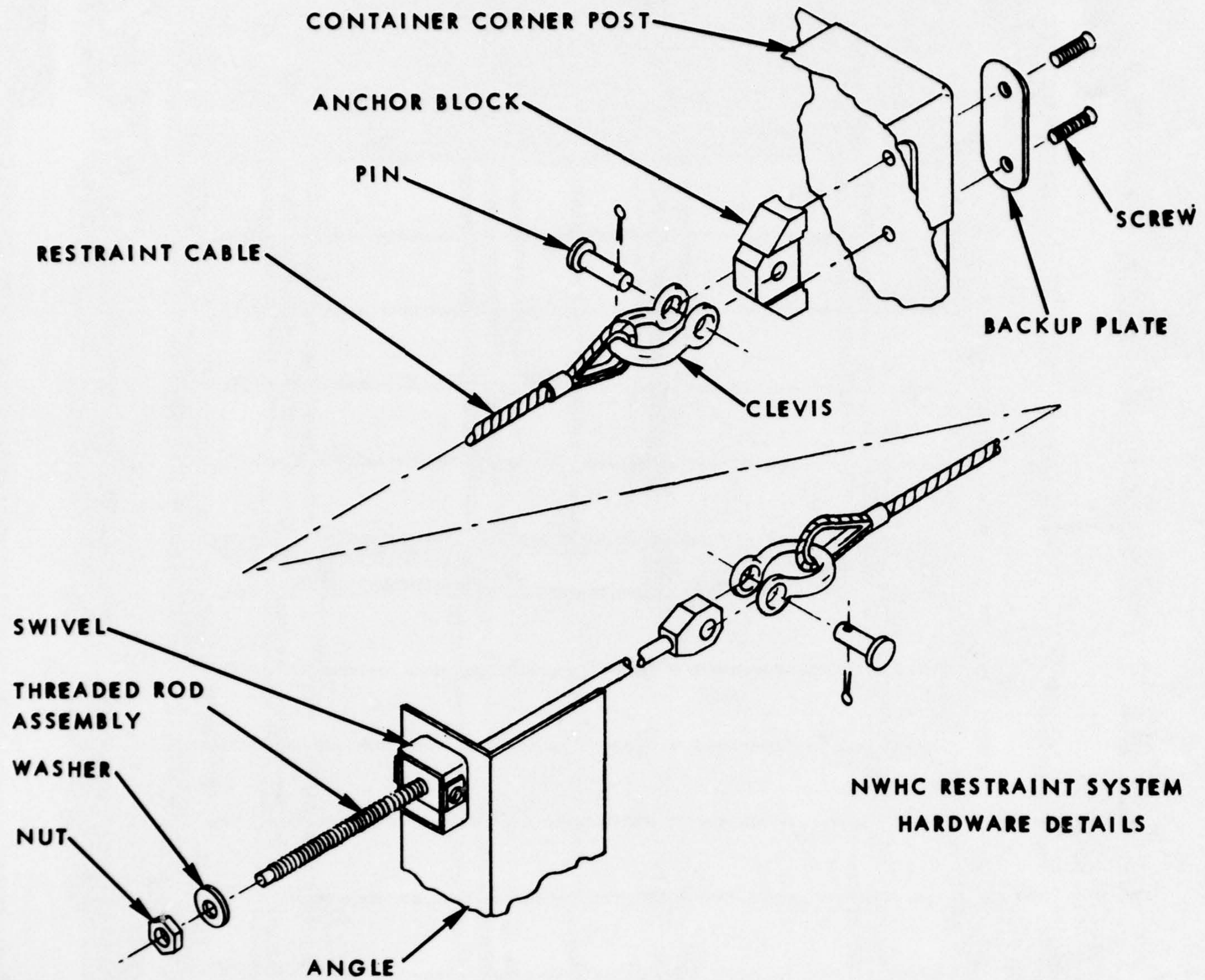


FIG. 5 F.R. P. CONTAINER WITH FOUR UNIT LOADS OF 105mm QRDNANCE



NWHC RESTRAINT SYSTEM
HARDWARE DETAILS

FIG. 6

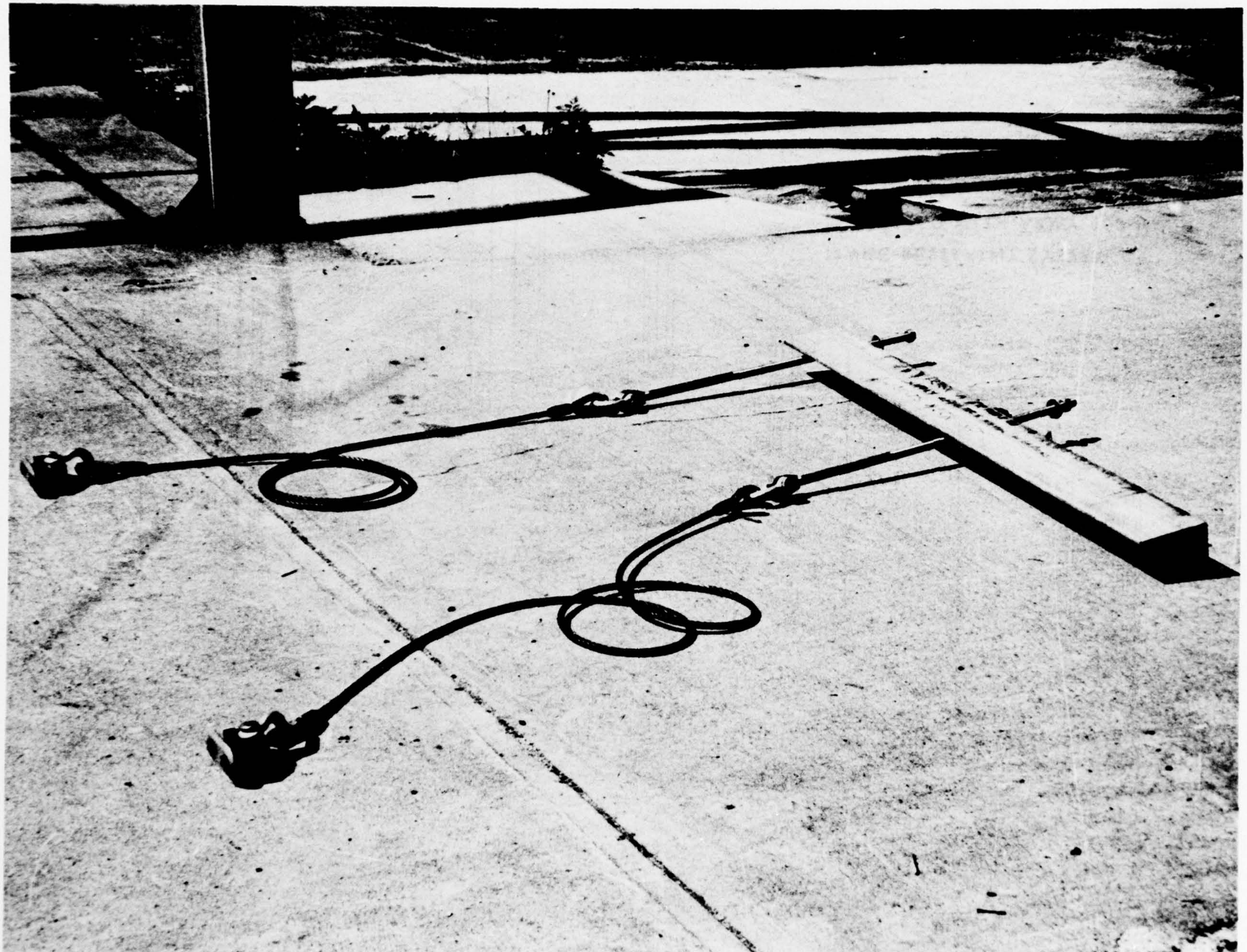
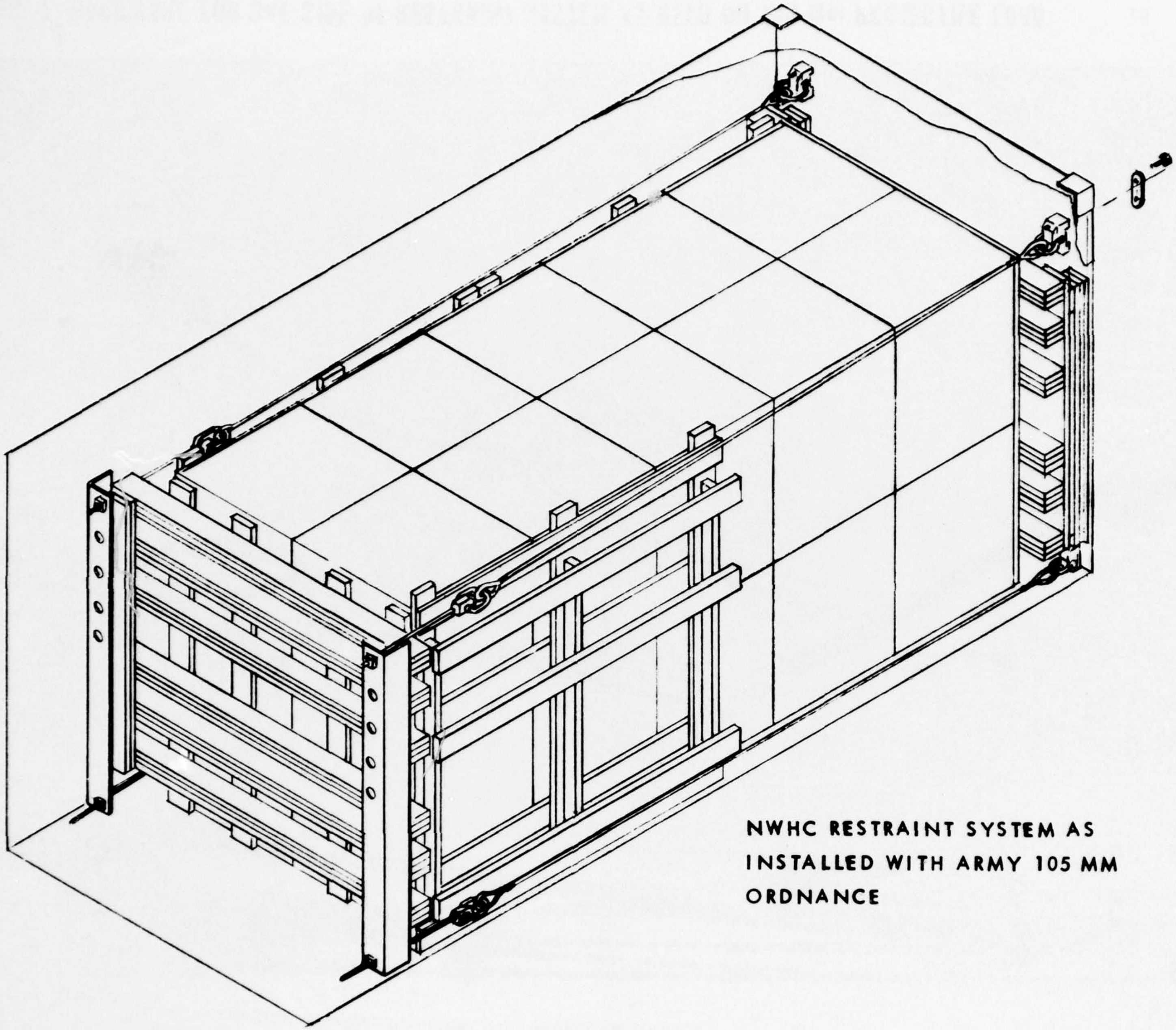
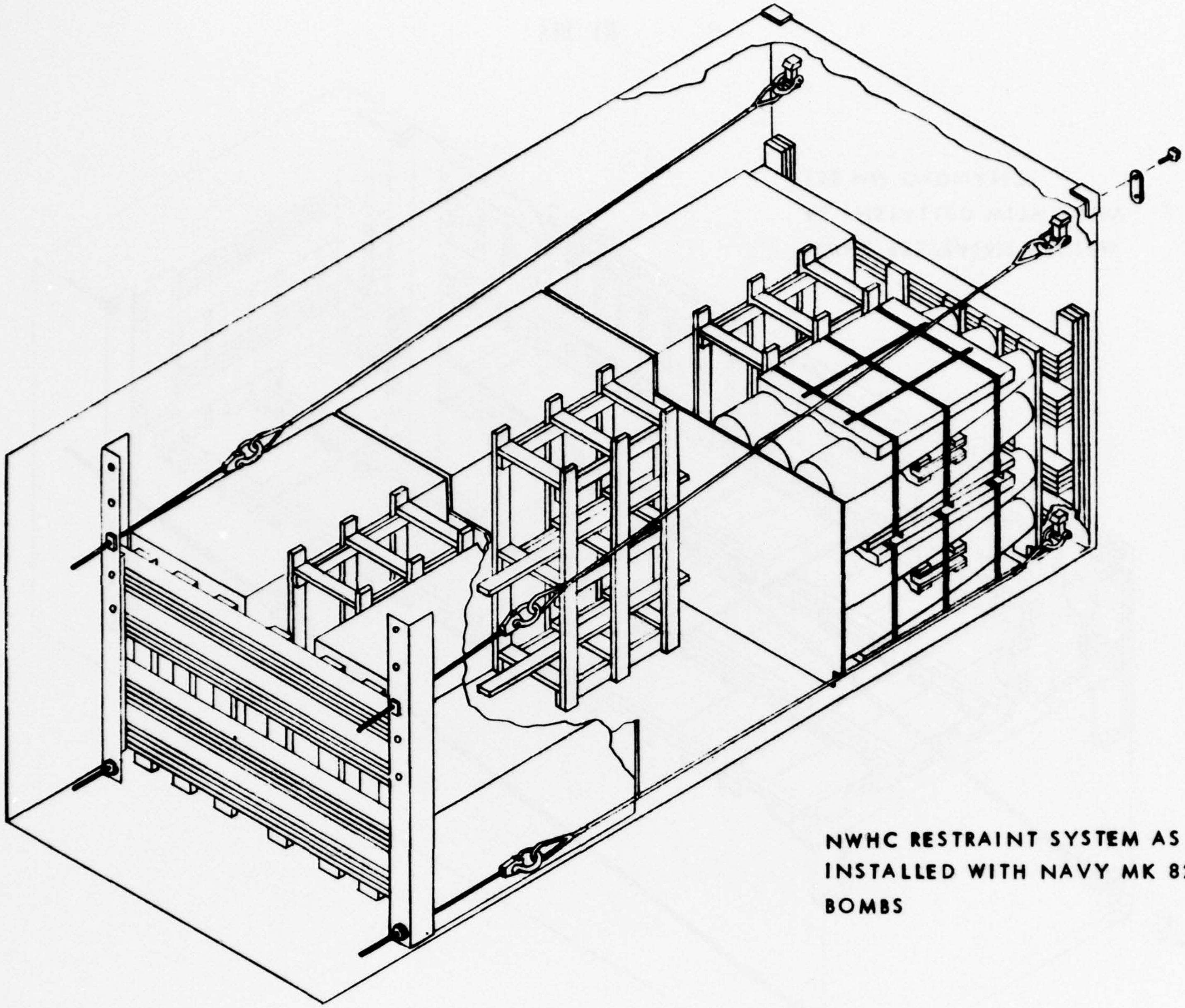


FIG. 7 HARDWARE FOR ONE SIDE OF RESTRAINT SYSTEM AS USED ON 155 mm PROJECTILE LOAD



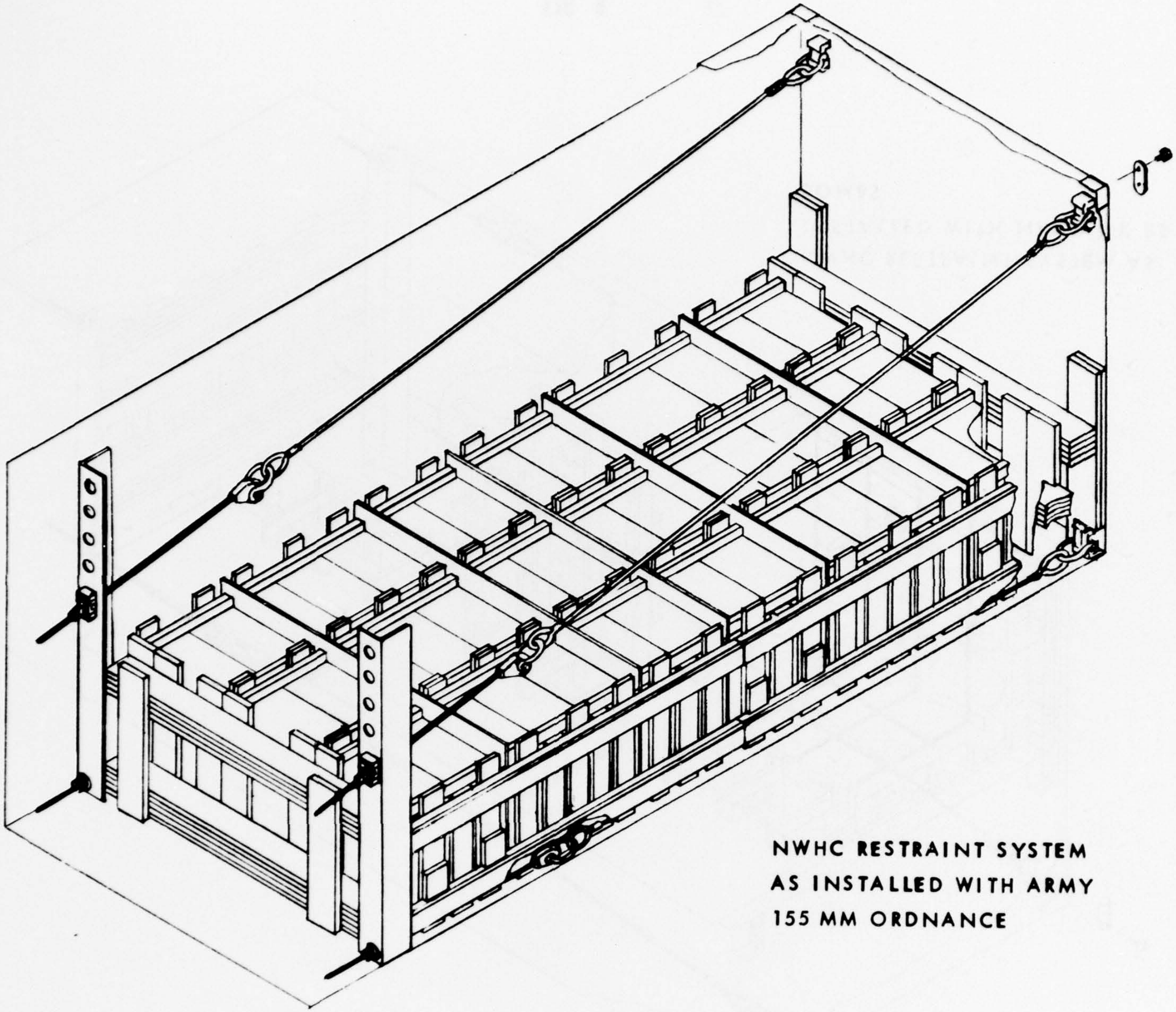
NWHC RESTRAINT SYSTEM AS INSTALLED WITH ARMY 105 MM ORDNANCE

FIG. 8



NWHC RESTRAINT SYSTEM AS INSTALLED WITH NAVY MK 82 BOMBS

FIG. 9



NWHC RESTRAINT SYSTEM
AS INSTALLED WITH ARMY
155 MM ORDNANCE

FIG. 10

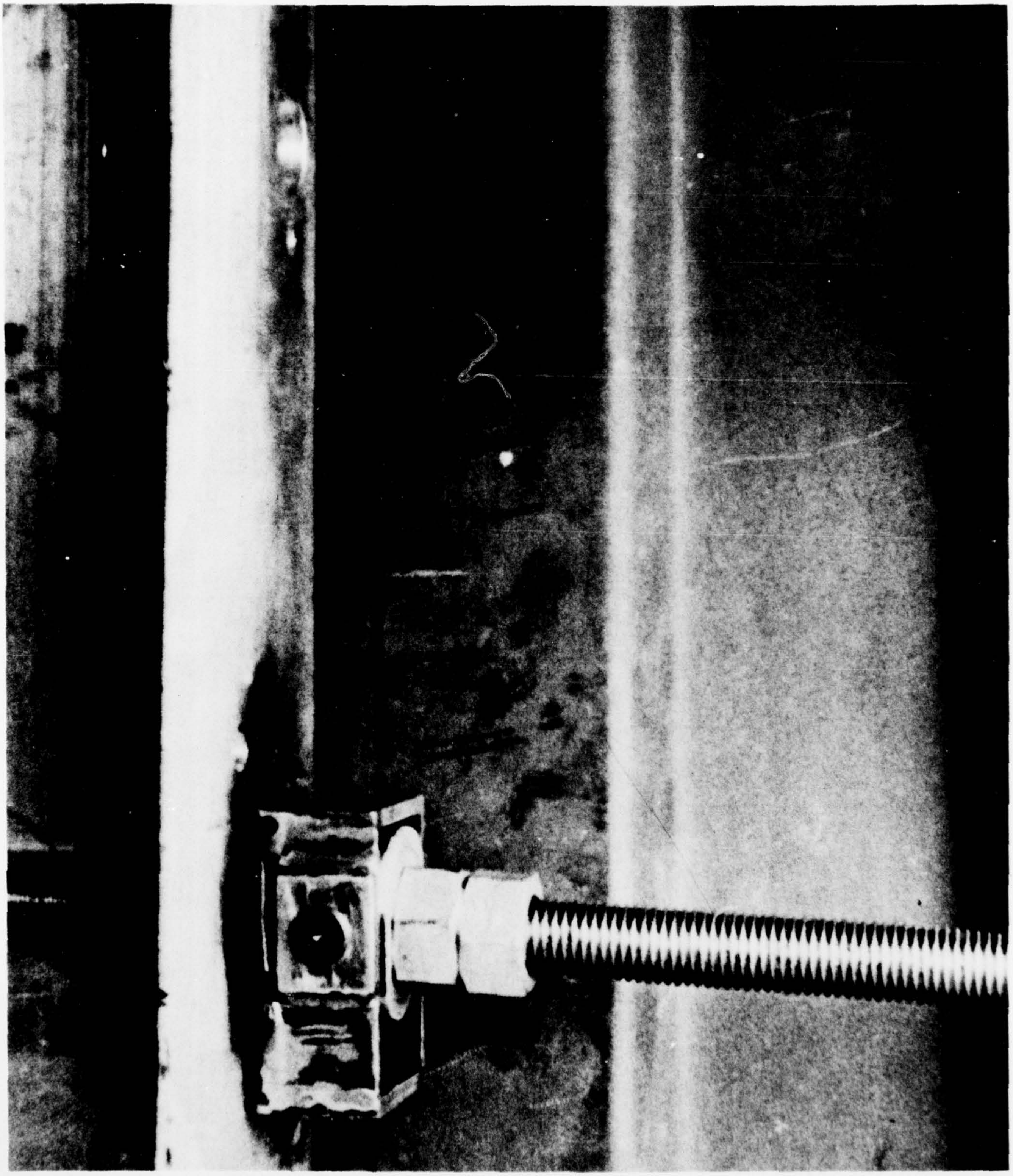


FIG. 11 SWIVEL FITTING, THREADED ROD ASSEMBLY AND ALUMINUM ANGLE AS USED WITH MK 82 TEST LOAD

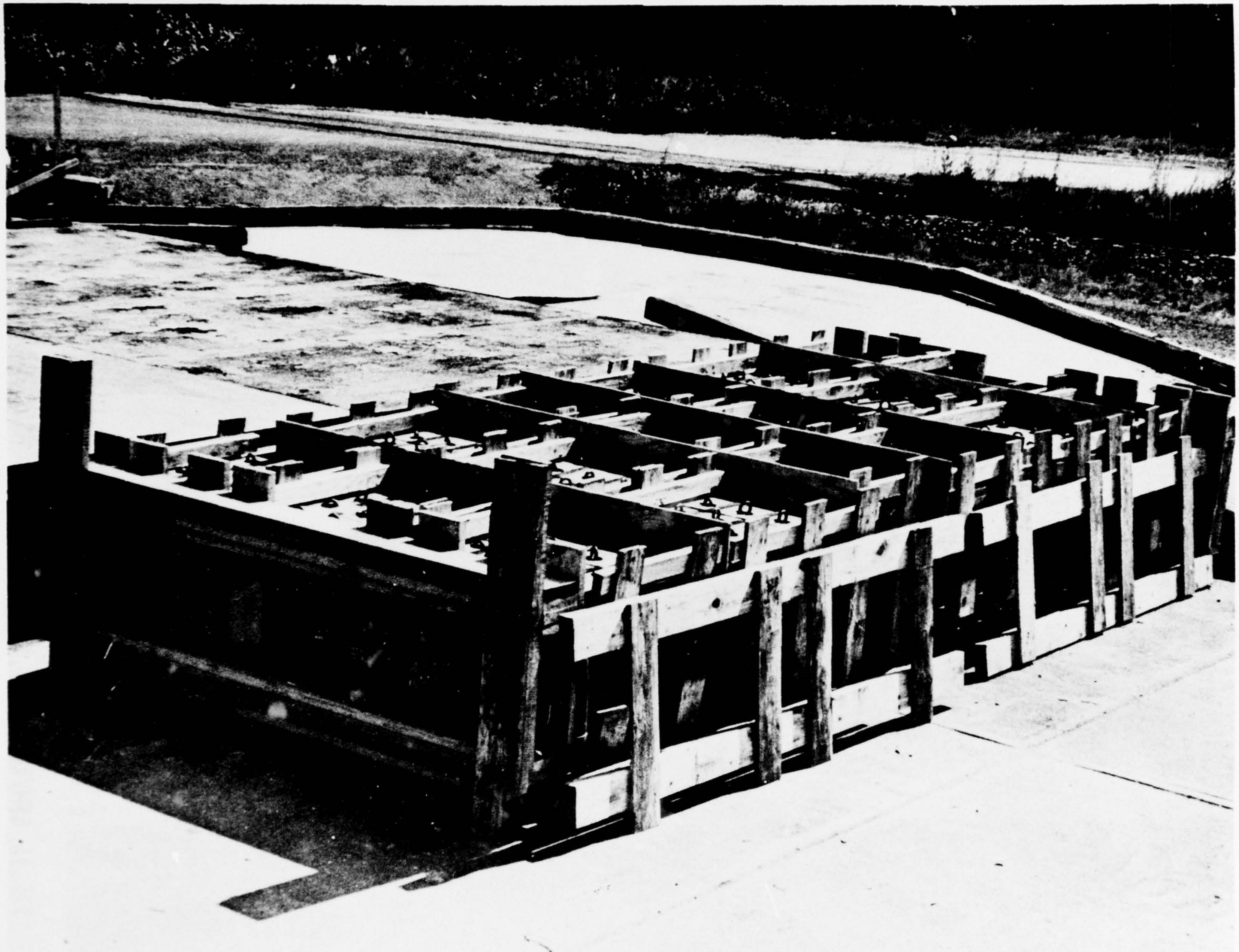


FIG. 12 155mm PROJECTILE LOAD AND DUNNAGE AS VIEWED FROM CLOSED END

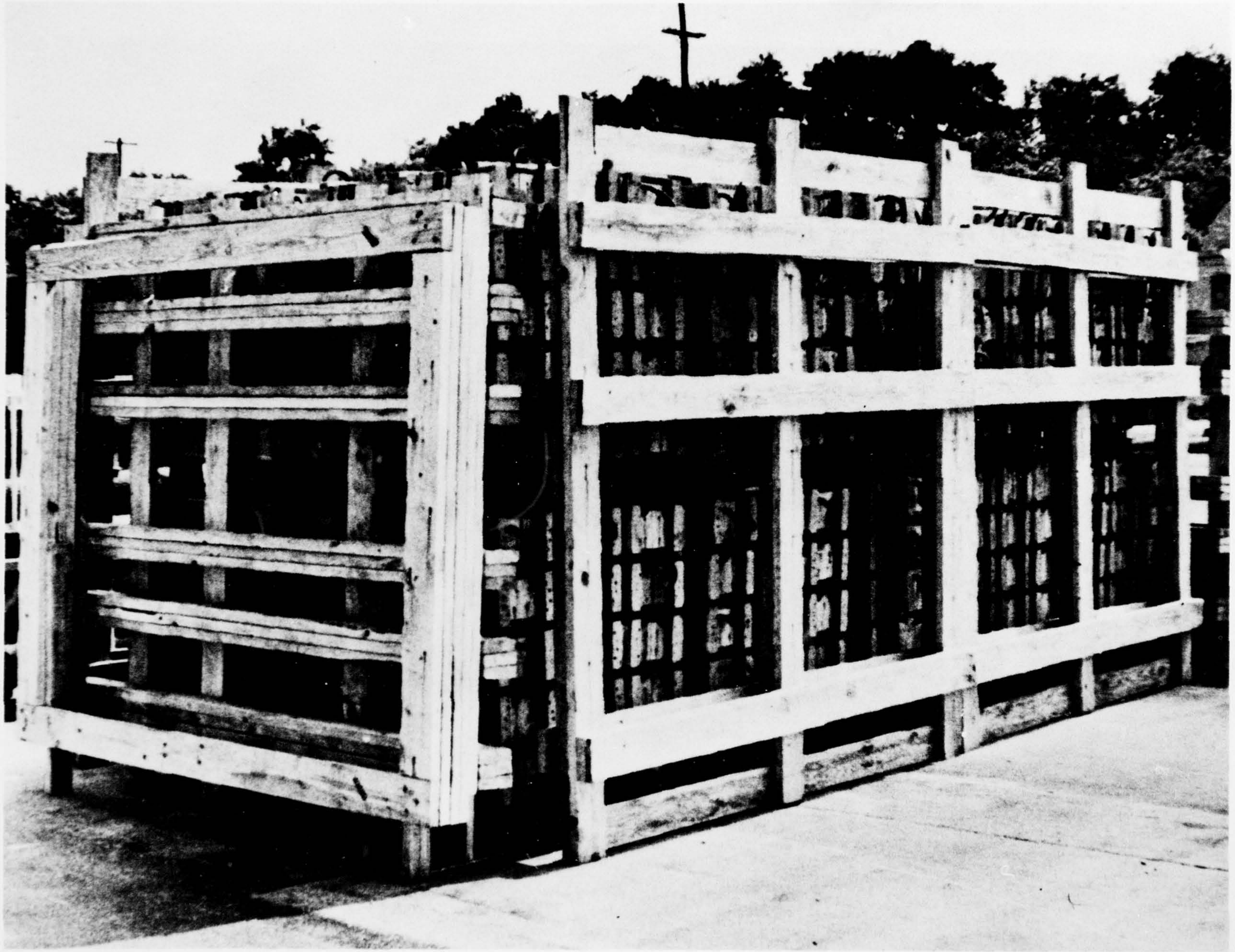


FIG. 13 105mm ORDNANCE AND DUNNAGE AS VIEWED FROM CLOSED END

FIG. 14 MK 82 BOMB LOAD AND DUNNAGE AS VIEWED FROM DOOR END

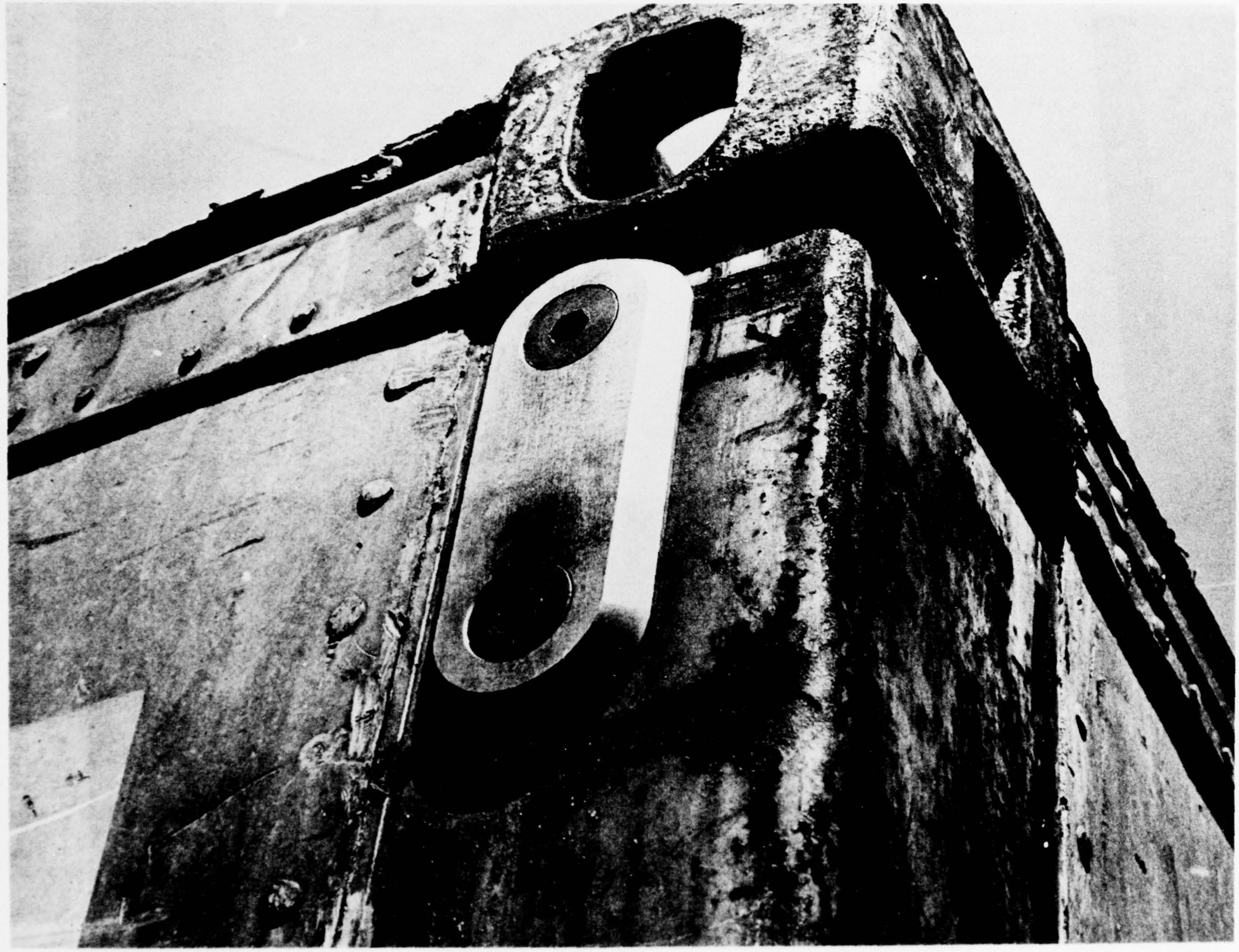


FIG. 15 BACK UP PLATES AND COUNTER SUNK HEAD SCREWS INSTALLED ON ALUMINUM PANEL CONTAINER

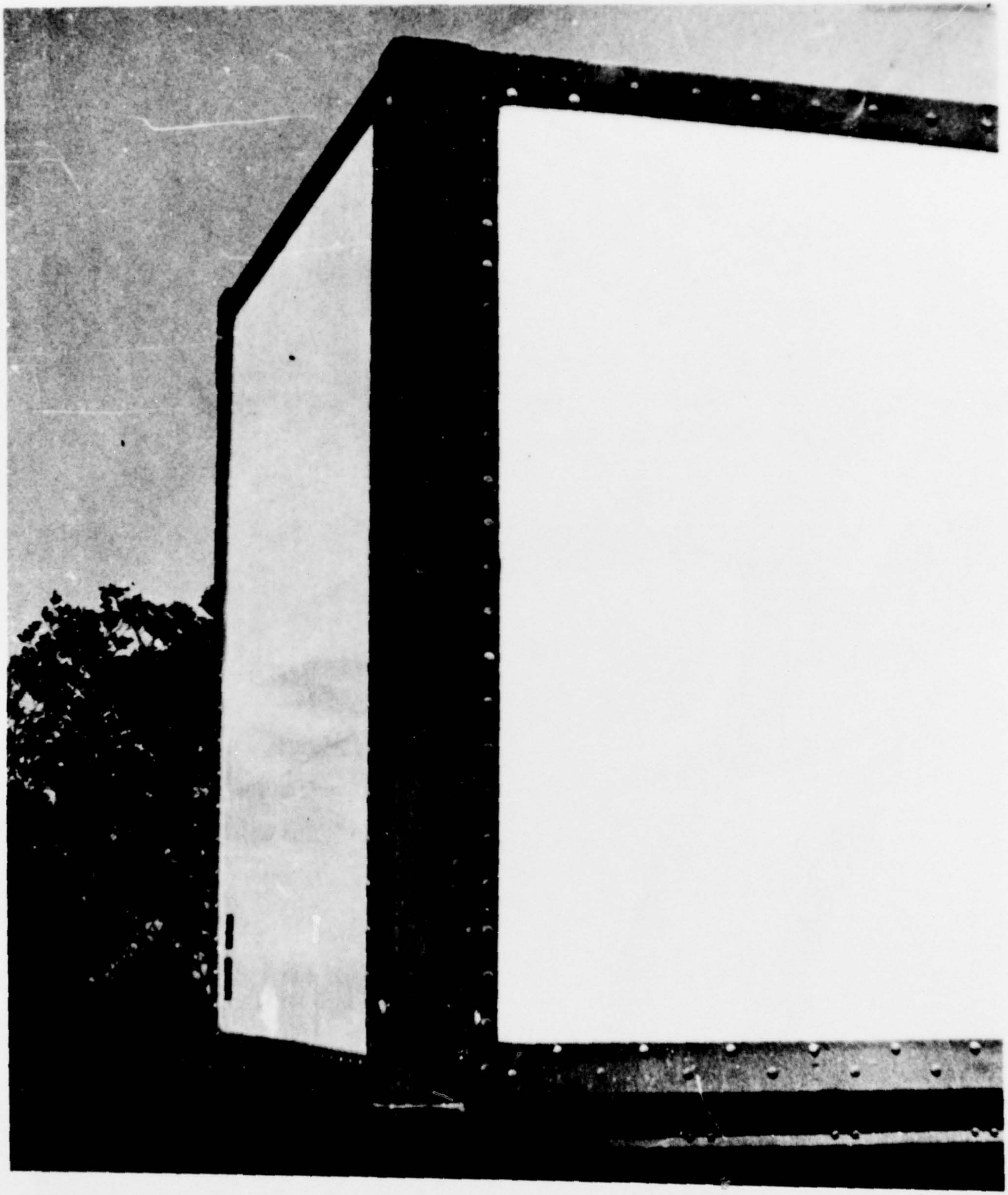


FIG. 16 FOUR BACK UP PLATES INSTALLED ON CORNER POSTS OF FIBRE GLASS REINFORCED PLYWOOD PANEL CONTAINER

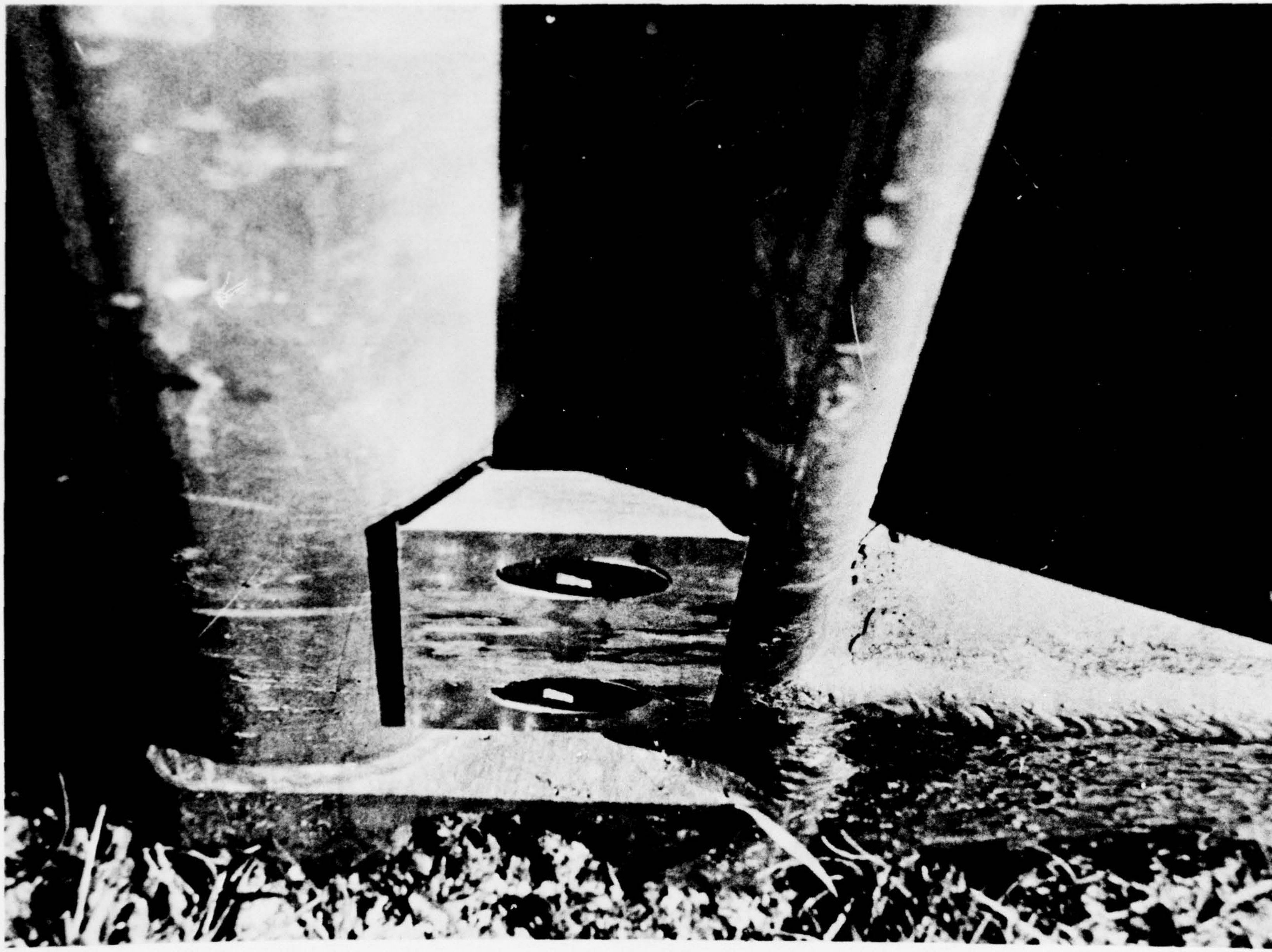


FIG. 17 BACK UP PLATE AND COUNTERSUNK HEAD SCREWS AS INSTALLED ON CORRUGATED CORNER POST STEEL PANELED CONTAINER

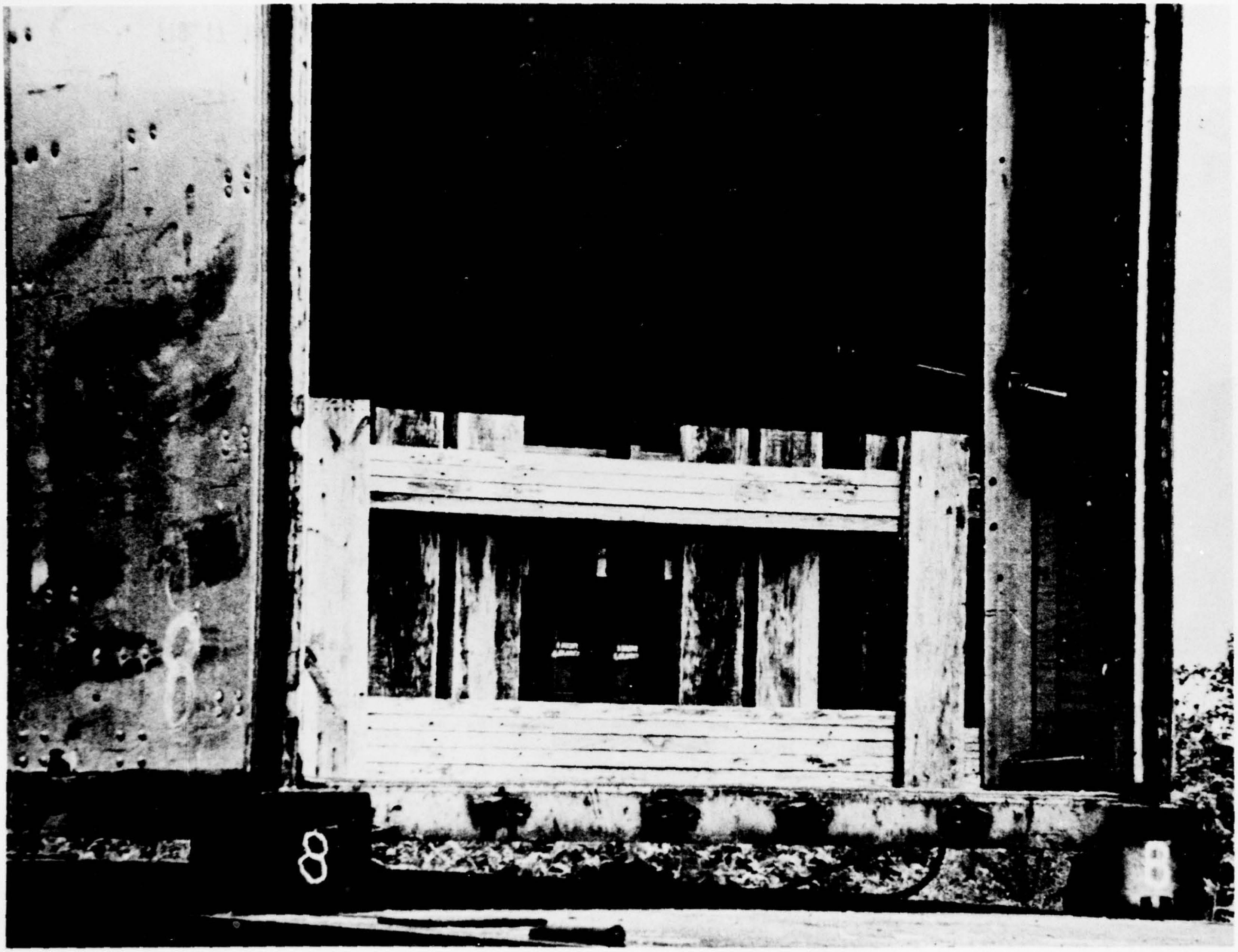


FIG. 18 155mm PROJECTILE TEST LOAD IN ALUMINUM PANEL CONTAINER MOUNTED ON IMPACT CAR

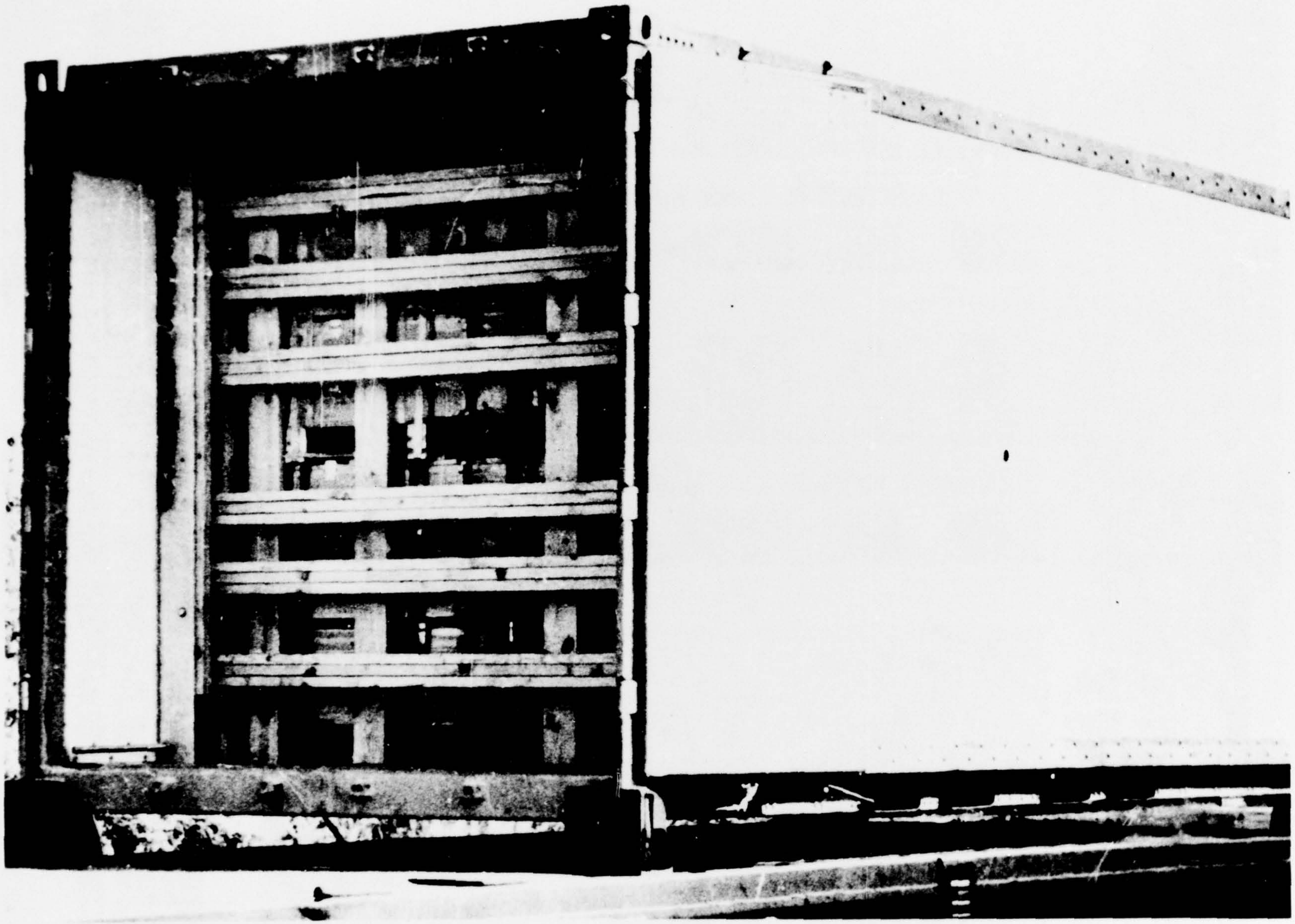


FIG. 19 105mm ORDNANCE TEST LOAD IN F.R.P. CONTAINER MOUNTED ON IMPACT CAR

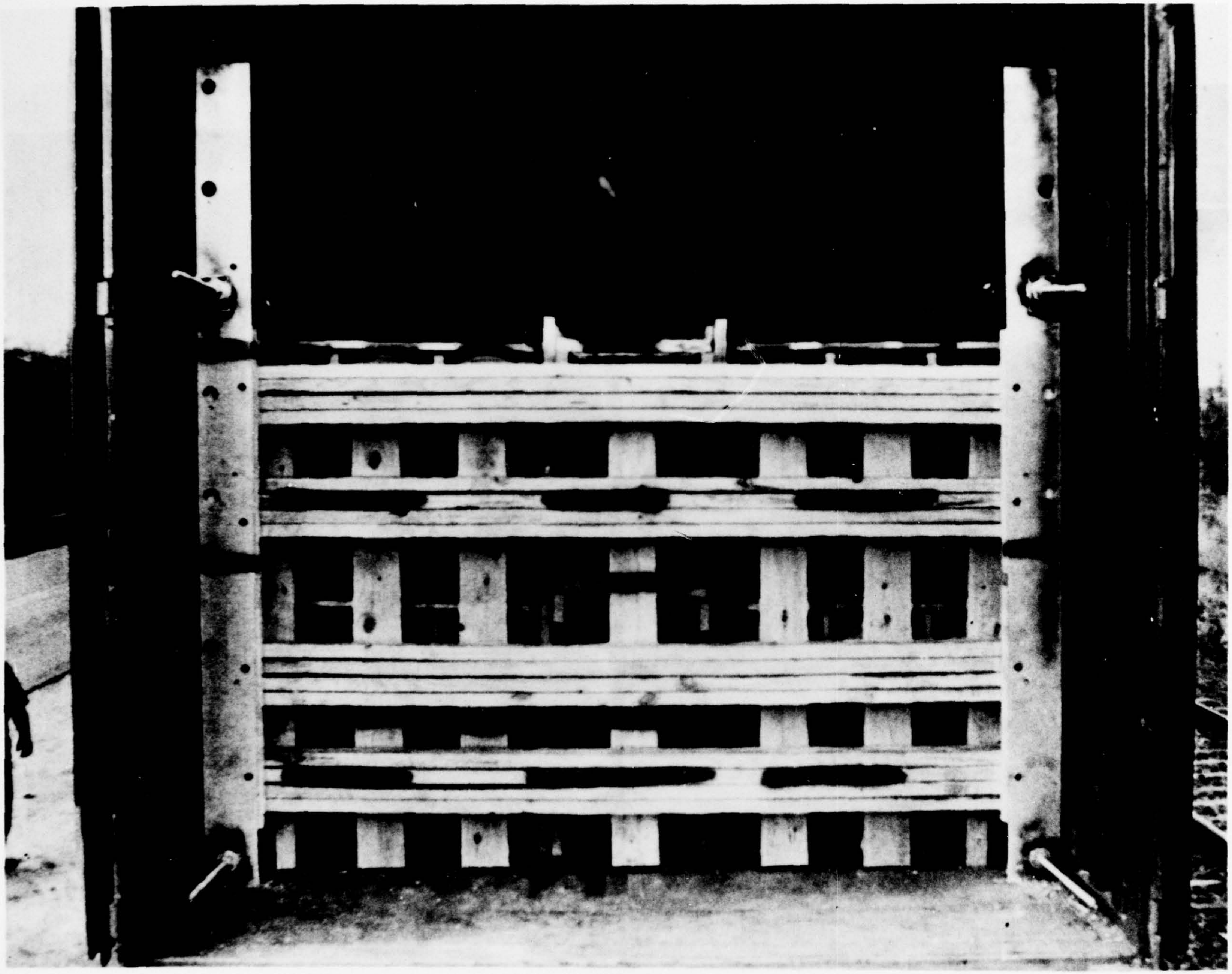


FIG. 20 STEEL CONTAINER WITH MK 82 BOMB LOAD MOUNTED ON IMPACT CAR