

## Section 7. OPERATIONS IN CONTROLLED HUMIDITY SPACE

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## 3-701. General

u. In high humidity environment, conventional storage facilities do not afford adequate protection (to certain types of supplies) against damage and deterioration that can result from excessive humidity. This is particularly applicable where supplies are to remain in storage for extended periods. Items selected for CH protection will normally be those items afforded a minimum degree of military protection, commercially packed or bare. To ensure that the capability of material to perform its intended function will not be impaired or that supplies will not become unfit for consumption as a result of exposure to excessive humidity, methods have been developed to provide control of humidity within storage warehouses.

b. The control of humidity within storage structures is a method of protection—not a method of rejuvenation. Controlled humidity storage will not remove rust that is already present, nor will it otherwise restore material that has deteriorated prior to storage. Material placed in this type storage in a condition other than clean may continue to deteriorate, particularly when contamination is of a corrosive nature.

c. The recommended relative humidity (RH) levels for broad categories of material are as follows:

Material	Percent RH
Metals	40-50
Plastics	Below 70
Paper	40-55
Wood	<b>40-55</b>
Textiles	40-50
Rubber	30-100
Leather	Below 70
Optics	Below 60

## 3-702. Policy

Controlled humidity space will be considered premium space and will be occupied at all times to the maximum practicable extent on a priority basis with those items to which controlled humidity affords

the greatest degree of protection and benefit. Procedures governing the control and usage of exterior doors in controlled humidity buildings will be developed locally to ensure that the operation of dehumidification machines is kept to a minimum.

## 3-703. Responsibilities

a. The following responsibilities will be assigned to a proper organizational element:

(1) Operate, calibrate and maintain humidity reduction equipment and all meters, recording devices, and other similar equipment related thereto.

(2) Accumulate, summarize, and distribute developed "control" data to the extent required to effect efficient operation of equipment and maintenance of humidity levels.

(3) Correct, or bring to the attention of the proper persons, any conditions exposed which indicate undesirable trends in inside moisture levels, unreasonable continuous operation of dehumidifying equipment, excessive "open door time," or any other factor which suggests excessive moisture ingress.

(4) Assure that full objectives of the controlled humidity storage program are realized, i.e., maximum practical utilization of this asset by reduction and retention of inside relative humidity at prescribed level through prudent control of "open door" time as well as other applicable moisture influencing considerations set forth herein. Insure the existence and maintain surveillance over safe" operating conditions with regard to the potentiality of carbon monoxide gas.

b. A centrally located exterior relative humidity recording instrument will be used as a means to advise controlled humidity space users when outside relative conditions are at such level as to allow access doors to remain open if desirable, and also to close doors when outside conditions rise above 50 percent relative humidity.

c. Conditions in controlled humidity buildings

which require repair will be reported as soon as detected.

### 3-704. Criteria for Facility Selection

a. Controlled humidity storage space should be provided for ~~areas~~ where the outdoor relative humidity is above 50 percent for more than 50 percent of the total time,

b. Equipment for the control of humidity in storage space will be operated to provide an environment not to exceed 50 percent relative humidity.

c. **The modern, permanent warehouses (WW II and later) are preferred for the storage of current distribution stocks.** These warehouses should be converted to controlled humidity space (by section or complete warehouse) as required and permitted by available funds.

d. The older type permanent warehouses with inconvenient loading docks or ramps, or other features which prevent maximum efficiency in storage operations will, when economically practicable, be converted to controlled humidity space for the long-term storage of selected items, including mobilization reserve stocks and industrial equipment reserves, which normally are not stored with regular distribution stocks for rotation.

e. Sections of warehouses used exclusively for shipping, receiving, and box shop operations normally will not be converted to controlled humidity space.

f. Considering cost of installation and continuing cost of operation, controlled humidity space can be installed most economically in permanent and standard portable frame warehouses, such as-

(1) Permanent type warehouses constructed with built-up roof, concrete roof decking with steel framing or laminated wood roof framing, block or brick side walls and dock level floors.

(2) Permanent type warehouses, gabled roof with steel framing; block or tile walls, windows, and louvers.

(3) Permanent type warehouses constructed with monitor in center third of roof, block or brick side walls, and dock level floor.

(4) Standard portable frame warehouses of a type properly constructed for controlled humidity installation.

g. The mobilization type warehouses, built-up roof with timber framing, monitor on roof; with continuous window openings, wood or asbestos siding, should not be considered for conversion to con-

trolled humidity space, except as a low priority, due to the expense of such conversion.

### 3-705. Selection of Supplies

a. Supplies to be stored in controlled humidity areas will be selected in accordance with the criteria and provisions prescribed by the military service or agency.

b. In the storage of ammunition, safety factors inherent to this commodity will be followed.

c. Humidity affects materials as follows:

(1) Ferrous metals corrode in varying degrees above 50 percent relative humidity.

(2) Aluminum alloy and nonferrous metals deteriorate to a limited extent at 90 percent relative humidity.

(3) Minerals such as mica, asbestos, and fibrous glass show no deterioration by moisture.

(4) Fibers of manila and sisal rope may become very brittle at humidities under 30 percent relative humidity; however, upon exposure to normal humidities, they absorb normal water content and resume normal physical properties.

(5) Items such as voltmeters, resistors, telescopes, pressure gauges, and items comprised of both electrical parts and ferrous metals such as electric motors, controllers, telephone hand sets, amplifiers, circuit breakers, and mechanical fire control computers show deterioration by moisture on various components and in various degrees above 50 percent relative humidity.

(6) If the relative humidity falls below 30 percent, there is a tendency for rubber cable coverings and other insulating materials or electronic equipment to dry out and crack.

d. Equipment items, mobile and immobile which, because of their physical characteristics, are not adaptable to stacking, should, when committed to controlled humidity storage, be first considered for storage in low roof areas, if such are available. Due consideration will be given to serially numbered items so far as stored methods may affect facility of in and out movement.

e. Unserviceable, economically repairable material awaiting repair, classification (return material), or repackaging, will be temporarily afforded controlled humidity storage in accordance with the priority established for the serviceable item on a space available basis.

f. Items for normal distribution and for mobilization reserve which are usually stored together for

rotation of stock will continue to be so stored when committed to controlled humidity storage.

g. Depots having dry storage tanks must recognize one basic difference between controlled humidity warehouse space and controlled humidity tanks. Supplies stored in dry tanks must of necessity be confined to inactive, reserve type stocks, since ready and frequent access to the interior of these tanks is not normally economical or practical.

### 3-706. Material Protection Factors

a. Items to be placed in controlled humidity storage may be afforded the minimum practicable preservation and packing, in accordance with requirements of the military service or agency.

b. Items currently in storage or received from procurement will not be repackaged' to attain a lower level of protection for controlled humidity storage, unless such is accomplished as a byproduct of normal care and preservation and maintenance operations.

c. Preservation and packing levels can be safely reduced to the minimum for material consigned to controlled humidity storage. However, the degree of additional hazard imposed on supplies from the time they are shipped from the safe confines of controlled humidity storage until they are consumed must be taken into account. Supplies in general must continue, as always, to be protected at a time of shipment to a degree commensurate with the maximum anticipated hazard to which they will be subjected in movement from storage to consumer.

d. In certain cases, supplies and equipment destined for storage in controlled humidity facilities are purchased at a reduced level of preservation and packing. Supplies received from vendors, so packed, will be placed in controlled humidity storage as soon as possible after receipt. In the event controlled humidity space cannot be made available after receipt, the level of protection will, if required, be raised consistent with the type of storage and the anticipated length of storage.

e. Items received from sources such as procurements, returns, and transfers, identified for controlled humidity storage, will be placed in available controlled humidity space according to priority. However, as a matter of judgment on the part of storage or inspection personnel, an item of higher priority, with levels of preservation and packing able to withstand normal storage, may be passed

over in favor of items of lower priority with lesser levels of preservation or packing.

f. Any action which reduces the level of packaging of material, on the assumption that it will be stored in controlled humidity space, will require adequate controls to assure storage in controlled humidity space.

g. Movement of supplies and/or pallets which are wet or damp into controlled humidity areas should be avoided.

h. Inter-warehouse transfers should be conducted under preferred climactic conditions.

i. Schedules for cyclic inspection will normally be extended for items under controlled humidity storage.

### 3-707. Utilization Factors

a. Only through maximum use of controlled humidity space will the full extent of inherent economic and physical benefits be realized. Maximum use, however, does not mean simply filling the warehouse, but maximum occupation by supplies that require the protection.

b. Storage operations in controlled humidity warehouses will utilize the same basic principles of good warehousing that are practiced in 'conventional warehouses. Specific attention will be given to modernization plans which are geared to the improvement of practices. Storage arrangement should provide for maximum utilization of available cube, direct accessibility of supplies and equipment for proper stock rotation, accurate and legible identification, mobility of each item, and application of safe storage practices.

### 3-708. Equipment and Operations Factors

a. Controlled humidity equipment should be located within the warehouse so as not to obstruct traffic aisles (fig. 3-118).

b. It is essential that the entrance of humid air into controlled humidity warehouses be kept to the minimum in order to maintain the relative humidity at desired level. Door control is most important, since the greatest source of moisture penetration is through open doors. An alarm system may be provided to signal open doors.

c. Movement of supplies into and out of controlled humidity space will be planned, to the greatest extent practicable, so that only one exterior cargo door in a section is open at a time. When two doors are open at the same time, particularly on opposite

sides of the warehouse, drafts are generated which greatly increase the infiltration of outside air.

*d.* To offset any operational disadvantage occurring as a result of the "closed door" policy, a convenient means can be provided that will cause cargo doors to immediately open and subsequently close when entrance or exit is made. It is time-consuming for operators to dismount from their vehicles, open the doors, remount the vehicles, and drive through the doors and then dismount once again to close the doors behind them.

*e.* Use of power-actuated auxiliary doors is one recommended means for counteracting this problem in active controlled humidity areas. Large curtain type rubber or metal doors actuated by contact with materials handling equipment (tractors, forklift trucks) can be installed in appropriate openings when desirable. These auxiliary doors are not intended to replace current security doors; therefore, they will be so positioned as not to interfere with the opening and closing of the permanent doors (fig. 3-119).

(1) In the normal warehouse operation, inside doors connecting the separate warehouse sections are left open during operational periods. For controlled humidity warehouses, during any extensive movement of materials into or out of a single controlled humidity section to an outside area, these inner connecting doors to adjacent sections should be closed to minimize spread of moisture.

(2) Normally, personnel traffic, using regular personnel type doors, will have little effect on controlled humidity operations. Personnel should be cautioned to use these doors in lieu of fire doors and that the doors do not remain open.

(3) It is advocated practice to seal as many access doors as practicable in conversion to controlled humidity space. The sealing of cargo doors should be so designed that doors can be opened for use as peak work situations of major significance and duration warrant. It is also advisable to design sealing techniques in a manner that will allow doors to remain in "hung" position. Closure should not involve bricking up of doorways or removal of doors.

*f.* In certain geographic areas, there may be pe-

riods when the relative humidity of outside air will fall below 50 percent. Under such conditions, cargo doors may be opened without securing the inside area from outside moisture penetration. This allowance of "free" air circulation must be predicated on day-to-day atmospheric conditions and not "time of year" considerations.

*g.* The use of battery-powered equipment in controlled humidity warehouses is preferred, and is particularly recommended in very active areas.

(1) Availability can be an important factor in equipment selection for handling supplies in controlled humidity storage. The handling of hazardous commodities and operations within hazardous areas will be given priority for use of battery-powered materials handling equipment.

(2) Where battery-powered equipment cannot be or is impracticable to obtain or use in controlled humidity storage, gasoline engine-powered equipment can be used with certain precautions. In use of such equipment, certain factors must be considered.

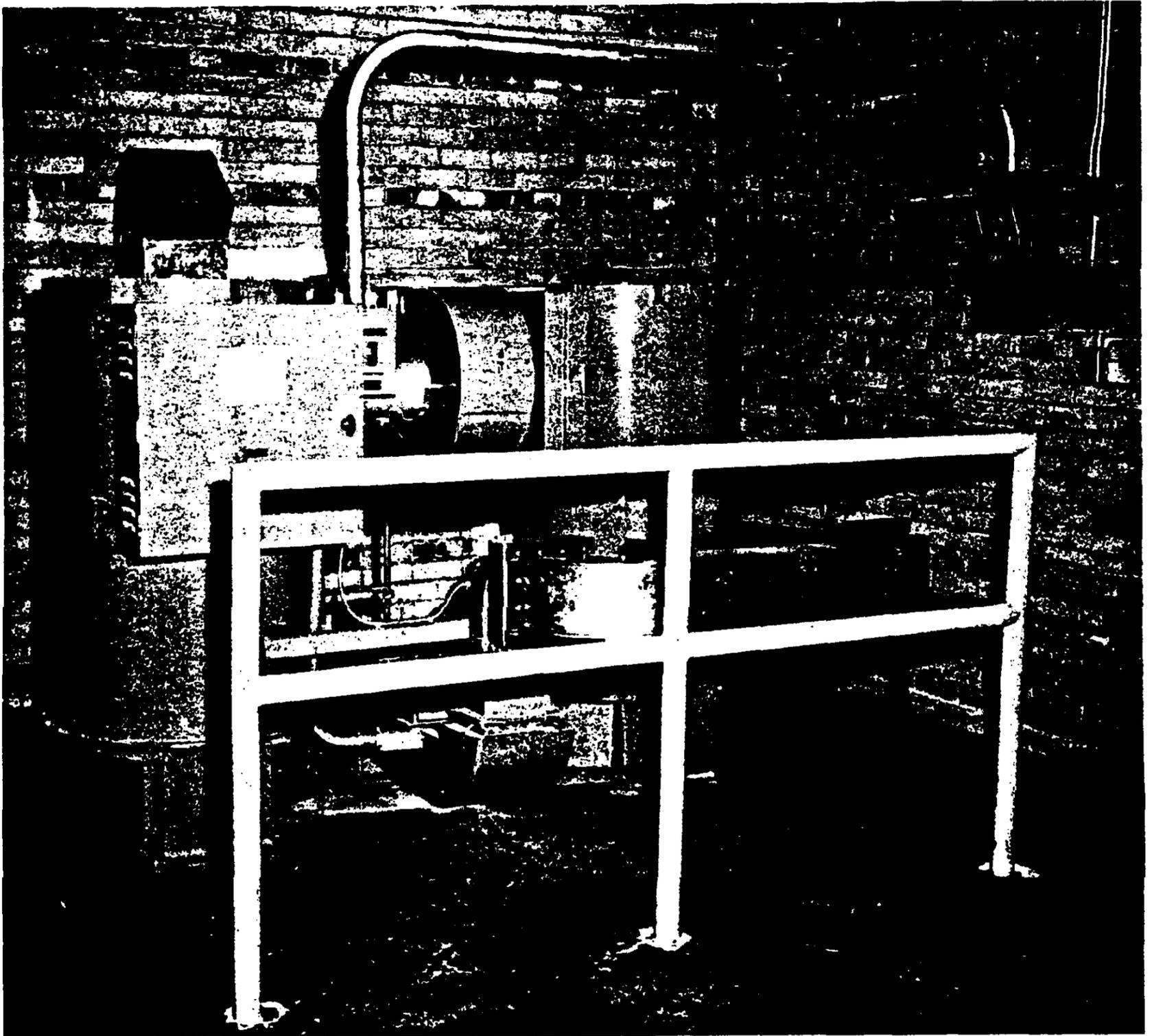
(a) Reduced ventilation multiplies the hazard of using gasoline engine-powered equipment, because of the increased concentration of exhaust contaminants.

(b) When utilizing gasoline engine-driven equipment in controlled humidity warehouses, any concentration of carbon monoxide gas which exceeds 50 parts of carbon monoxide per 1,000,000 parts of air must be prevented.

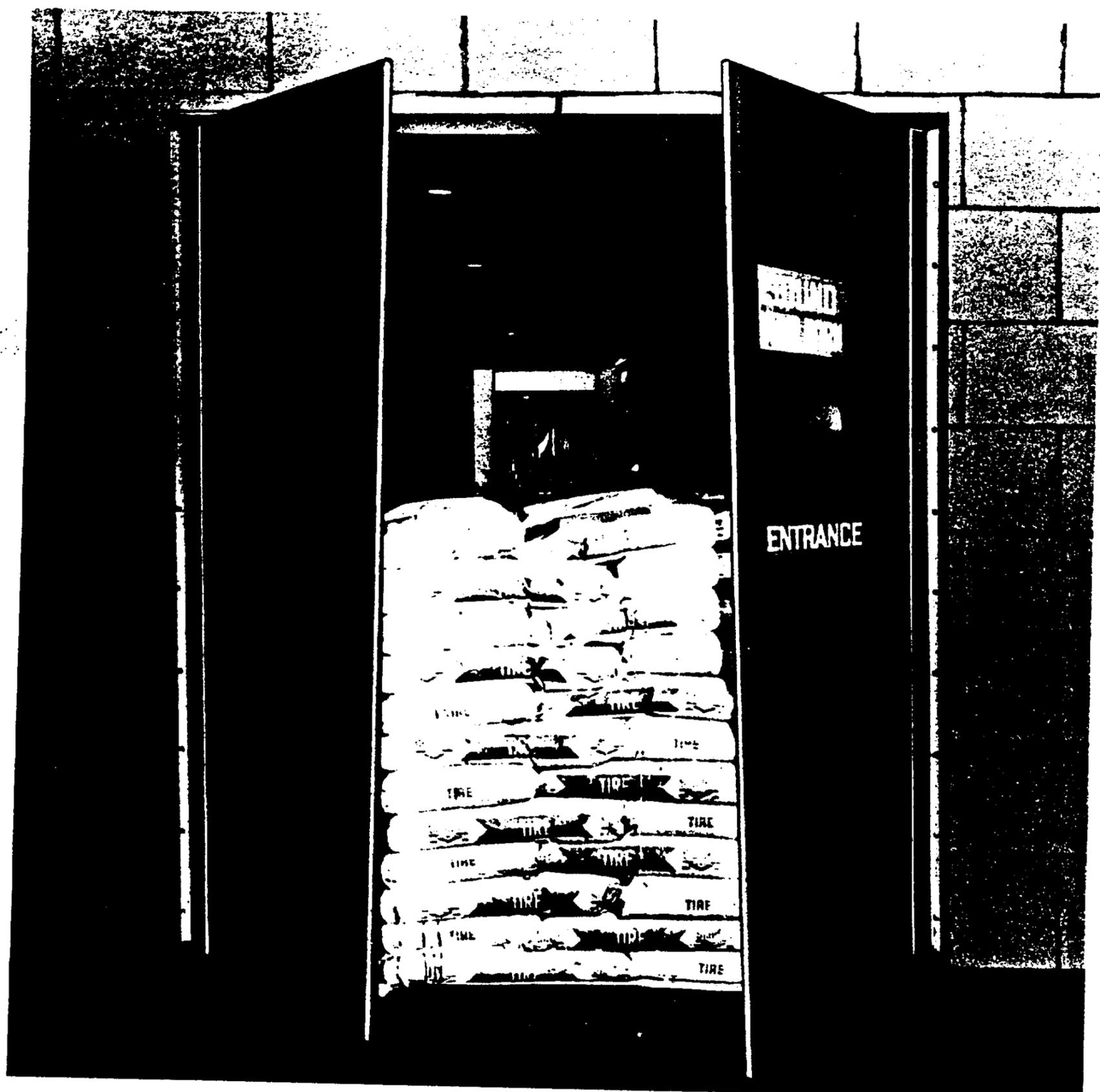
(c) An engine with a "rich" mixture produces far more carbon monoxide than one with a "lean" mixture, and the rate of evolution of carbon monoxide is much greater when the engine is cold.

(d) Gasoline engines in controlled humidity storage should be turned off when not in service, and should never be allowed to idle in standby service.

*h.* The installation safety officer, upon request, will perform or obtain qualified personnel to perform tests and make determination as to the extent of hazard caused by equipment engine exhaust and when deliberate ventilation must be introduced to prevent undesirable concentrations.



*Figure 3-118. A desiccant type dehumidifier. These machines are installed at prescribed intervals within the warehouse to draw in the moist air, extract the moisture and blow the dry air back into the area. To eliminate obstructing operating areas these machines can be located on elevated platforms.*



*Figure 3-119. Auxiliary door actuated by contact with materials handling equipment.*

## Section 8. SECURITY OF MATERIALS IN STORAGE

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## 3-801. Purpose

This section establishes the minimum security requirements for the storage and handling of classified, pilferable, and sensitive material. It also addresses the requirements for serial number control and reporting of small arms under the DOD SASP.

## 3-802. Definitions

a. **Classified material.** Material which requires protection in the interest of national security.

b. **Pilferable material.** Material having a ready resale value or civilian application as to personal possession, and **is** therefore especially subject to theft (e.g., watches, certain tools, and clothing).

c. **Sensitive items.** Material which requires a **high** degree of protection and control due to statutory requirements or regulations, such as narcotics and drug abuse items; precious metals; items which are of high value, highly technical or of a hazardous nature; and small arms, ammunition, explosives and demolition material.

d. **Small arms.** Handguns; shoulder-fired weapons; light automatic weapons up to and including, .50 caliber machine guns; **recoilless** rifles up to and including 106MM; mortars up to and including 81 MM; rocket launchers **manportable**; grenade launchers, rifle and shoulder fired; and individually operated weapons which are portable and/or can be fired without special mounts or firing devices and which have potential use in civil disturbances and are vulnerable to theft.

## 3-803. General

a. **Protection of property.**

(1) The protection of property, including the prevention of internal pilferage or major **thefts** of government supplies and equipment, is one of the functions in warehousing. This function must in-

clude the protection of supplies and equipment both in storage areas and **while** they are in transit.

(2) Military installations throughout the world would lose millions of dollars worth of property each year if subjected to uncontrolled pilferage or theft. However, the risks incurred cannot be measured in terms of dollars alone. Loss of critical supplies for tactical units **could result** in unnecessary **loss** of life and danger to national defense.

(3) In some areas, losses have assumed such proportions as to jeopardize the mission of the installation. All installations can anticipate loss. Actual losses will depend on such variable factors as type and amount of materials, equipment, and supplies which are produced, processed, and stored at the facility; number of persons employed; social and economic conditions in surrounding communities; command attitudes; and physical security measures employed. Because these factors will differ greatly in various types of installations and in different geographical locations, each must be considered **separately**.

b. **Measures for control.** Specific measures for prevention of pilferage will be based on careful analysis of the conditions at each installation. The most practical and effective method for controlling pilferage is the establishment of adequate physical security and psychological deterrents. This may be accomplished in a number of ways.

(1) An aggressive security education program is an effective means of convincing employees that they have much more to lose than they do to gain by engaging in acts of theft. It is important for all employees to realize that pilferage is **morally** wrong no matter how **insignificant** is the value of the item taken.

(2) It is particularly important for supervisory personnel to set a proper example and maintain desirable moral climate for all employees.

(3) All employees must be impressed with the fact that they have a legal responsibility to report any loss to proper authorities.

(4) Adequate inventory and control measures should be instituted to account for all material, supplies, and **equipment**. The awareness of poor accounting controls provides one of the greatest sources of temptation to a potential pilferer.

(5) An effective material control system will be established which includes inspection of delivery and vendor vehicles.

...: (6) All suspected losses. **will** be investigated **quickly and efficiently**.

(7) An effective key and lock control system **will** be established and monitored regularly for security purposes.

(8) Bulk quantities of highly pilferable stock will be stored in enclosed security areas and distributed from there to using sections in limited amounts.

(9) Accurate methods of taking physical inventories and of accounting for stock procurement, usage, and salvage will be established.

### 3-804. Responsibilities

a. Commanders will administer the necessary physical security measures for protection of **classified, pilferable**, and sensitive material, together with small arms control and operation of SASP in accordance with applicable military service/agency regulations.

b. Commanders will insure that all persons involved in the receipt, storage, issue, repair and inspection of classified material are versed in the instructions contained herein and in regulations governing the security of classified material.

c. The installation TOP SECRET Control Officer, or his alternate, will insure the security control of TOP SECRET material during receipt, storage and issue.

### 3-805. Storage Security

a. *Storage of classified items.* These items should be kept separate from other material. The most satisfactory method is **to store** such items in a separate building with a higher degree of physical protection than other buildings. Where a separate **building** is not available or where its use is not **warranted** by the quantity of classified storage, a room, cage, or crib may be constructed within a warehouse building. All areas which contain **clas-**

**sified** material will be secured by means of approved locking systems. This will include any temporary storage space used for intransit classified material. In addition to classified items being stored separately from other material, classified material will be segregated in storage from sensitive but unclassified items. This further segregation will prevent exposure to compromise of classified material incident to a break-in aimed at stealing unclassified but sensitive items. Standards for the physical protection of **classified** items are specifically established in DOD Directive 5200.1 as implemented by each Military Service and the DLA.

#### b. *Storage of pilferable and sensitive items.*

(1) In addition to normal installation security procedures, commanders will assure that storage procedures and techniques afford adequate protection for **pilferable/sensitive** items. Structural standards and control procedures should be as set forth in implementing military service/agency regulations. Depending on local conditions and experience, these protective measures should include vault types or caged **and/or** fenced and locked security areas, assignment of responsibility for control of **pilferable/sensitive** items to **specific** individuals, restricting access to **pilferable/sensitive** item storage areas, and procedures to control movement of these items within the storage installation.

(2) **Pilferable/sensitive** items will not ordinarily be stored in the same area with classified material. However, when instances require **pilferable/sensitive** and classified items be stored together, the entire storage area will be classified, and controls applied, equivalent to the highest security classification of **any** item therein.

(3) **Pilferable** items ordinarily will not be stored in warehouses where security protection is lacking. Circumstances, however, may result in pilferable items requiring general purpose storage environment, i.e., items in **large** banded containers for which secure storage space is temporarily not available. When this situation presents itself, general purpose storage environment is permitted, however, when such containers are opened for partial issues, the residual quantities will be transferred to a specified secured area.

(4) Sensitive items classified as "controlled substances" in the Drug Act of 1970 must be stored in an approved vault or safe with a three-tumbler combination unless a US Department of Justice, Drug Enforcement Administration (**DEA**) Regional Of-

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 fice has approved another type of secure facility. Retrograde controlled substances must be approved for disposal by the DEA Regional Office before such disposal actions can be taken. Disposal actions must be observed and attested to by responsible personnel.

### 3-806. Storage of Small Arms

a. Small arms will be stored apart from other pilferable and sensitive items for the purpose of maintaining strict physical security and limiting access to specifically authorized personnel.

b. When available facilities do not permit geographic separation of small arms into separate buildings, then, storage is permitted in buildings where other pilferable or sensitive items are stored. When this occurs, small arms will be separated from these items by a locked security cage, fencing, or other acceptable means.

c. Storage layouts for small arms should be designed to facilitate receipts, issues, inventory counts, and serial number verifications.

d. To meet these requirements, small arms storage areas must be planned to accommodate large, medium, and small lots of material with minimum rewarehousing.

e. Retrograde small arms awaiting decontamination, inspection, classification or processing action prior to storage or disposition will be controlled, secured, and given surveillance to the same degree as provided issuable small arms.

f. Small arms will be stored in vault type or highly secured storage areas in accordance with DOD and military service/agency directives addressed to this subject.

### 3-807. Receiving (classified material; pilferable/sensitive items; small arms)

#### a. Classified material.

(1) All duties involving handling or access to unpacked or unpackage classified material, and the applicable classified documents or correspondence pertaining thereto, will be accomplished only by properly cleared individuals. All receipts will be subjected to a 100 percent verification of quantity.

(2) In cases where classified shipments are received with violations of security requirements, the installation Security Officer will be notified immediately. The shipment in question should not be left unattended until properly documented and securely stored.

b. Pilferable/sensitive items (to include controlled substances).

(1) Receipts of pilferable or sensitive items will be provided controls to assure proper handling, recording, and storing. Receipt inspection procedures for pilferable/sensitive items will include determination of any evidence of tampering and the material placed under control as expeditiously as possible. If pilferage or loss (shortage) in shipments is suspected, immediate coordination between the transportation and security office will be effected.

(2) Whenever possible, the unloading will be accomplished at the storage location site or as deemed necessary an authorized person from the receiving area will accompany the material to the storage area and obtain warehouseman's signature upon release.

(3) Where pilferable or sensitive material moves to a storage area over a mechanical handling system, such as a power and free conveyor or a towline conveyor system, special locked (padlocked) containers will be used. This also applies to material moving from the storage to shipping area.

c. Small arms. In addition to b above the following will be applied:

(1) All small arms receipts will be subjected to a 100 percent verification of -weapons and serial numbers plus a quality check of the operations.

(2) Unloading of small arms will be accomplished on a priority basis and material placed under control as expeditiously as possible to reduce the opportunities for loss or pilferage. When unloading procedures cannot be completed during operational hours, a separate, secured area, vault or cage, meeting the structural and security standards of the military service/agency regulations will be utilized as a temporary holding area.

(3) Whenever possible, the unloading will be accomplished at the storage location site, thereby eliminating additional movement.

(4) Stringent inspection procedures will prevail throughout operations to determine any evidence of tampering.

(5) Timely and close coordination between transportation and security offices will be accomplished in cases of suspected pilferage or loss (shortage) in shipments of small arms.

### 3-808. Inspection

a. All inspection, identification, repair, testing, packing, marking, checking, and associated physi-

**cal** operations required in connection with classified, sensitive and pilferable material (including small arms) should be performed within the restricted storage area whenever possible. When quantity or complexity of processing precludes this, temporary restricted area should be established as required.

*b.* Discrepancies discovered during the receipt, issue, storage, inspection, and shipping operations **will** be processed in accordance with DOD and **military service/agency** directives addressed to this **subject**.

### 3-809. Inventory

Inventory of classified, pilferable, and sensitive items will be in accordance with DODI 4140.35 and military **service/agency** directives addressed to this subject.

### 3-810. Shipping and Marking

*a.* Shipments will be provided controls necessary to assure proper handling.

*b.* Preferably, classified, sensitive and **pilferable** items selected for shipment should be packed by the consignor in the building where the material is stored.

*c.* Whenever the above cannot be accomplished, stringent visual and/or escort controls will be enforced during preshipment processing and material movement.

*d.* Shipments will be preserved, packed, and marked to minimize intransit exposure of material to scrutiny, container rupture, undetected entry, loss, damage, illegal acts, and security compromise.

*e.* Markings will not reveal the nature of the material except to the extent required for compliance with transportation regulations, or when the shipper service has determined that ready identification of items being shipped is necessary (ref MIL STD-129).

*f.* Loading will be accomplished as soon as the cargo is brought to the carrier. Load preassembly outside of security areas should not be practiced.

### 3-811. DOD **Small** Arms Serialization Program (sASP)

*a. Criteria.* All DOD Components, activities, and installations will be part of a worldwide small arm serial number control system.

*b. Concept and procedures.*

(1) The concept for the serial number control of small arms is based on the use of the DOD Central Registry that provides investigative agencies, within 72 hours, the identification of the last accountable activity having a specific serial numbered small arm. Investigative agencies will process all inquiries to the DOD Central **Registry**.

(2) The procedures for **serial** number control and reporting are found in DOD **4140.22M**.

## Section 9. CARRIER LOADING

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#### 3-901. Introduction

*a.* Improper loading is one of the major causes of **loss** and damage during transportation and the **resulting** delay in use of **material** at destination. The purpose of this section is to provide guidance in proper loading and thereby help prevent discrepancies during transportation.

*b.* After determination has been made to move materials and supplies, the freight traffic office should be advised so that the proper mode of transportation may be selected. This advice should include, among other things, information as to whether the shipment-

(1) Is **palletized** or **unpalletized**.

(2) Consists of high center of gravity items, requiring special tie down or bracing methods.

(3) Consists of items having heavy concentrated weights.

(4) Consists of fragile or critical items.

(5) Consists of items subject to contamination, such as flour, sugar or other items.

(6) Consists of explosives or other hazardous

commodities and whether they have been properly marked and labeled.

(7) Will be handled at origin or destination or both by materials handling equipment. In addition to the above information, selection of the proper mode of transportation requires consideration of conditions at origin and destination, probability of transshipment, degree of security needed in movement, military requirements, the cost of transportation, the type of service provided, etc.

*c.* Stowage of freight aboard vessels is not usually encountered by warehousing personnel and will not be discussed in this section; likewise, less carload and less truckload shipments will not be included since they are generally loaded and unloaded by the carriers, except shipments of explosives and ammunition.

*d.* This section does not establish organizational **alignments** or functions. Although certain warehousing and traffic functions are described, it is not intended to imply that those functions will be performed by particular organizational elements within the services or shipping activities.

### Subsection 1. CAR LOADING

#### 3-902. General

*a. Types of commodities handled.* The shipment of military supplies is possibly the most complex traffic function in the world. This is due, in part, to the wide variety of commodities involved and their diverse physical characteristics. The commodities shipped range **from** small items easily handled by one person to those which are so bulky as to require the use of multiple or idler cars, or exceed the size or weight limitations of standard transportation equipment and facilities, and require the use of special routings or heavy duty equipment. Others may be hazardous (explosives, acids, poisonous gases, etc.) and require caution in preparation for transportation; perishable, and require protective service from heat or cold; delicate, and require special handling, or in critical supply. Another factor

leading to this complex situation is the multiplicity of types of shipping containers used.

*b. Selection of type of rail car.*

(1) Of initial importance in car loading is the selection of the proper car. This must be done with a view to its fitness for the particular commodity to be loaded, since properly loaded shipments are often damaged by **unfit** equipment. On the other hand, freight which in itself is not highly susceptible to damage may cause damage to equipment better suited for other classes of **freight**. Selection of rail cars for shipments of explosives and ammunition will be in accordance with the requirements of DOT regulations.

(2) Rail freight cars are generally classified as box, gondola, refrigerator, hopper, tank, and flat. In this general range will be found many cars con-

strutted to transport specific commodities. Many freight cars are specially equipped with blocking and **bracing** appliances which form an integral part of the car. While it is the duty of the carrier to inspect cars thoroughly before they are placed for loading by shippers, it is to the shipper's interest to ensure that cars selected are in **all** respects suitable for the kind of freight to be shipped.

*c. Shipper's loading responsibilities.*

(1) Freight should be loaded to withstand the normal hazards of transportation. Shippers are **required to load** freight, carried at carload rates; **unless otherwise** provided by **tariff**, and are also required to load heavy or bulky freight which is **carried** at less than carload rates, but which cannot be handled by regular station employees or at stations where carrier's facilities are not sufficient for handling. In addition, shippers must observe carrier's rules for safe loading of freight and protection of equipment, and movable parts (machinery) must be secured. When articles are loaded on open cars, small detachable parts must be removed and placed in packages or secured within the article. Shipments of explosives and ammunition will be loaded in accordance with service regulations and publications,

(2) In addition to selecting the proper type of car, the following precautions should be taken against the use of defective *or* unclean cars:

(a) Examine the interior of the car for any defects of roof, sides, or floor that might cause **snagging, tearing**, scarring or rupture of container, or permit the entry of rain, dirt or other matter likely to injure the height.

(b) Remove protruding nails and other obstructions not part of the car.

(c) Reject cars that cannot be suitably conditioned without mechanical or other extensive repairs.

### 3-903. Loading Rules for Rail Carriers

*a. Conformance with loading rules.* Personnel engaged in or responsible for loading, blocking, and bracing freight should have available for use and be **familiar** with the rules for the proper loading and securing of shipments, as outlined in the publications referred to in *b* below and in applicable service/agency publications. By complying with the applicable rules, procedures and methods, the shipper has accomplished the **first** step in assuring safe and economical **carloading**.

(1) **Mandatory requirements.** Rule 27 of the Uniform and Consolidated Freight Classifications requires shippers to observe carriers' rules regulating the safe loading of freight and the protection of equipment. Mandatory rules are contained in the Association of American Railroad's Circular Number 42-E, "General Rules Covering Loading of Carload Shipments of Commodities in Closed Cars," and **all** Associations of American Railroads pamphlets covering the loading and securing of shipments on open top cars.

(2) **Minimum standards.** The various methods and specifications contained in all Association of American Railroads car loading pamphlets will be **observed** as minimum requirements for the proper loading, blocking and **bracking** of shipments for movement by rail **freight** on or in open top and closed cars.

(3) Loading methods *not specified*. When freight is to be loaded on or in open top or closed cars, and no loading and securing methods are provided therefor, it will be blocked and braced according to the best method or procedure that can be devised **from** Association of American Railroads (**AAR**) pamphlets or other sources covering similar material (see also para 3-919).

*b. Source of rules.*

(1) **AAR.** Pamphlets and bulletins containing rules governing the loading of railroad cars are issued by **AAR**. These are usually filed in the office of the installation transportation officer.

(a) **Following** is a list of closed car pamphlets published by AAR:

<i>Pamphlet</i> No.	<i>Title</i>
1	Automobiles-Motor Vehicles Shipped in Auto Loader Cars.
2	Automobiles-Motor Vehicles Shipped <b>L.C.L.</b> or Carload in other than Auto <b>Loader</b> Cars.
3	Baga-Commodities in Flour and Other Grain Products, Sugar and Kindred Commodities, Rice, Salt, Coffee, Beans, Peanuts, etc.
4	Barrels, Drums or Kegs.
5	Batteries-storage.
6	Brick and Hollow Building Tile.
7	<b>Brick-Hot Top.</b>
8	Plywood.
9	Cable on Reels and Wire Commodities.
10	Car-Doors-Battening as Protection Against Damage by Weather, Cindera, etc.
12	<b>Cylinders—Empty</b> , With or Without Caps.
13	Fiberboard Containers (Solid or Corrugated% Commodities.

**Pamphlet**

<i>No.</i>	<i>Title</i>
14	Freight-Loading, Bracing and Blocking of
15	<b>Furniture—Carload.</b>
16	<b>Furniture—Less Carload.</b>
17	<b>Grain and Grain Products in Fibre-board Containers and Sacks.</b>
18	Cylindrical Steel Containers (Small) and Mixed Loads in Larger Steel Drums and Boxes.
19	Livestock—Loading and Handling.
20	Lumber (Dressed) and Mill Work.
21	Machinery.
22	<b>Marble in Slabs—A-Frame Method.</b>
25	<b>Paper” and Similar Commodities on Skids.</b>
26	Gypsum Plasterboard, Wallboard, Sheathing, Lath and Plaster.
27	Projectiles, Bombs and Cartridge Cases (empty).
28	Radiators-Cast Iron.
29	<b>Refrigerators—Mechanical.</b>
30	Roofing Materials-Prepared.
31	Soda Ash.
32	Stones-Pulp Grinder.
33	Stoves and Ranges.
34	Tank Cars-Transporting Non-dangerous Commodities.
36	Untreated Cross Ties.
36	Bulk Grain.
38	Unsaturated Roofing Felt and Pulpboard Paper.
39	Newsprint.
40	Vitrified Clay Sewer Pipe.
41	Dictionary of <b>Standard Terms.</b>
42	<b>Rolled and Plate Glass (Not Bent).</b>
42C	General Rules Governing Loading of Carload Shipments of Commodities in Closed Cars.

(b) The Loading Rules Committee, Mechanical Division, AAR, has issued a loose leaf binder containing 7 sections of “Rules Governing the Loading of Commodities on Open Top Cars.” The sections are listed by number and title as follows:

<i>Section No.</i>	<i>Title</i>
1	General Rules.
2	Loading of Steel Products Including Iron and Steel Pipe.
3	Loading of Road Grading, Road Making and Farm Equipment Machinery.
4	Loading of Miscellaneous Commodities Including Machinery.
5	Loading of Forest Products
6	Loading of Department of Defense Material
7	General Rules Governing the Loading of Commodities on Open-Top Trailer to be handled in <b>TOFC.</b>

Section No. 6 will be the primary guide for loading and securing all Department of Defense material shipped on open top rail equipments. Sections Nos.

1 through 7 prescribe loading methods for practically every type of commodity which is loaded on open type rail cars. Sections Nos. 1 through 5 and 7 will be used only if the commodity to be shipped is not covered in Section No. 6.

(2) *Bureau of explosives.* The instructions concerning the loading of ammunition, explosives, and other hazardous materials in closed cars and on open top cars **which have been issued by the Bureau of Explosives** are listed below. These may be obtained from the Association of American Railroads, Bureau of Explosives, 1920 L St. NW, WASH DC 20036.

**Pamphlet**

<i>No.</i>	<i>Title</i>
6 -----	Drawings and Photographs, Loading and Bracing Carload and L.C. L. Shipments, Explosives and Other Dangerous Articles.
6a -----	Illustrating Loading and Bracing Methods, Carload and L.C. L. Shipments, Loading Projectiles, Loaded Bombs, etc.
6b -----	Approved Method Loading Carload Shipments Gasoline in “Blitz Cans.”
6C -----	Illustrating special bulkhead braces for open top and closed vans and flat bed trailers and methods for loading and bracing less than trailer shipments of explosives and other dangerous articles via Trailer-on-Flat Car (TOFC).

## 3-904. Action of Pressures on Cargo

*a. Types of pressure.* The types of pressure action on loads shipped by rail are as follows:

(1) Lateral, or crosswise, pressure occurs when rounding curves.

(2) Vertical pressure occurs because of the action of the trucks hitting low joints and crossings.

(3) Lengthwise pressure occurs in coupling, starting, stopping, switching, and in slack action.

*b. The closed car.* Considering the pressures that materials are subjected to in over the “road travel by rail and considering the boxcar as a big shipping container on wheels, the bracing and blocking mediums in the car should be essentially the same as the interior packaging of individual shipping containers.

*c. Vertical pressure.*

(1) **Absorption of vertical pressure.** The vertical pressures or vibrations, over and above the overhead weight of the load, are the most numerous but are small in magnitude and are accumulative. Generally, the damaging action from vertical pres

sure is absorbed by the interior cushioning or bracing within the individual package or containers.

(2) *Commodities affected by vertical pressures.* Certain commodities are sensitive to vertical pressures and must receive additional bracing or cushioning as well as a selected method of loading. For example: If rolls of **linoleum** are loaded flat the **vertical** pressures of vibrations will tend to flatten the rolls; bundles of light metal tubing or pipe will undergo a settling from vibrations and may become flattened or dented. However, if the linoleum is **stood on end and separation gates** are used to divide the "load, and if the pipe or tubing is stowed with a filler between layers to absorb the pressures, there is little chance of damage to the shipment in transit unless the car should be subjected to abnormal shocks or impacts.

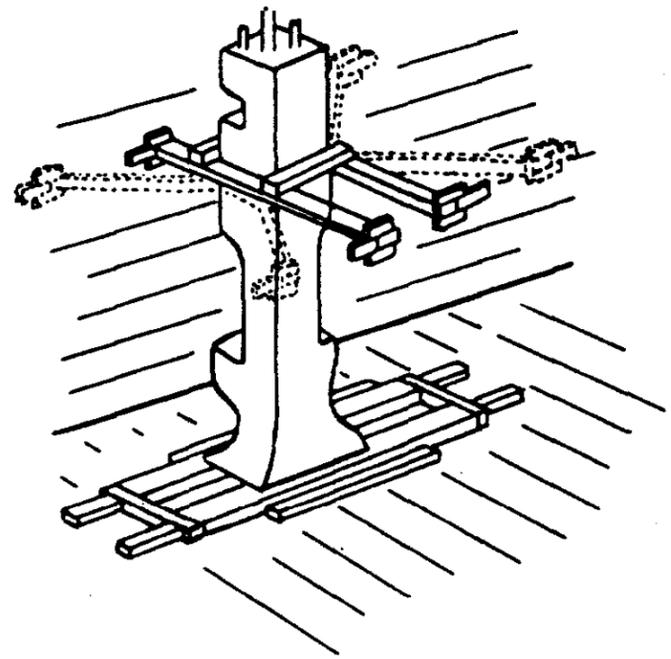
*d. Lateral pressures.*

(1) *Type of action.* Lateral pressures are toward the side walls induced by a car rounding a curve which tends to move the containers out of alignment with adjacent containers. Also, lateral pressures tend to crush the containers on the off side of the car when rounding a curve. Although these pressures are of small magnitude, if the containers are out of alignment, subsequent lengthwise forces can cause damage because of uneven distribution of pressure.

(2) *Distribution of weights.* To insure against uneven distribution of weight in the car, the load should be braced to prevent cross car movement of the load. Uneven distribution of weight within the car may cause the side bearings to become fouled and the car derailed, as the trucks bind and do not roll around curved track. Of great importance is the side bracing of high center of gravity items; applicable bracing must be applied to prevent tipping (fig. 3-120). For additional illustrations of bracing for high center of gravity or top heavy items see **AAR Pamphlets 14 and 21.**

(3) *Doorway protection.* Provide proper doorway protection to assure that load does not cause doors of car to bulge or break open when rounding curves, and to facilitate opening of doors, and assure protection to personnel opening doors (see figs. 3-121, 3-122 and 3-123).

(4) *Prevention of lateral movement.* To provide adequate protection against lateral movement at all times the **load** must be tight crosswise. Proper blocking and bracing must be applied to prevent the load from shifting or moving out of alignment.



*Figure 9-120. Side bracing of high center of gravity items.*

*e. Lengthwise pressures.* Most damage in rigid braced loads is prevented by loading containers tightly to prevent development of **slack** within the load. Once **slack** begins to develop within the load, repeated impacts may cause a void large enough to allow the containers on the top layer to fall between the load and the ends of the car. To protect against damage in rigid braced loads, containers will be loaded tightly with the strongest parts arranged to provide support lengthwise of the car. All loads (excluding floating loads) should be loaded or braced to minimize **any** possibility of movement.

**3-905. Floating Loads.** (Not permitted for shipments of explosives, ammunition and other hazardous materials, nor permitted in any box car equipped with under-car or end-of-car shock mitigating cushion devices.)

*a. Types of floating loads.* There are two types of floating loads; the full floating load and the controlled floating load commonly called the "Snubbing Method." Many items present special loading and bracing problems because of the weight, size, shape, or fragility; such items of this type brought about the development of the floating load. For further information concerning loading to withstand the various types of pressure see AAR Pamphlets 14 and 21.

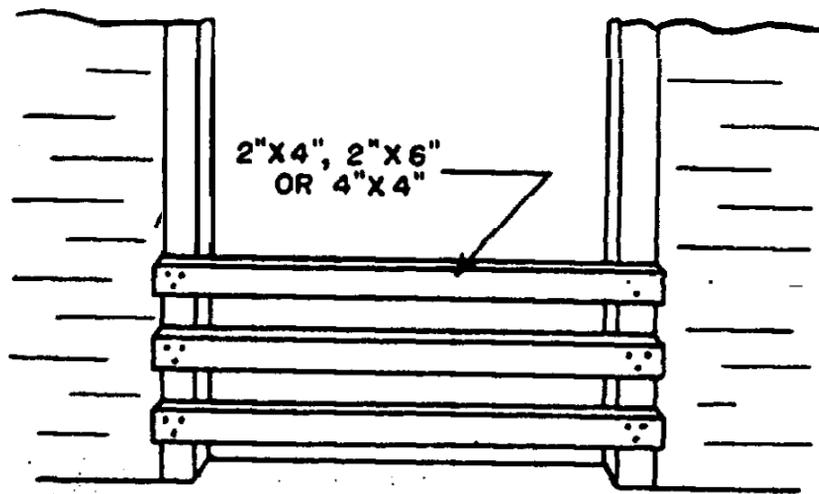


Figure 3-121. Doorway protection for rough freight only.

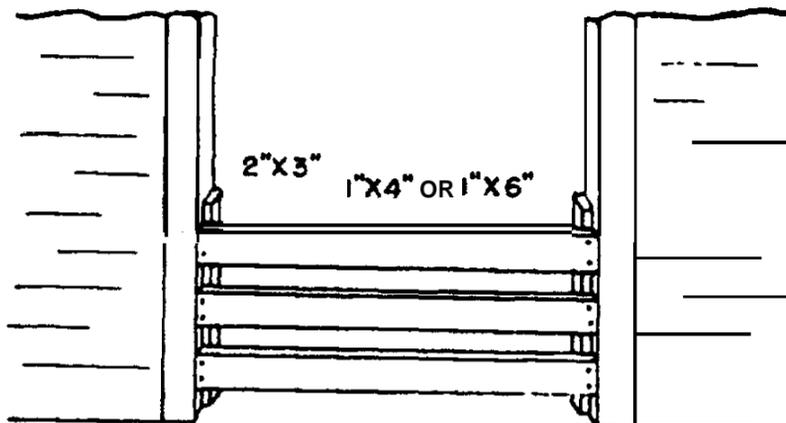


Figure 3-122. Flush doorway protection for cars with wooden doorposts.

*b. Controlled floating load.*

(1) *Description.* When using the controlled floating load, blocking is not applied against the front or rear of the unit or the units to be shipped. Generally, as the units are to be shipped by this method are items that are skidded, that is, engines, machine tools, generators, or large motors, snubbing or braking devices are applied against the side of the skids. Under lengthwise impact, the shift of the skidded item is controlled, and the item is held in contact with the floor of the car. Thus, the greater part of the shock forces are dissipated through the friction and riding of the skid structures. The item is actually isolated from lengthwise shock forces. There are two commonly used snubbing devices-antiskid plates and lag screws. The antiskid plate and method of application are shown

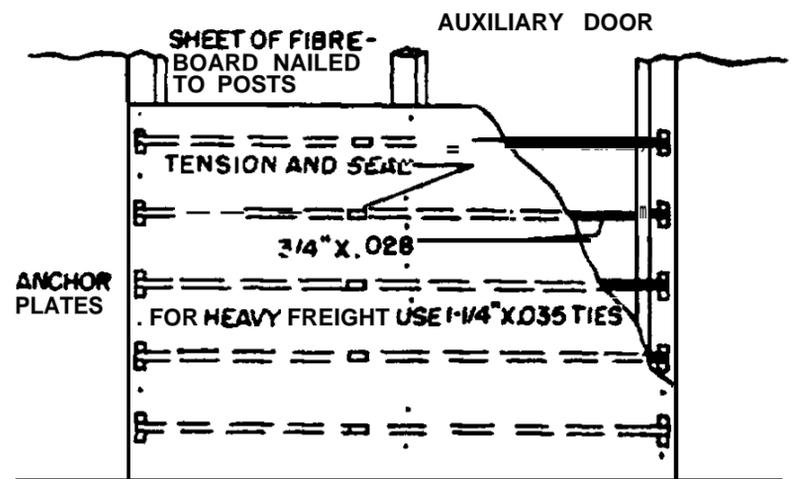
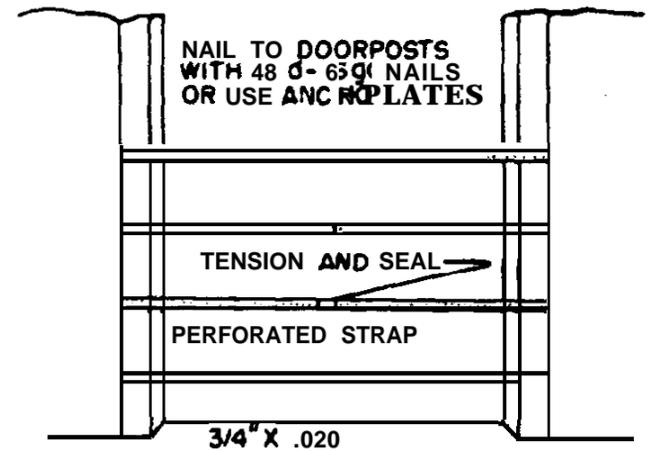


Figure 3-123. Use of steel straps for double door auto boxcar.

in A and B, figure 3-124. The lag screw and method of application is shown in C, figure 3-124.

(2) *Application of snubbing devices.* In applying the lag screw snubber, the lag screw is turned in, in a predrilled hole in the snubbing block, until the screw tip is flush with the inside face of the block. The snubbing block and the backup cleat are securely nailed and spiked to the floor. Measure the amount the lag screw head projects beyond the outside face of the snubbing block and with a wrench turn the lag screw into the side of the skid until  $\frac{1}{2}$ -inch penetration is obtained. The bite of the screw tip into the side of the skid will serve as a retarder to control both lengthwise and upward movement. The antiskid method is basically the same except that a plate is inserted in lieu of a lag screw. The method of arrangement for placing either the antiskid plate or the lag screw snubbing device is shown by figure 3-125. The maximum distance for locating the end snubbing devices from ends of the skid should be approximately 24 inches

to 30 inches (fig. 3-125). The snubbing devices on each side of the skid should be equal in number and located directly opposite. The number of snubbing devices to be employed on each side of skid will

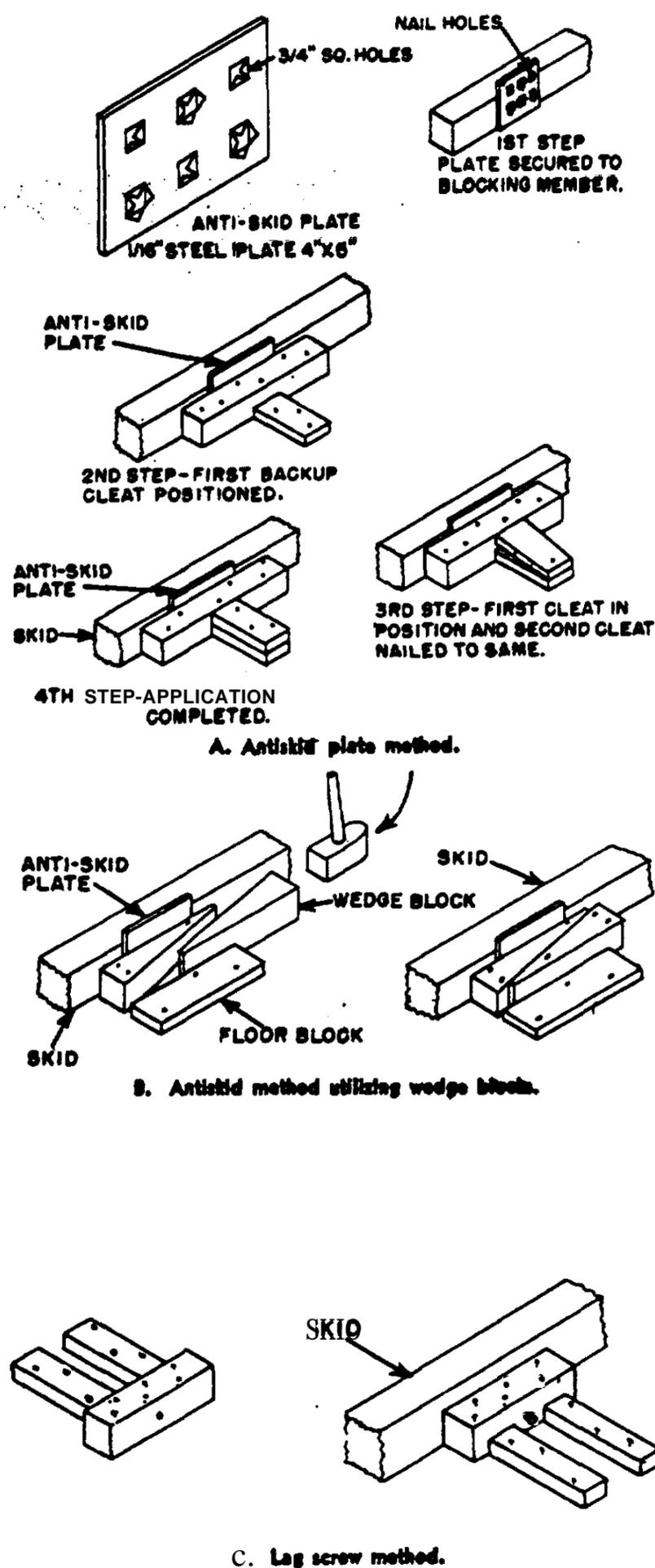
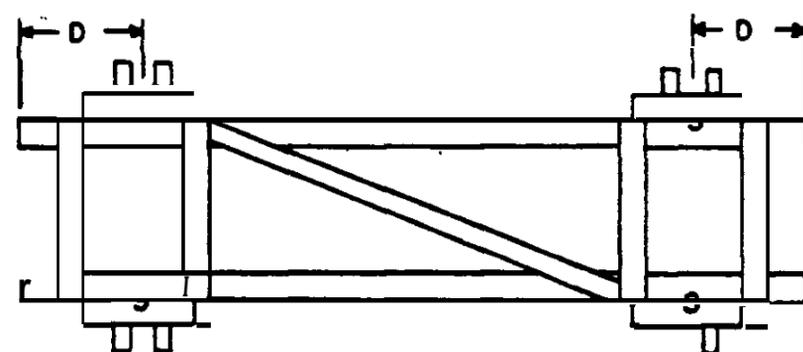


Figure 3-124. Snubbing machine.



NOTE: DISTANCE "D" NOT MORE THAN 30". "S" REPRESENTS  
SNUBBING DEVICES.

Figure S-125. Location of snubbing devices.

vary with the weights of the item and the desired amount of restriction of movement. Generally, the number varies from two to five devices on each side of the skid. **After** end devices are located, the additional devices are spaced in between.

(3) **Application and use.** The snubbing devices should be used on machinery, especially legged type, boats and those commodities that should be protected from sudden or severe shock.

(4) Several *items cleated together*. The use of the snubbed load is recommended wherever practicable.

c. *Floating load*, The floating load absorbs a great amount of shock pressure as containers slide over the floor of the car, thus riding with the "punch." The materials may or may not be palletized. However, the pallet loads or containers are secured in a unit by binding with steel straps. Units may be placed in each end of the car, or as a single unit extending through the doorway area. Space for floating may be at each end wall and doorway; all in the doorway; or with a single unit at the end walls. There are variations of this load which are termed "Restricted" floating loads. (For additional details see **AAR Pamphlets Nos. 14,21, and Section 2 of Loading Rules for Open Top Cars.**)

### 3-906. Mixed Loads

a. *Nature of problems.* The variety of different shapes, sizes, and weights of articles and containers, so frequently required to be loaded together in one car, furnishes a greater problem than solid loads of one type container or commodity. It is paramount that the number of mixed cars be held to a minimum. Planning the shipments to obtain the maximum of solid loads will not only result in less

damage, but **will** prove to be more economical in bracing material and loading time required. (See AAR Pamphlets 4, 13, 18, and 24 for additional information. )

*b. Segregation of load.*

(1) *Scheduling for segregation.* The same type containers or articles in a mixed load **should** be loaded together in the car; the loading and bracing practices should be followed as for solid loads of these individual items. More efficient working **procedures** are obtained when it is possible to schedule **flow** of **supplies** to the loading platform in order to be segregated.

(2) *Methods of segregation.* The following methods of segregation are suggested by—

(a) Layer.

(b) **Units** lengthwise of the car.

(c) **Units** crosswise of the car.

(3) *Segregation by layer.* When segregating or separating articles by layers, the heavy articles should be in the lower layers; the lighter and fragile items in the upper layers. For example: Drums, barrels, heavy crates, or boxes in the floor layers; bagged commodities, wirebound boxes, and fiberboard boxes should be loaded on top of the heavy containers. If the lighter containers or items cannot be loaded directly on top of heavier containers, separators or fillers will be placed between the layers. These separators **may be of wood or fiberboard** depending on the amount of protection or support required. When loading commodities in bags or fiberboard containers or lightly constructed wood boxes on top of barrels or drums, wood filler boards will be used for separating medium; when separating bags loaded on fibreboard containers, a heavy paper will suffice. Generally, separators are not required between layers of the same type wood boxes, wirebound boxes, or fibreboard containers; however, small dimension containers will not be **loaded** directly on or against unsupported panels or cleated panel containers or open crates without adequate separating material.

(4) *Segregation by units.* When separating containers by units lengthwise of the car, the recommended loading pattern for the different containers as covered in the AAR Pamphlets for solid loads of the containers should be followed, that is, **fibreboard** boxes in bonded block patterns, cylindrical type containers by nesting or offsetting, anti bagged commodities by brick wall or binding methods.

*c. Separation gates.* Generally, separation gates

are required when" containers of different type and size are loaded side by side. Separation gates may be of the floating type (not secured to the car side **walls**) when used between units of containers having practically the same strength and rigidity. When separation gates are used between a unit of heavy strong containers on one side and a unit of lighter and weaker containers on the other side, the separation gate should be fastened in place to prevent the heavier containers crushing the lighter containers when subjected to load pressures. When the load pressure exerted in either direction may cause damage, the separation gate should be anchored in both directions by the reverse steel strap method. See AAR Pamphlet No. 14 for detailed information concerning the construction of separation gates. In addition, AAR Bulletin No. 527 of the General Information Series contains information on the construction of a **re-usable** car brace for securing part car loads. This brace is adaptable for use when switching cars on the station during the loading of mixed shipments. Certain types of special box cars have built-in fixtures and equipment for quick application of multiple-deck flooring, adjustable gates, bulkheads, etc. These cars are particularly adaptable to the securement of delicate 01 fragile freight.

*d. Blocking.* Machinery and rough items such as castings, steel frames, pipes, and bars should be blocked both lengthwise and crosswise of the car as recommended for these commodities in the applicable AAR Pamphlets.

*e. Separators.* Separators will be used when one side of the car contains items or containers that **may** be crushed because of lateral pressures caused by side shift of heavier articles. The separators will be reinforced by blocking to car floors and side **walls**. Where the containers loaded adjacent to each other need protection only **from** tearing, **snagging**, or **chafing** it will not be necessary to secure the **separators** in a fixed position. The separators will be placed lengthwise of the car between the two **different** type containers, that is, when open crate are loaded adjacent to fibreboard containers. The fillers or separators serve the single purpose of **preventing** physical contact between two types of **containers**.

*f. Compliance with general rules.* The weight distribution requirements of the General Rules in AAR Circular No. 42-E will be complied with when

loading mixed loads in cars, using the separation or segregation methods or procedures.

### 3-907. Bagged Commodities in Closed Cars

a. *Types of damage.* The types of damages which can occur to **bagged** products are-

- (1) Contamination.
- (2) Snagging of bags on car walls, floors, and in doorway areas.
- (3) **Chafing.**
- (4) Moisture damage.

b. *Contamination and snagging.* Contamination and **snagging** can be prevented "by application of the principles mentioned in paragraph 3-902.

c. *Prevent chafing.* Chafing against car wall can be controlled by loading the bagged commodities away from the car wall in a "pyramided layer" build Up (fig. 3-126). Tight loading and proper floor protection will prevent chafing in the lower layers. Jamming or wedging of bags in the doorway area can be prevented by installation of proper doorway protection, or by setting back the load at least a half a bag length from each door post, continuing through the doorway area interlocking the bags in a pyramided layer pattern or by the retaining paper method (B and C, fig. 3-126).

d. *Control of moisture damage.* Moisture damage to bags can be controlled by proper protection from the elements while loading the car. Bags should not be stacked on damp platforms or damp car floors.

### 3-908. **Palletized** Loads in Closed Cars

a. *Economy of **palletized** cargo.*

(1) Introduction. **Palletization** is a system whereby a large number of small items are grouped and unitized on a pallet for handling by mechanical means, such as a forklift truck. The efficiency gained by reducing the number of **handlings** is shown in the example of loading a freight car with 1,800 small boxes. For example: By grouping the boxes on 36 pallets, each containing 50 boxes, the ratio of transfers has been reduced from 1,800 individual box **handlings** to 36 mechanized pallet moves. Also, each time a package is handled there is the possibility of damage, therefore, reduced handling results in less damage to cargo.

(2) *Stable pallet loads.* If the items are assembled carelessly on a pallet, the pallet will not protect the material during handling or transit operations. If a pallet unit becomes disarranged, it is not much better than individual loading, and requires a large

amount of manual handling to reassemble in an orderly arrangement. Therefore, it is important that the **palletization** of items be arranged carefully and the individual items be secured properly into a strong compact unit, capable of being handled and shipped safely.

*Note.* See section 10, this chapter, for more detail on unit loads.

b. *Boxcar information.*

(1) *General.* For guidance in planning pallet units and loading, basic data on boxcars is necessary. While the dimensions listed in subparagraph (2) **below** are the most common for **standard** boxcars, dimensions of some older or special cars may vary.

(2) *Inside floor dimensions of boxcars.* Typical inside floor dimensions of boxcars are as follows:

- (a) 9 feet 2 inches wide by 40 feet 6 inches long.
- (b) 8 feet 6 inches wide by 40 feet 6 inches long.
- (c) 9 feet 2 inches wide by 50 feet 6 inches long.
- (d) 8 feet 6 inches wide by 50 feet 6 inches long.

(3) *Car door widths.*

(a) *Single door boxcars.* The doors in single door boxcars are six feet wide. Some of the newer cars have doors with a 7-foot and an 8-foot width.

(b) *Double door boxcars.* The doors in double door boxcars vary from approximately 10 feet 6 inches to 16 feet 6 inches. The average standard clear width opening is 15 feet 0 inches.

(4) *Refrigerator car information.*

(a) *Inside floor dimensions.* The inside floor dimensions of a standard size refrigerator car are 8-foot 2 $\frac{1}{2}$ -inch width x 33-foot 2 $\frac{1}{2}$ -inch length. Some cars will vary from this standard.

(b) *Car door widths.* Car doors are 4 feet 0 inches wide although newer cars are being built with 6-foot 0-inch wide doors.

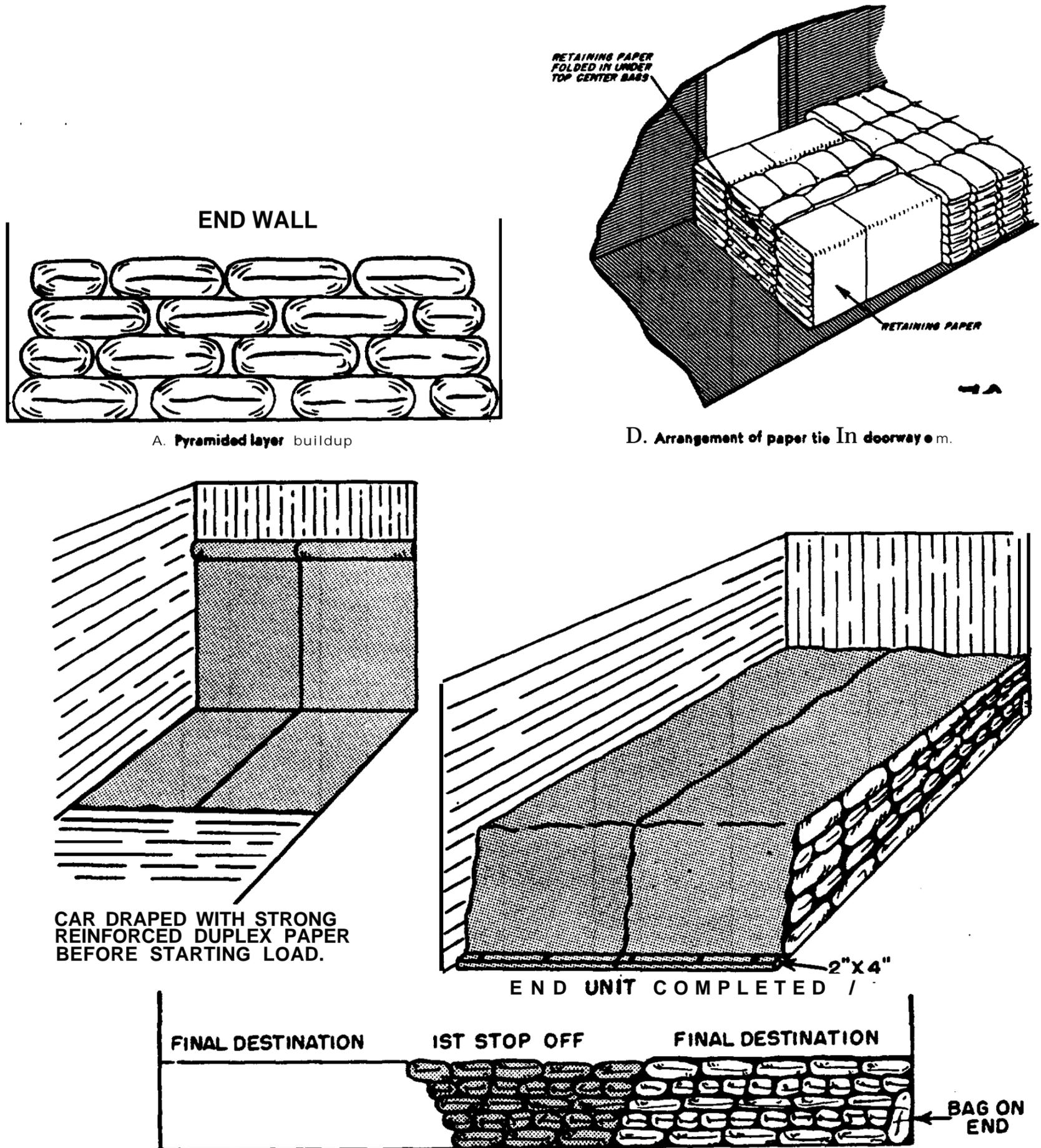
(5) *Boxcar floors.* When moving in and out of cars with a loaded forklift truck, this heavy concentrated load in motion causes a considerable strain on the car floors. In order to avoid accident or injury, the car floors must be protected. Circular 42E, Rule 5(D), **Operating-Transportation** Division, **AAR**, General Rules Covering Loading of Carload Shipments of Commodities in Closed Cars, requires, when lift trucks are used for loading and

**unloading**, suitable steel plates must be placed in car to prevent damage to floor (fig. 8-127).

c. Loading on *pallet*.

(1) *P?Went pressure on load*. When the pallet

units are loaded into a car, each unit must have a firm bearing contact against the adjacent unit. Pallet unit A, shown in figure 3-128, provides bearing contact along the edges of the pallet only and not



A. Pyramided layer buildup

D. Arrangement of paper tie In doorway

CAR DRAPED WITH STRONG REINFORCED DUPLEX PAPER BEFORE STARTING LOAD.

END UNIT COMPLETED /

C. Paper unit tie for stop-off loads.

Figure 3-126. Prevention of chafing.

against the load. Generally, this is not recommended for small container assembled units as it is difficult to prevent the unit moving on the pallet.

(2) *Broad load bearing surface.* In the arrangements, as shown by pallet units B and C in figure 3-128, a broad **faced** bearing contact is obtained between the vertical faces of the units, when placed in a carload. However, since this places the containers in the direct line of the load pressures occurring during transit, it is necessary that the containers and the assembled pallet unit must be **sufficiently strong** and **carefully** secured together **on the pallet.**

*d. Loading factors.*

(1) *Tight loading.* Pallets should be placed tightly in both ends of the car. Generally, for practical purposes it is necessary to have some side clearance space of approximately 1 to 2 inches between pallets in order to maneuver the pallets into place by the forklift truck. As shown in section A-A, figure 3-129, the total crosswise slack space between pallets and side walls of car is relatively small (approx. 6 in) and, ordinarily, would not require any additional crosswise bracing.

(2) *Side shifting.* In order to prevent side shifting of load and with a possible derailment of car in transit, Circular 42E, Operating-Transportation Division AAR, Rule 4(C) requires ". . . where the vacant space across the car, between piles and between load and car side, exceeds a total of 18 inches, the load must be secured so as to prevent moving or tipping towards side of car." If, in loading narrow pallets, there is 18 inches or more of space concentrated along the center line of the car, the pallets must be braced to prevent side shifting of load by some form of sufficient crosswise bracing.

(3) *Doorway space.* The loading at the doorway is finished off with proper bracing to secure and hold the load in place during transit. The doorway section of the load is a critical area in which to work as space is needed to maneuver the forklift trucks or other mechanical equipment which might be used (parts (A) and (B), fig. 3-130). For example: The space C, indicated on part (A), figure 3-130, at the doorway is braced securely by means of a wooden center gate D or steel strap anchored gate E indicated on part (B), figure 3-130. By this method, the bracing can be removed at destination and with

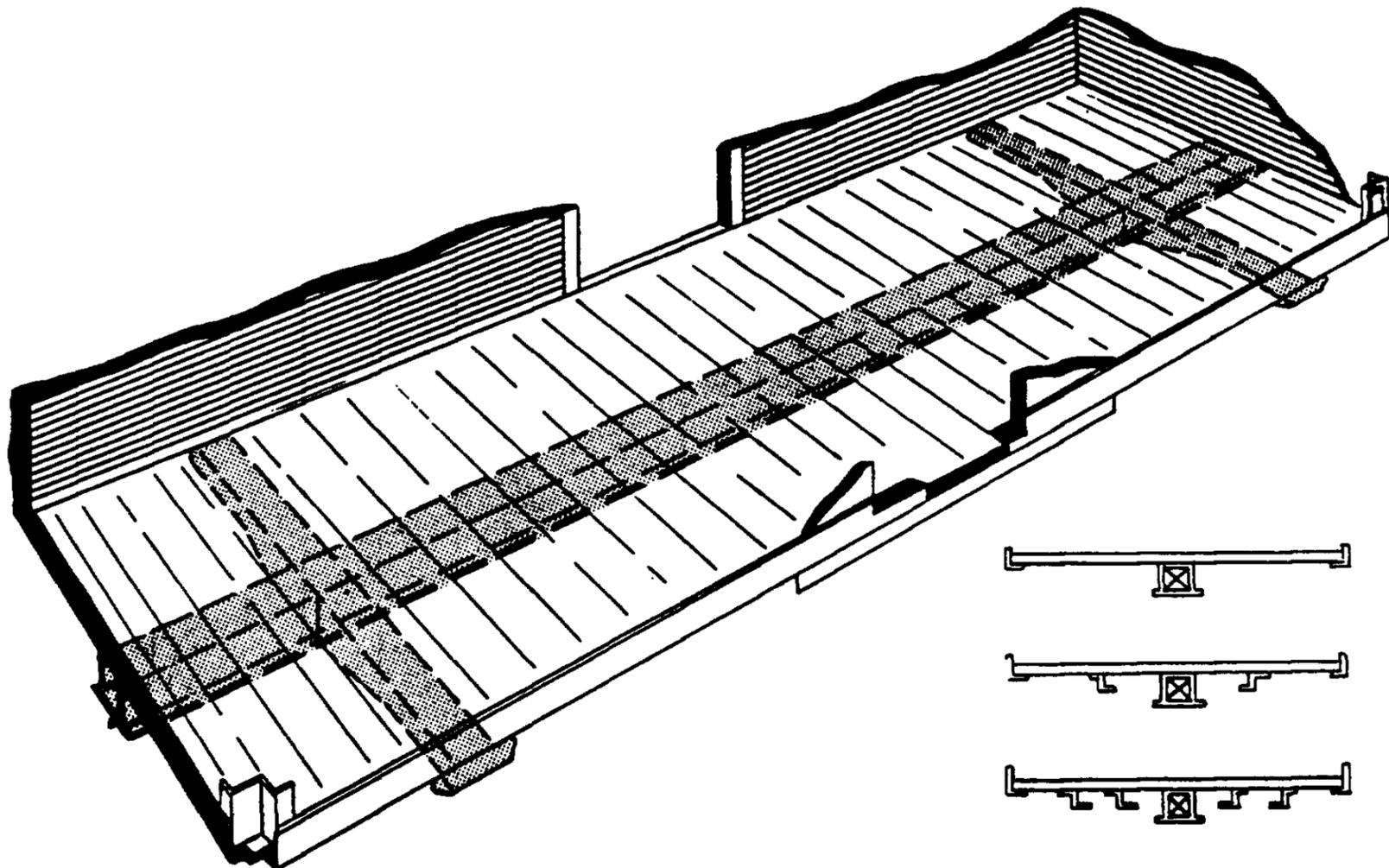


Figure 3-127. Floor supports

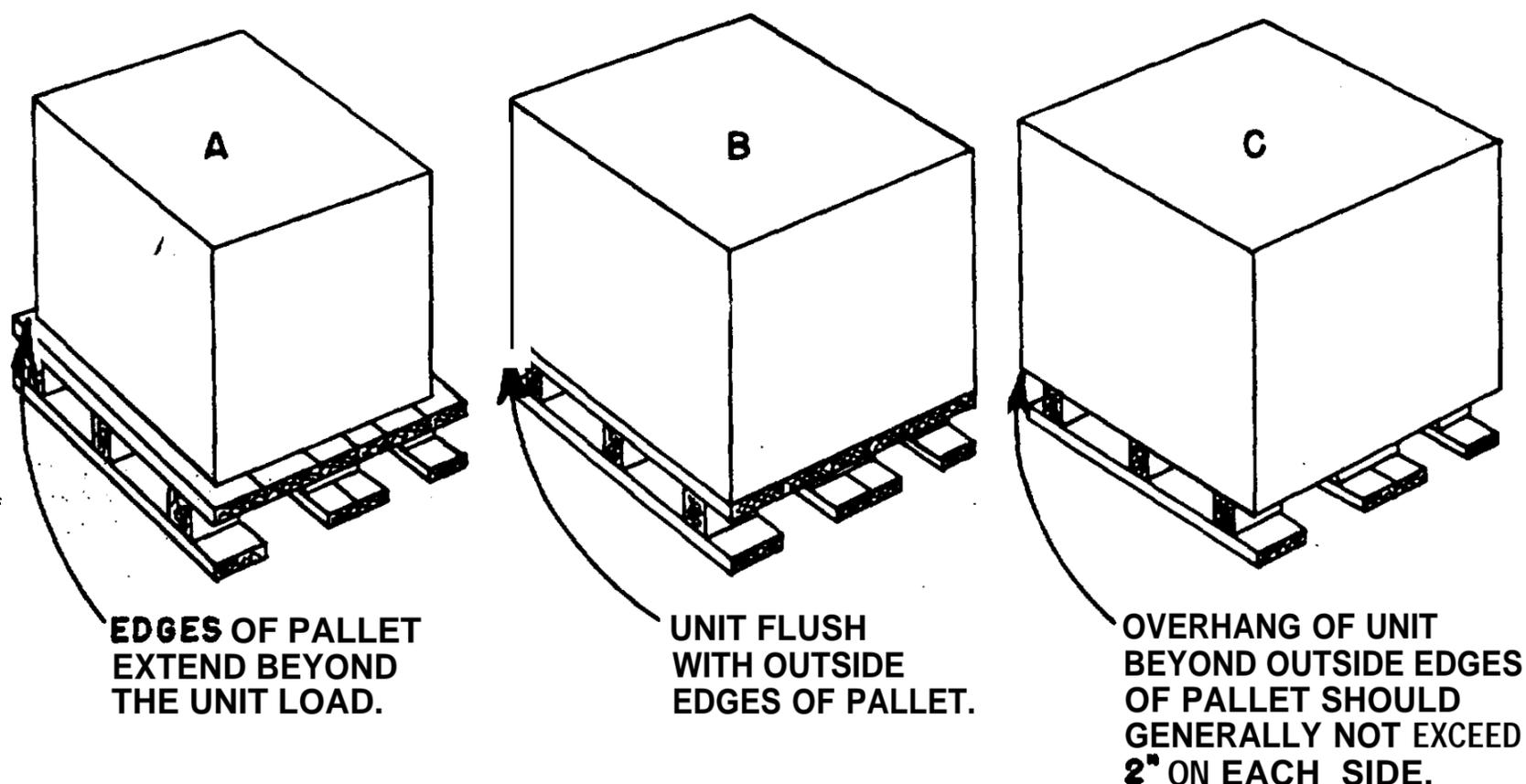


Figure 9-1.878. Palletized loads.

this work space in the doorway section, the car can be unloaded without difficulty.

(4) *Filling the doorway.* As shown in the example in (3) above, it is desired to completely fill the lengthwise space of the car with pallet units; however, some practical difficulties arise. When the last two pallets, shown by the shaded portion of figure 3-131, are moved into place, invariably, there is some slack space (possibly 4 to 12 inches) at one or both sides of these doorway pallets (fig. 3-130). When this occurs, it is necessary to squeeze into this slack space some form of bracing dunnage that will secure the load tightly in place to prevent shifting and damage in transit. Also, it should be considered that in this type of a through solid load, the pallet units in the doorway will be squeezed tight during transit and, consequently, will be difficult to pull out of the load at the destination. This difficulty can cause damage to the merchandise on these first few doorway pallets when trying to "break into" such a load. Therefore, many shippers and receivers prefer to brace the loads as explained in (3) above leaving a space in the doorway section of the car to facilitate handling operations (part (B), fig. 3-130).

### 3-909. Cylindrical Containers in Closed Cars

#### a. Special problems of loading.

(1) *Description.* Cylindrical containers include

steel barrels, drums, slack, and tight coopered wooden barrels, kegs, pails, and fibreboard drums. See AAR Pamphlet No. 4 for more detailed information on loading of cylindrical containers.

(2) *Shape affects stability.* Cylindrical containers have a circular contour and when loaded in a car, do not have complete face or surface contact or support between adjacent containers, which creates an unstable condition. Many containers in use are constructed of lightweight materials that will flex, bend, or crush under concentrated pressure. Therefore, it is necessary to have at least a two-point contact between adjacent containers.

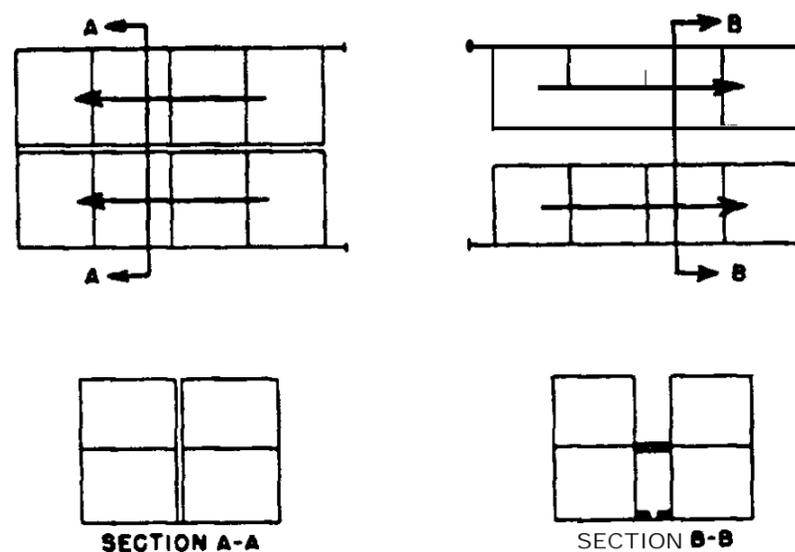


Figure 3-129. Crosswise slack.

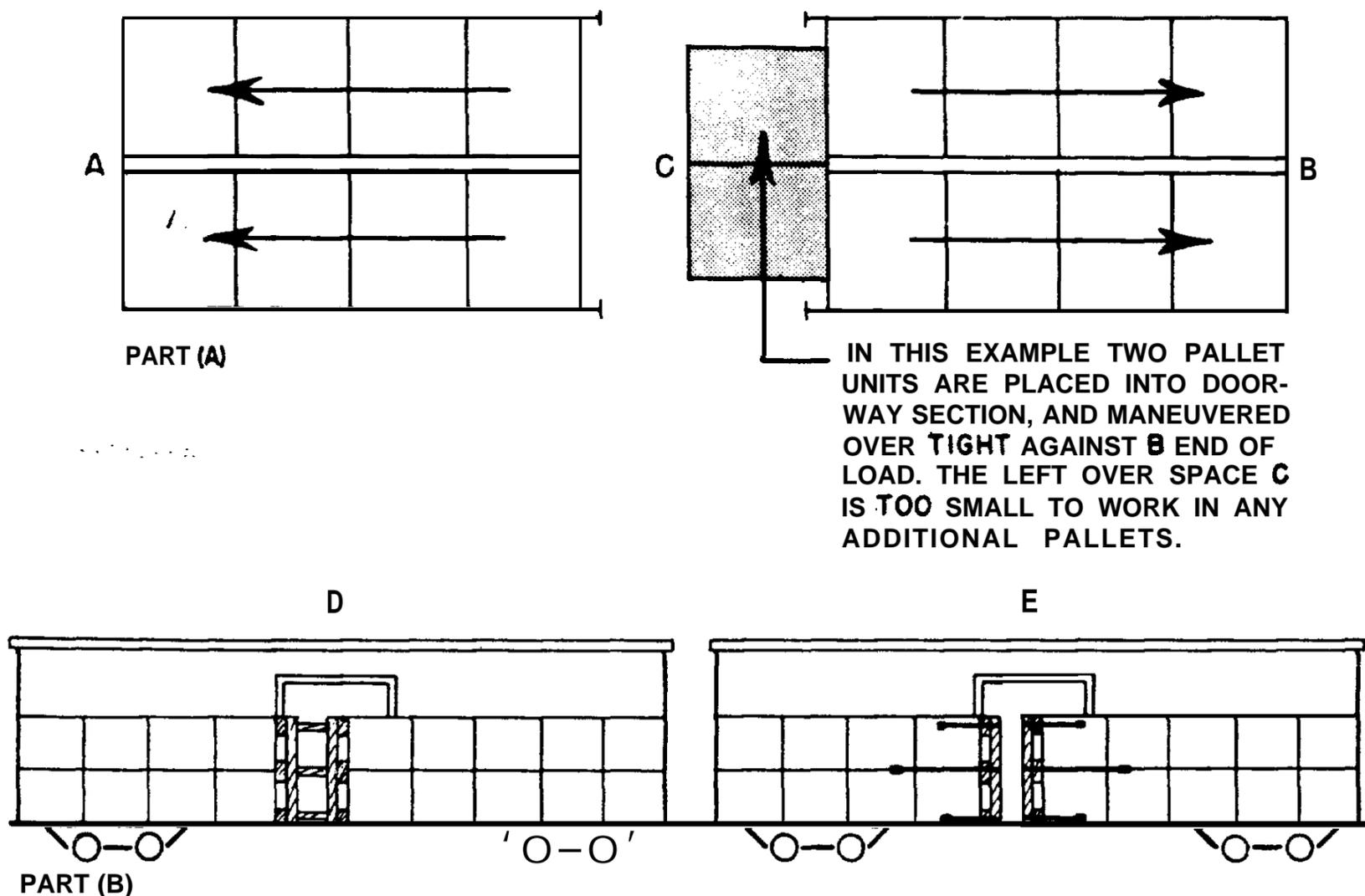


Figure 9-190. Doorway area.

(3) *Contrasted stability of square and cylindrical shapes.* The alignment in bearing surfaces between containers **having** square or **rectangular** shapes is shown in part a, figure 13. With the units placed as illustrated, the construction resembles a multistoried house. This arrangement provides complete stability for such containers. If cylindrical containers were placed in straight lines, as shown in part b, figure 3-132, there would be no stability between the containers. This would be similar to trying to stack billiard balls one on top of another as shown in part c, figure 3-132.

(4) *Offset loading.* The method of loading containers shown in part d, figure 3-132, is the preferred method due to the stability obtained by offsetting the containers. This method provides a two-point contact between containers and any force or pressure brought to bear against a container is distributed to the adjacent containers. Other advantages are that this method retards rotation of containers and **will** accommodate crosswise loading where drums will not **fill** the voided space.

(5) *Diagram.* It is necessary at times to load

a desired number of containers in a car as shown in part e, figure 3-132. However, there is a disadvantage to this method since the containers tend to be forced into the voided space at either side of the car. In the pattern shown in part d, figure 3-132, this open space is divided into three smaller spaces.

(6) *Importance of tight loading.* Emphasis will be placed on tight loading. The proper positioning of cylindrical containers placed tightly against others is a basic requirement. Tensioning of steel straps or the application of wooden braces **will** not produce a tight load if the containers are not loaded tightly during the process of loading.

*b. Loading wooden barrels.*

(1) *Bilge protection.* Bilge protection is necessary in the loading of wooden barrels and should be placed so that it will contact the barrel at the strongest point which is 6 inches from the top and bottom chimes. The bung stave is the weakest stave in the construction of the barrel. The barrel should be positioned so that the bung stave does not contact adjacent barrels or the end or side walls of the car.

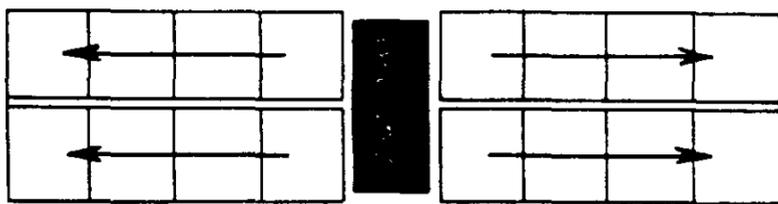


Figure 9-131. Placing of last two pallets.

(2) *Double decked load.* When it is necessary to double, deck the load, dunnage of not less than **1-inch thickness** must be placed lengthwise on top of the bottom or floor layer.

c. *Center bracing.* When planning a load of cylindrical containers decide upon a pattern which will leave the least amount of open space in the doorway area; thus, the load in each end of the car will have the same number of containers against the bracing, preferably the lesser number.

d. *Drums with rolling hoops.* When loading drums with rolling hoops in a rigid, braced load, the

load must be arranged so as to prevent the hoops **from** riding up on each other and thus creating slack lengthwise on the load. This method is also effective for preventing the latches from coming open, when loading drums with detachable tops.

e. *Pails and 5-gallon containers.* Because of the flexibility of light gage pails and the method of fastening the tops (particularly of 5-gallon containers of paint), it is mandatory that the **load** be sectionalized into at least four units. Divisional gates will be fastened securely to the side walls of the car (fig. 3-133). The blocking and bracing will be placed against the strongest part of the container when blocking and bracing pails, 5-gallon containers, and fibre drums.

### 3-910. Machinery and Machine Tools

#### a. Importance of proper loading.

(1) *Dollar damage.* Because of the high dollar value of this equipment any damage can involve a large loss.

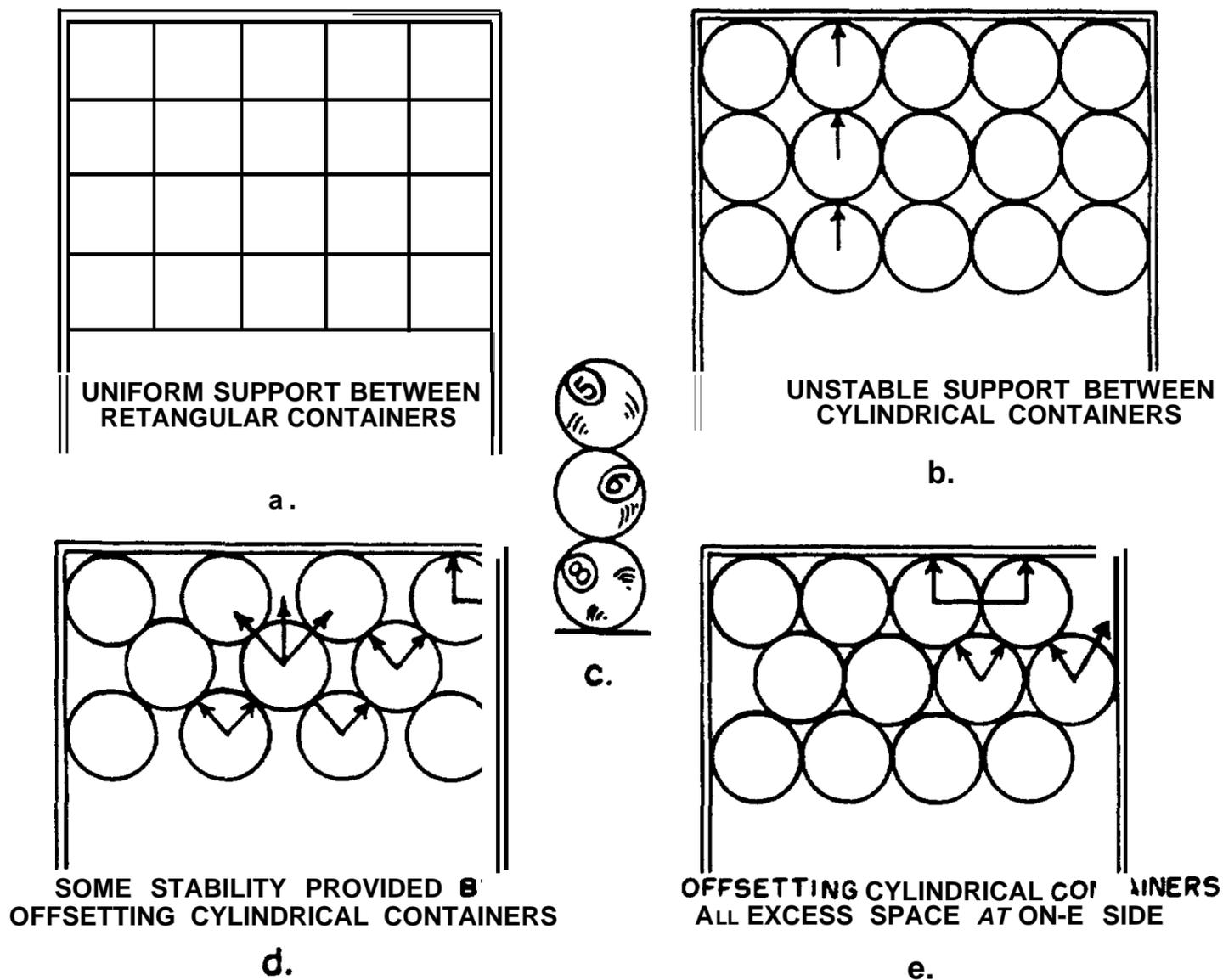
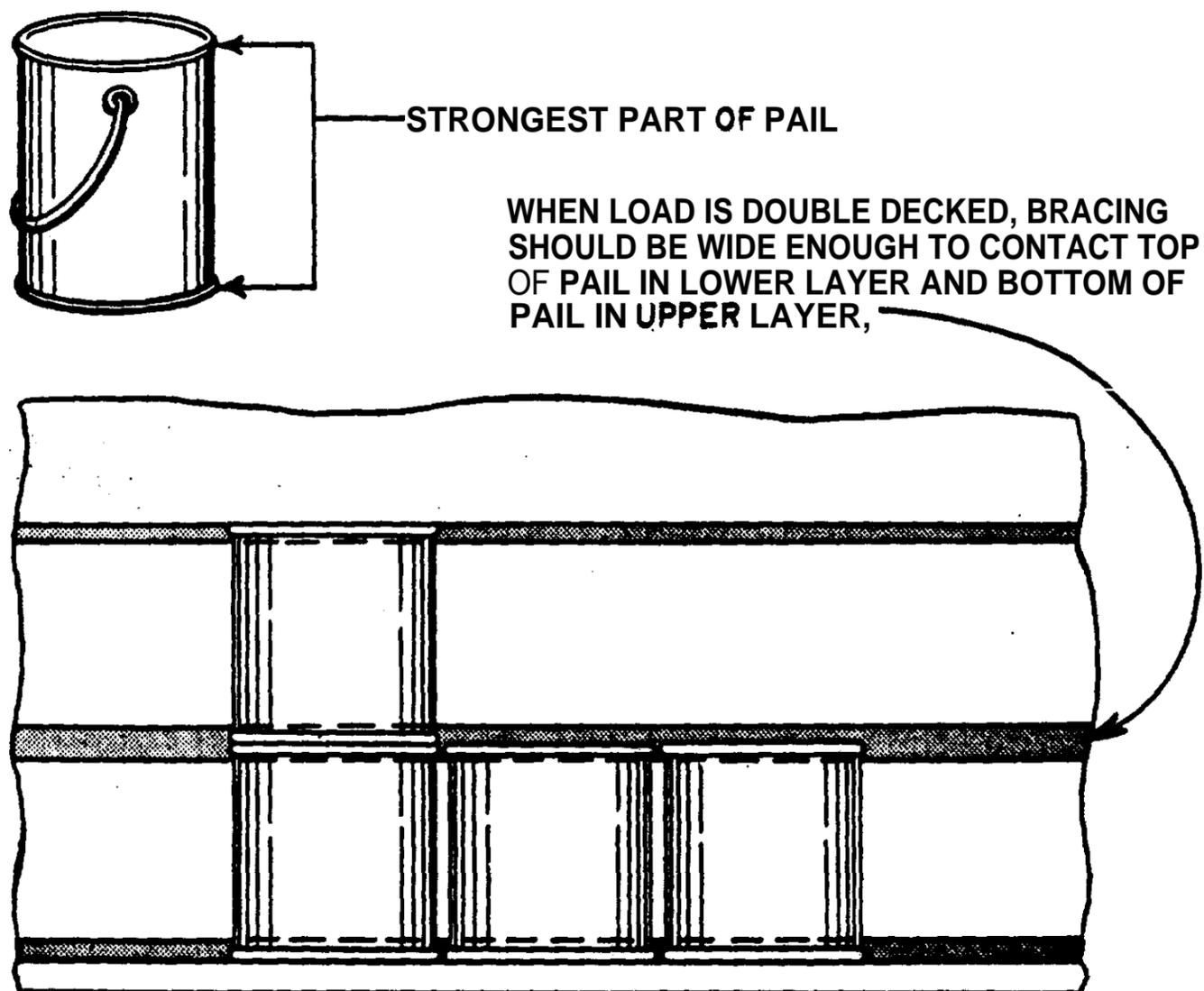


Figure 3-132. Loading diagrams cylindrical containers.



*Figure 3-133. Bracing for flexible or light gauge cylindrical containers.*

(2) *Delay to production.* When machinery destined to a manufacturing point is received damaged, there is a resultant delay in production until replacement parts can be produced.

(3) *Difficulty of replacement.* If possible, repairs can be effected or, if this is not feasible, it may be necessary to manufacture a unit or part as the damaged item may be the only one of its type.

*b. Inspection before preparation for shipment.* Prior to shipment (particularly if the machinery has been in inactive storage) a **careful** inspection will be made of the item or items to be shipped. The items **should** be examined to determine if there are any damaged or missing parts that would make the machine inoperative or hazardous for shipment. Of special importance is the securing of interior bracing of movable parts such as tail stocks, counterbalancing weights, and swing turrets.

*c. Blocking and bracing requirements,* Department of Defense machinery and allied or like items moving on open top equipment will be blocked and braced in accordance with the mandatory minimum

requirements of AAR Section No. 6, of the Rules Governing the Loading of Commodities on Open Top Cars. When loaded in closed cars, General Rules in Circular No. 42-E will be followed. Recommended loading methods for blocking and bracing of machinery and allied or like items in closed care are covered by **AAR Pamphlet No. 21.**

### **3-911. Loading of Hazardous Commodities**

#### *a. Adherence to regulations.*

(1) *Other than Military Services.* Under an Act of Congress, the Interstate Commerce Commission formulates regulations for the safe transportation of explosives and other hazardous articles which are binding upon all carriers engaged in interstate or foreign commerce and upon all shippers forwarding such shipments. All shipments of hazardous commodities will be prepared and forwarded in strict compliance with all pertinent shipping regulations. These regulations are based upon knowledge of the characteristics and past experiences with chemicals, compressed gas, and other hazardous **com-**

modities. The mandatory rules for all open top cars is Section 1 of the rules governing the loading of commodities on open top cars and closed car rules as outlined in AAR Pamphlet No. 42-E are applicable in the loading of hazardous commodities as well as the rules of the Interstate Commerce Commission and the Bureau of Explosives.

(2) *Military Services*. The responsibility for development of safe handling techniques for explosives and live ammunition is the responsibility of the individual service. Publications of these services govern safe handling practices.

*b. Hazardous commodities offered to carrier.* Explosives and other hazardous commodities may be offered to carriers for transportation only when such commodities are in proper condition for transportation, are as defined, and are packed and marked, labeled, described, certified, and loaded and braced according to pertinent regulations. Methods of manufacture, packing and storage, insofar as they affect safety in transportation, must be open to inspection by a duly authorized representative of the initial carrier or of the Bureau of Explosives. Shipments that do not comply with the regulations must not be offered for transportation.

*c. Inspection.* Inspection of Equipment for Transportation of Class A Explosives—A car must not be loaded with Class A explosives unless it has been inspected by an employee of the carrier and certified by him to be in proper condition for such loading. After a certified car has been furnished by the carrier and before loading has commenced, the shipper must inspect the interior of the car and, after loading, certify to its proper condition. When shipments are loaded by the shipper, an employee of the carrier must inspect the finished load and certify to its compliance with governing regulations.

*d. Loading Methods.*

(1) *General.* AU hazardous commodities must be loaded in the car in such a way that such commodities will maintain the position as placed, under normal transportation conditions. Small lots of hazardous items must be blocked and braced securely; such lots will not be loaded in such a manner as to depend upon other freight for bracing. Also, all

other items in the car must be braced in a manner to prevent heavy items from coming into contact with the hazardous commodities. For example: Forgings coming into contact with acid carboys or batteries.

(2) *Blocking and bracing methods.* All the blocking and bracing procedures or methods as outlined in the various carloading pamphlets, with slight alterations, can be adapted to fit the requirements for safe loading of hazardous commodities. The floating center gate with slight alterations will provide bracing for carload shipments of boxed carboys, barrels, cylinders of compressed gas, drums, and boxes. The controlled floating load for handling of filled or empty compressed gas cylinders has proven most satisfactory. (See Bureau of Explosives Pamphlet No. 6 and AAR Pamphlet No. 12.)

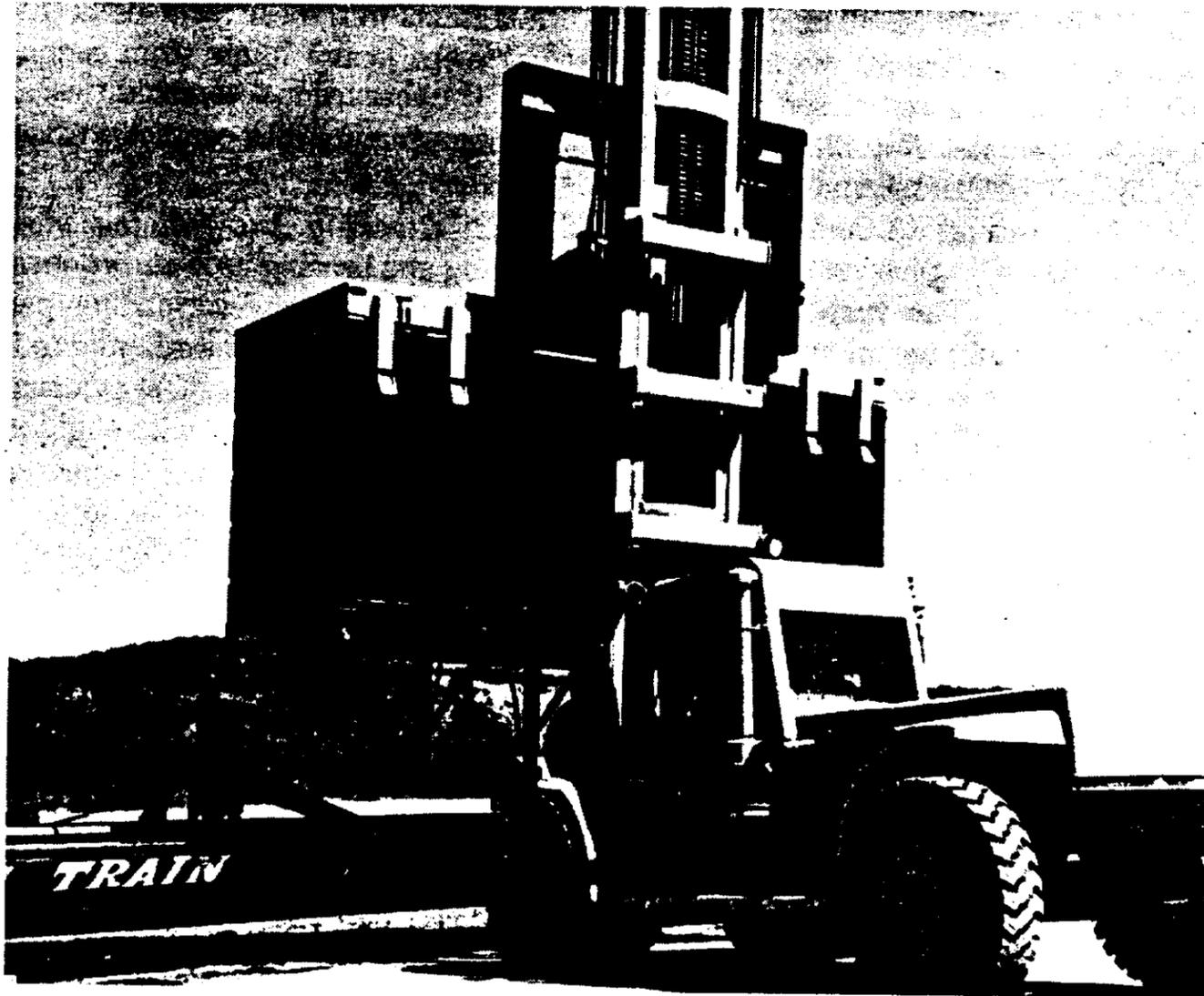
(3) *Cylinders of compressed gas.* Small shipments of cylinders containing compressed gas will be loaded on their sides except when boxed or crated. Cylinders may be loaded upright, if securely braced to the car. Acetylene cylinders will be loaded upright at all times because of the construction of the interior of the acetylene cylinder. Chlorine gas cylinders should also be loaded in an upright position at all times.

(4) Mmunition commodities shipped in ISO containers will be secured with AAR (American Association of Railroads) and CG (Coast Guard) approved restraint systems.

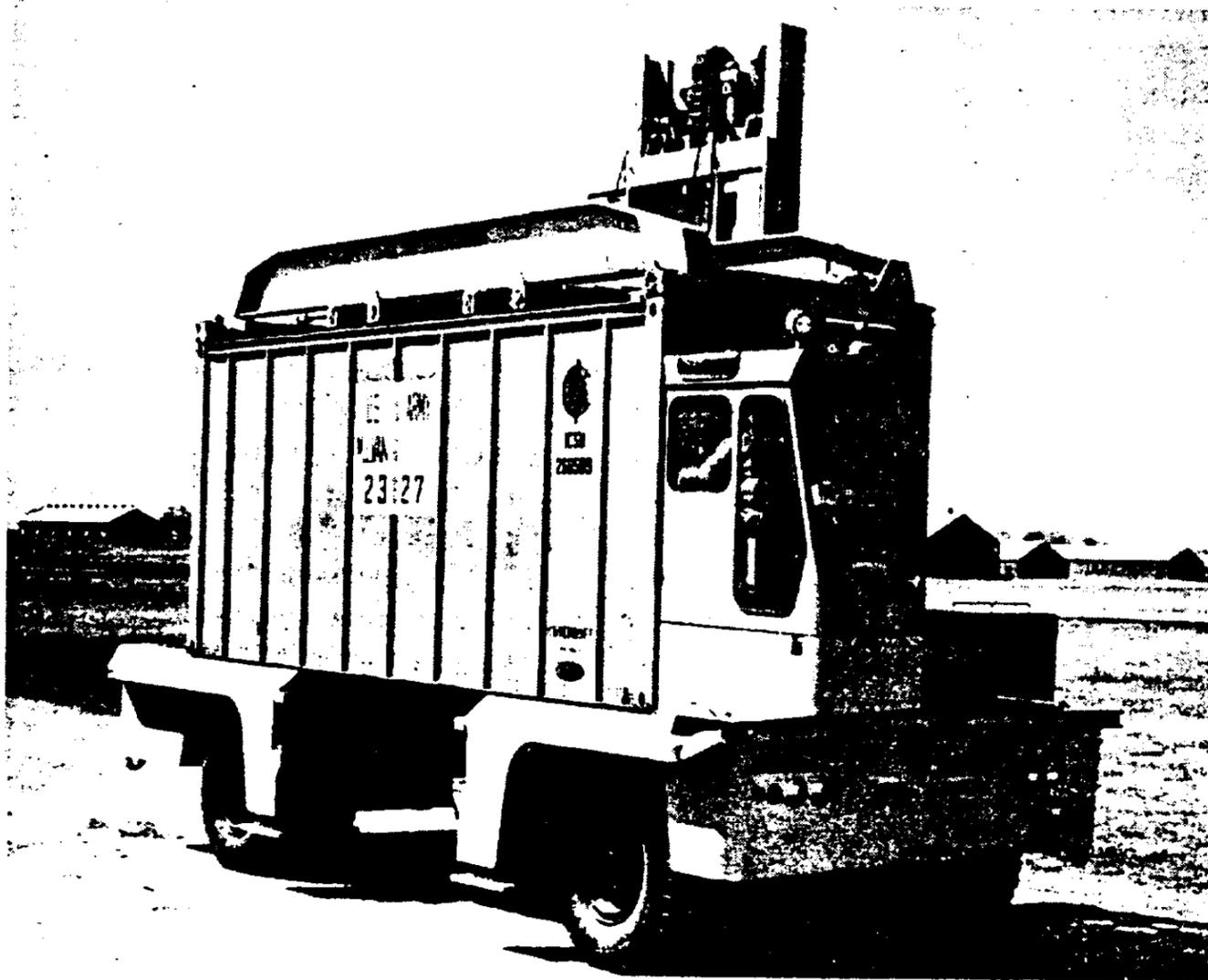
### 3-912. TOFC/COFC Loads

a. Trailer-on-flatcar (TOFC) shipments usually require a ramp to allow the chassis to be driven onto the flatcar. Two types of equipment are used for TOFC loads: (1) Improved strength semitrailers (piggyback trailers), or (2) ISO containers mounted on a chassis.

b. Containers (including ISO containers) not mounted on a chassis are often shipped on flatcars (COFC). Specialized equipment is available to lift these containers and position onto a flatcar. Several examples of handling equipment for such containers are shown in figures 3-134, 3-135, and 3-136.



*Figure 3-13.S. Frontloader forklift truck equipped with toplift attachment*



*Figure 3-135. Sideloader truck equipped with toplift attachment*

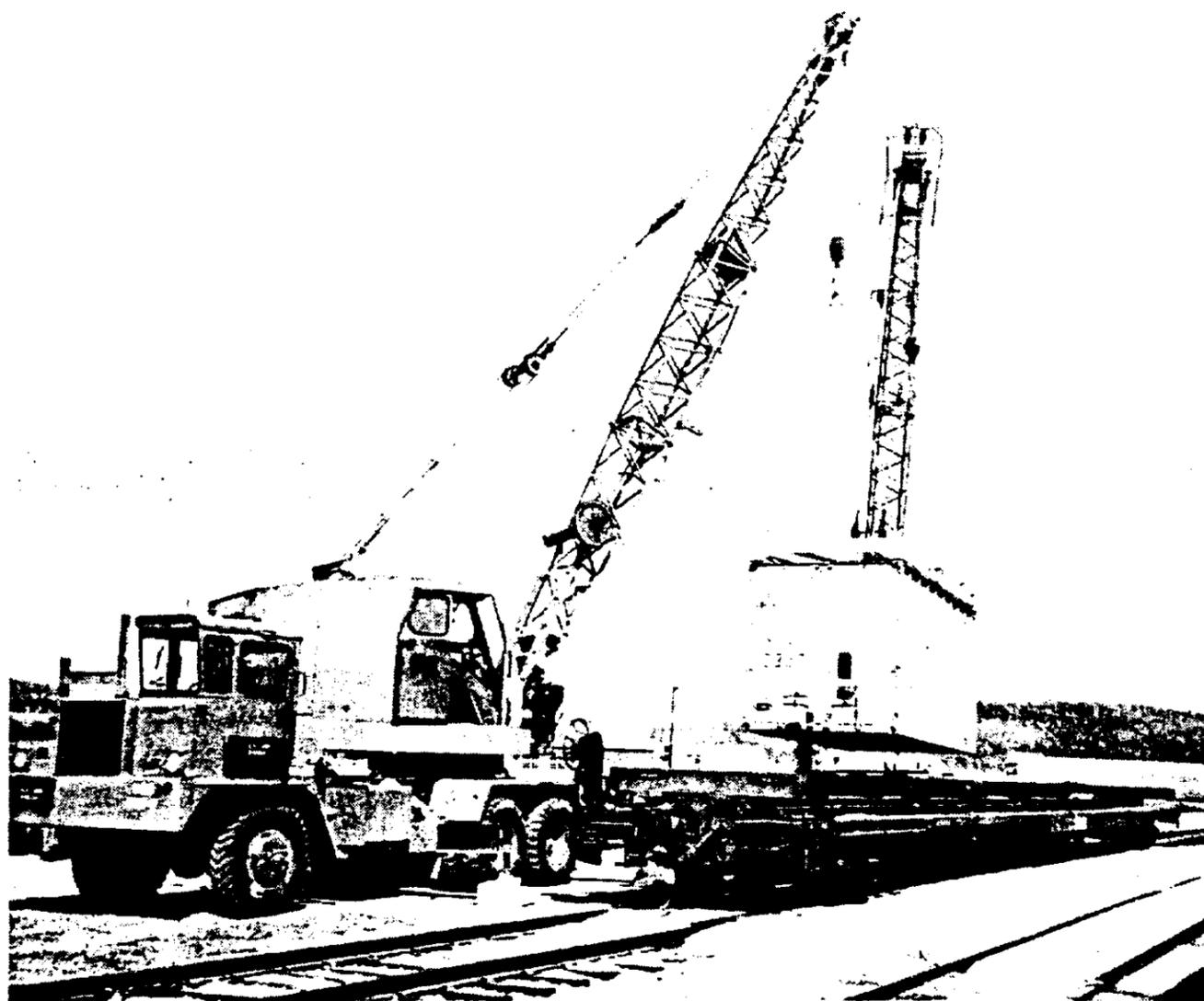


Figure 3-136. Mobile crane equipped with toplift attachment.

## Subsection 2. TRUCK/TRAILER LOADING

### 3-913. Preparation for Loading

*a. Need for good equipment.* Generally, a carrier has several types of vehicles, one of which may be suitable or more adaptable to the commodity to be shipped. It is the joint responsibility of the shipper and the carrier to make every effort to assure safety in transit, as well as safe arrival at destination.

*b. Explosives and other hazardous articles.* Department of Transportation regulations for the preparation of explosives and other hazardous articles for transportation by highway common carriers, construction of containers, packing, marking, etc., are contained in American Trucking Association, Inc., Publishing Interstate Commerce Commission Regulations for the Transportation of Explosives and other hazardous articles by Motor, Rail and Water, Current Issue. This publication is normally filed in the office of the installation transportation officer.

### 3-914. Loading

*a. Importance of proper loading.* The delivery of truck and trailer shipments in good condition depends to a large extent on the manner in which the vehicle was loaded and on the care which was taken in preparing the vehicle for loading. Personnel responsible for loading, blocking and bracing freight should have available for use and be familiar with the rules for the proper loading and servicing of shipments. Shipments of explosives and ammunition will be loaded in accordance with approved procedural publications/drawings issued by the Military Services.

*b. Tight loading.* The most important single factor contributing to the prevention of damage in truck and trailer loading is that of tight loading, which cannot be overemphasized. Rarely does the material to be shipped fit a closed truck, van, or trailer without side slack or end slack, particularly

when the front end is rounded or curved. In most instances slack may be taken up with bulkheads or dunnage.

c. *Difficulty of tie down.* The construction of present day closed trucks, vans, and trailers does not facilitate tight **loading**, blocking, or bracing. Most commercial closed trucks, vans, and trailer bodies are made of aluminum, plywood, or other thin metal shells designed to protect the materials **from** weather in transit. Ordinarily, provision is not made for the essential requirements of blocking, bracing, or **tie down**. The safe bracing of high center of gravity **items in closed trucks**, vans, and trailers presents a problem calling for good judgment, ingenuity, and sound workmanship to assure safe arrival of these items at destinations.

d. *Variation in vehicles.* Physical dimensions, capacities, weight limitations, and load distribution of trucks and trailers vary greatly. These variations preclude the covering of all types of loads. Accordingly, the methods or procedures described must be considered typical and will be adapted to individual loads of various commodities as required.

e. Containers loaded with ammunition on qualified flat bed trailers will be tied down on the flat bed in accordance with approved regulations.

3-915. **Balanced Load.** Equal distribution of load is just as important in **truckloading** as in **carloading**. The importance of weight distribution is shown in figures 3-137 and 3-138.

### 3-916. Load Movements

#### a. *Causes of load movement.*

(1) *Forward movement.* The forward movement of loads, if not braced properly, will be caused **by—**

(a) Braking of vehicle on steep descents.

(b) Sudden stops to avoid hitting pedestrians or vehicles.

(2) *Rearward movement.* The rearward movement of loads, if not braced properly, will be caused **by—**

(a) Ascension of steep hills.

(b) Load rebounds after the sudden application of brakes.

(c) Sudden increase of speed in order to avoid an accident.

(3) *Lateral movement.* The lateral movement of loads, if not braced properly, will be caused **by—**

(a) Rounding corners on **sharp** curves.

(b) **Traveling** on high crowned or banked roads.

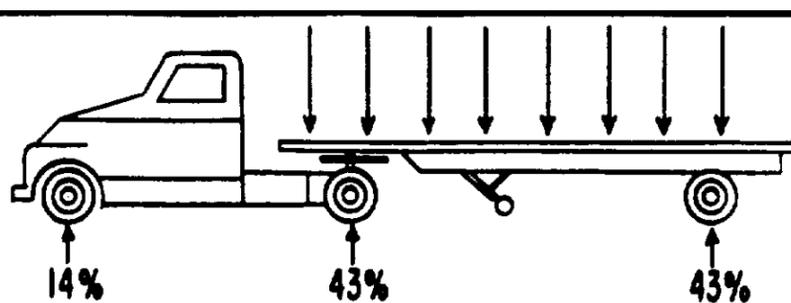
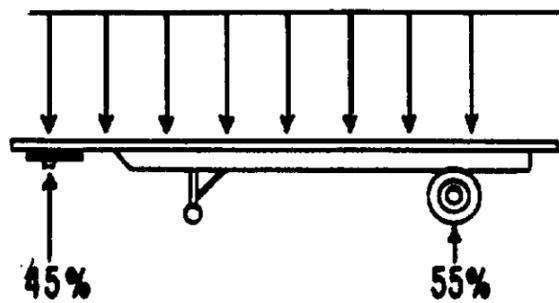
(c) Swerving to avoid accidents.

#### b. *Prevention of load movement.*

(1) *General.* All of the movements of loads may occur when vehicles are traveling on rough or unpaved road *or* when traveling over snow and ice. However, practically all load movement can be prevented or eliminated by proper blocking and bracing. All loads will be balanced in the vehicle lengthwise and crosswise before the vehicle is released. Precautions will be taken to prevent vertical movement because of sudden stops or travel over rough terrain; as vertical movement can cause the breakdown of good blocking and bracing practices. If the load is not tight or **is out of alinement**, the unbalanced loading will cause unequal pressures. The use of bulkheads, separation gates, dividers (lengthwise and crosswise), layer separations, runners, blocks, cleats, and strapping properly fabricated and applied, **will** eliminate or prevent all load movement.

(2) *Forward movement.* Forward movement can be prevented by shoring firmly against the front or nose bulkhead. The front bulkhead serves to square the load and to distribute load pressures over the frontal area of the vehicle rather than just at points of contact. When vehicle, furnished by the motor carriers, has a rounded or streamlined front end or an end other than square and the material to be loaded is a critical item, a delicate or fragile item, or an item that requires special protection and straight **alinement** to assure safe arrival at destinations, front bulkheads of a type and size compatible with the weight and type of commodity to be shipped may be used. A typical nose or front bulkhead is shown by figure 3-139. Front bulkhead detail and installation is shown by figures 3-140 and **3-141**. The use of front bulkheads is not necessary in square nose trailers or vans unless the nose of the trailer or van has been bulged by forward **load** movement in previous shipments. If such a condition exists and the material to be shipped **falls** in the category previously outlined, the front bulkhead should be used.

(3) *Rearward movements.* Rearward **movements** can be prevented by use of a rear bulkhead or gate. The rear bulkhead or gate must be braced, either with diagonal supports back to the door posts of the vehicle or by secured risers against the door posts and the bulkhead or gate. Backup blocks must



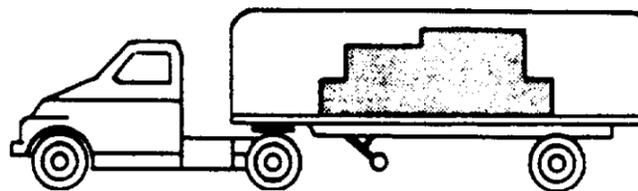
Trailers are also designed for uniform load distribution, as shown by the above sketches. The fundamental difference between loading trailers and trucks is: In the case of trucks, the average design provides for about 90% of the payload on

the rear tires and 10% on the front tires. In the case of trailers, the payload should be distributed equally between the rear tires and the fifth wheel which transfers its load to the truck tractor.



**WRONG**

With a part load or with a very heavy load having little bulk, it is common practice to put it at the front end of the trailer to get traction on truck tractor rear tires. This overloads the truck tires and shortens their mileage life, to say nothing of bending the



**RIGHT**

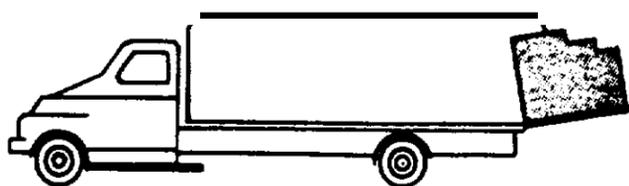
truck rear axle housing. Application of trailer brakes may lock wheels, cause tire flat spots, or skidding, or both.

The load should be distributed over the full length of the trailer floor or platform.



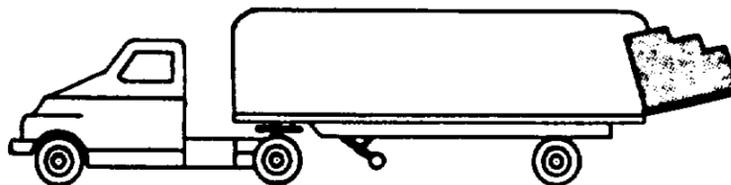
**WRONG**

These examples are obviously wrong. In the case of the first trailer, the heavy load at the rear is overloading the rear trailer tires. There is practically no load on the fifth wheel, and the truck tractor rear tires would certainly slip and wear away rubber. Braking distribution would also be very uneven.



**WRONG**

Tailgate loading, of course, should never be practiced, even in the interest of speed, as it puts a severe strain on the equipment, and frequently results in serious accidents,



*See above for the correct method of loading.*

Figure 9-197. Approximate distribution of total weight—vehicle plus payload.

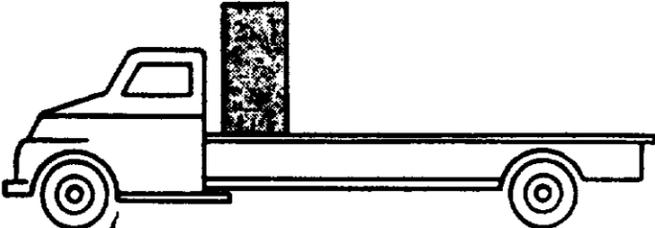
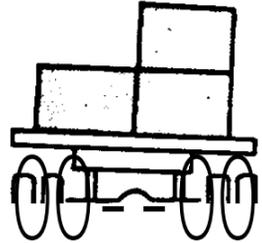
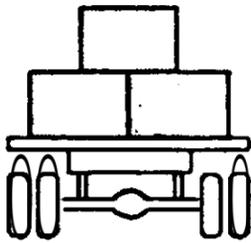
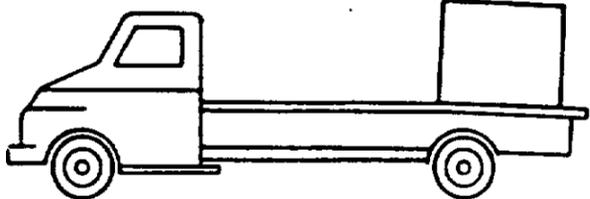
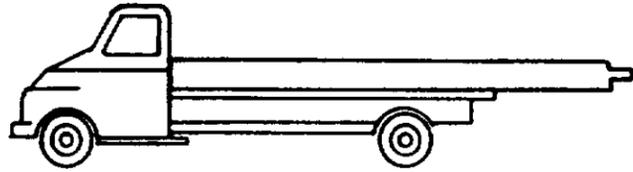
 <p style="text-align: center;"><b>WRONG</b></p> <p>A heavy load, like a big piece of machinery or a safe, should not be loaded against the cab. This loading will bend the frame, perhaps permanently. It will also overload the front tires, may even cause a blowout on the front tires. Hard steering will also result, and the load may be top-heavy.</p>	 <p style="text-align: center;"><b>RIGHT</b></p> <p>A heavy concentrated load should be placed near the rear and on its long side at all possible. Most of the load should be over the rear axle to get proper tire loading and prevent twisting of the frame.</p>
 <p style="text-align: center;"><b>WRONG</b></p> <p>A very heavy load should not be loaded at one side. This overloads one spring and the tires on that side. This loading could be bad enough to allow the brakes to lock on the wheels on the light side and cause flat spots on the tires, or to skid on a wet surface.</p>	 <p style="text-align: center;"><b>RIGHT</b></p> <p>This loading has equal loads on all rear tires and eliminates twisting of the frame, which might loosen rivets of cross members or frame brackets. Uniform loading crosswise prevents axle housing and wheel bearing overloading, too.</p> <p style="text-align: center;"><i>This above example applies to trucks and trailers alike.</i></p>
 <p style="text-align: center;"><b>WRONG</b></p> <p>This loading should never be permitted. The frame bends, the rear tires are very much overloaded, and enough weight is taken from the front tires to make steering almost impossible.</p>	 <p style="text-align: center;"><b>RIGHT</b></p> <p>Again, the proper place for a concentrated load like this is just ahead of the rear axle, with the longest side on the floor.</p>
 <p style="text-align: center;"><b>WRONG</b></p> <p>This type of loading results from the use of the wrong vehicle for the job. Such loading can result, on rough roads, in an excessive pivoting of the truck on its rear wheel, and taking the front wheels entirely off the road.</p>	 <p style="text-align: center;"><b>RIGHT</b></p> <p>A tractor-trailer combination is the proper vehicle for use in service like this. By using the proper vehicle, damage to the truck and tires, and - serious accidents, may be avoided.</p>

Figure 3-138. Examples of right and wrong truck loading.

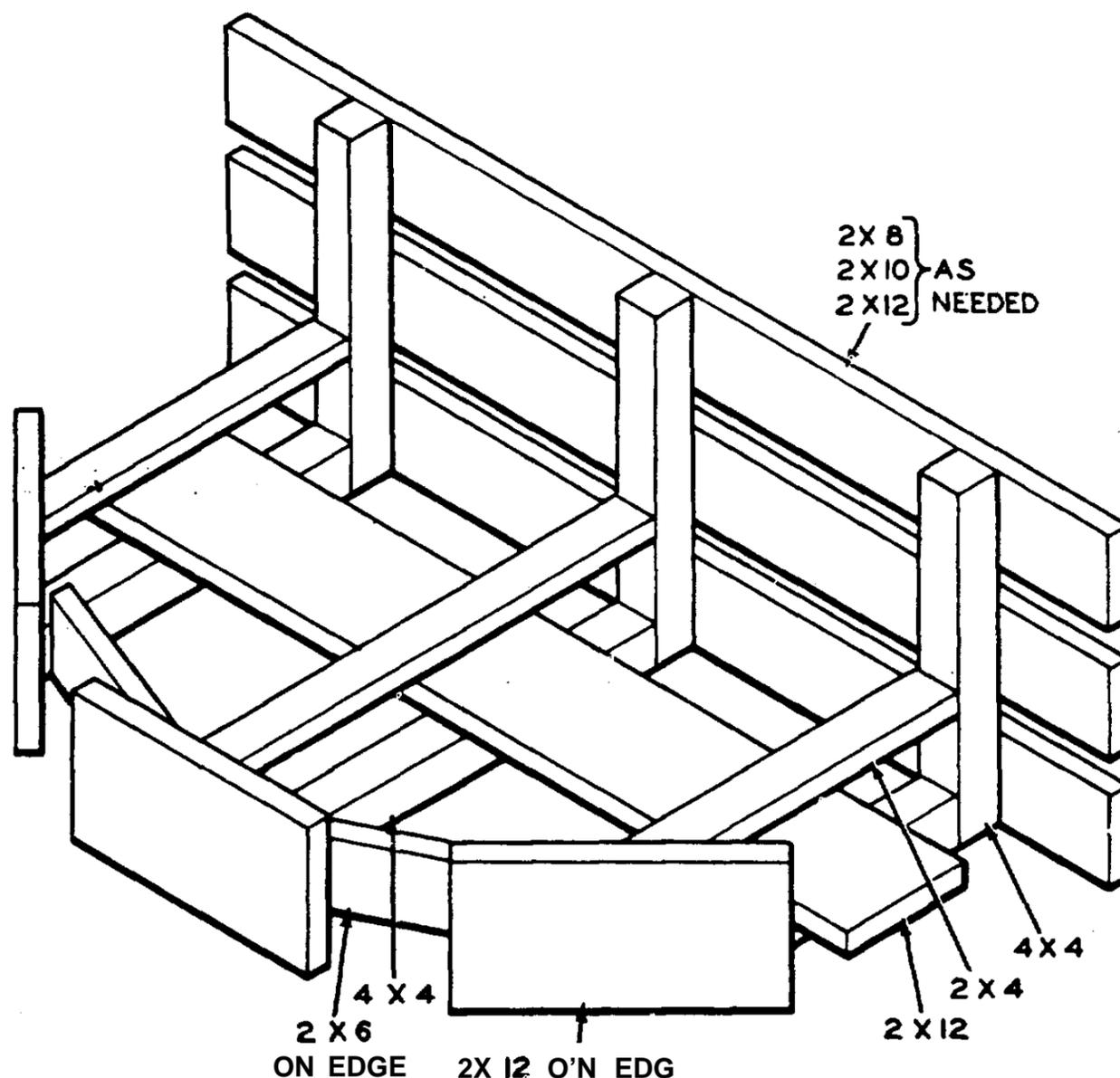


Figure 3-139. Front bulkhead.

be driven into place and nailed to the risers and gate to eliminate slack (A and B, fig. 3-142 and figs. 3-143 and 3-144).

(4) Lateral movement. Lateral movement can be eliminated by the use of space **fillers**, longitudinal separators, steel strapping, and by the use of rigid blocking and bracing devices.

### 3-917. Types of Loading

*a. Wheeled containers.* Closed trucks and trailers should be considered as large containers on wheels; as such, the interior bracing or blocking of the vehicle should conform as near as possible to the packing of individual containers. Through the use of filler material, bracing, blocking, separation gates, and layer separators it is possible to adapt the wide variety of items to the dimensions of the vehicle. Interior blocking and bracing provides cushioning and interior packaging to the material in this wheeled container and also protects the vehicle. Cargo containers of ISO/ANSI standards loaded

with general commodities will also use conventional blocking and bracing methods.

*b. Adaptability of vehicles.* The truck and trailer is adaptable to the many and various types of loads required to move the varied types of commodities such as, heavy or light items, fragile, bulky, compact, dense and rough, and high center of gravity items. In order to accommodate this variety of items the shipper must plan the load; properly prepare the truck; and block and brace accordingly. One method of preparing a truck for shipment of cylindrical items is shown by figure 3-145.

*c. Unit loads.* There are many types of loads suitable for truck loading, that is, the bonded block load for materials shipped in fibreboard containers; brick wall method; key sack method; paper retaining method; and lengthwise crosswise methods for loading bagged materials. However, the key sack method of loading is restricted to cloth bags and is not recommended for **multiwall** paper sacks. Paper retaining method of loading can be used for full truck load or stop off load (see A, fig. 3-146).

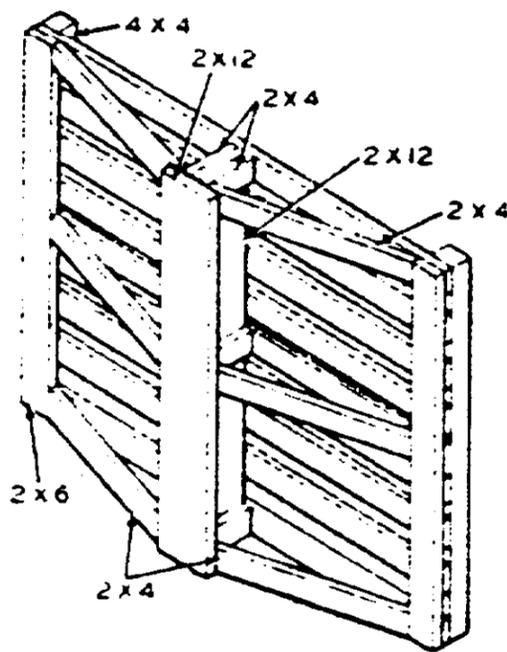
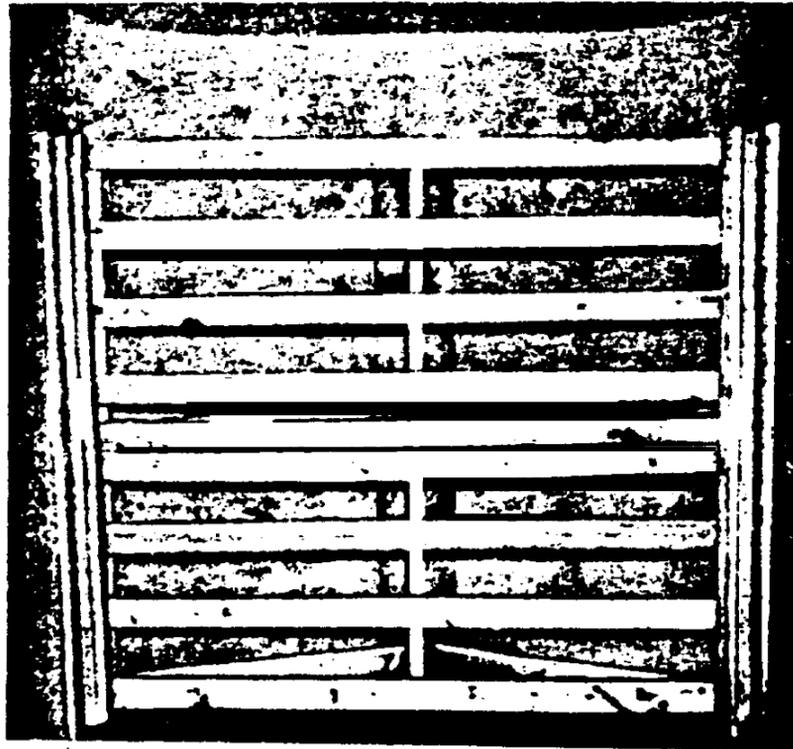


Figure 3-140. Front bulkhead—positioned in trailer, detail of bulkhead.

*d. Step down load.* In the step down type load, the bulk of the weight is on the axles and is stepped down to the center of the vehicle. The stepping down of the load is achieved by use of a riser; the height of the riser must be half the height of the unit or container being braced. The item or container may be utilized as a riser; however, in most instances, the riser should be fabricated **from** lumber or other suitable material (see B, fig. 3-146).

*e. Palletized loads.*

(1) *Advantages.* The advantages of a **palletized** load is that a quantity of small packs or units can be consolidated into a few large packs; thereby reducing the number of **handlings**. For example: 300 containers of a given item can be consolidated into

10 pallet loads, thus, reducing the number of **handlings** by plus 96 percent. Consequently, the number of **handlings** involved in loading and unloading may be reduced from 300 to 10. Accordingly, **palletization** of materials for shipment would be beneficial to both the shipper and the carrier. Explosives and ammunition will be **palletized** in accordance with approved procedural publications/drawings issued by the military services.

(2) *Forming pallet loads.* **Palletized** loads may form a full uniform load, a tiered load, a staggered load, or a strapped **load**. The load should be balanced, weight should be evenly distributed, and blocking and bracing should be kept to a minimum. A staggered load of **palletized** items is illustrated

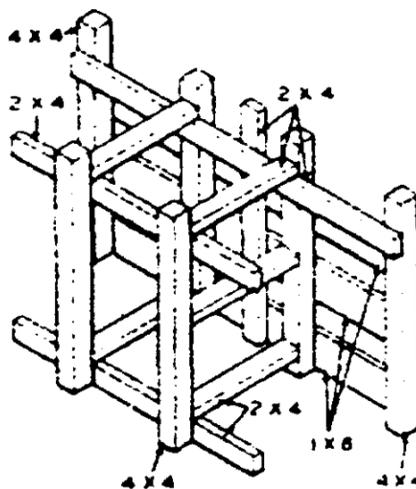
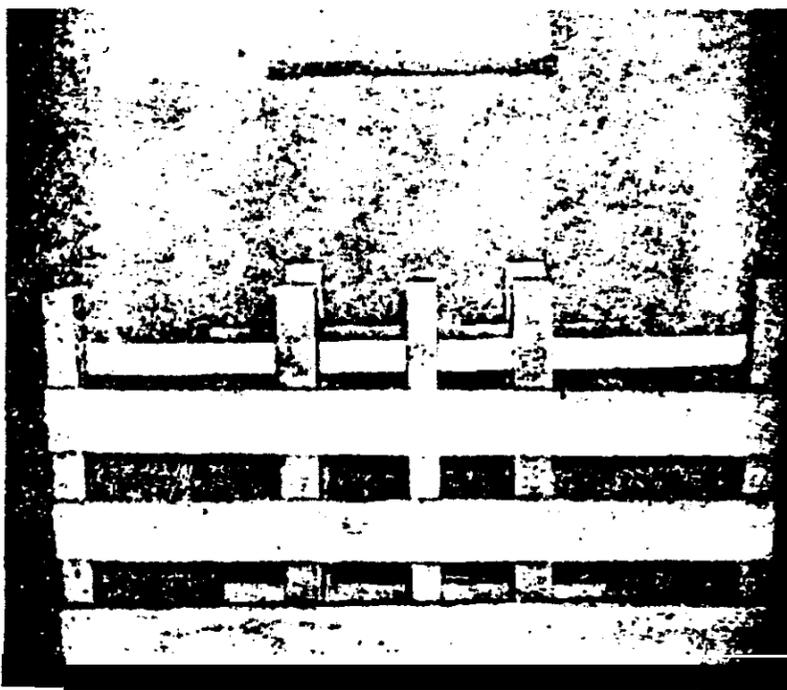


Figure 3-141. Front bulkhead—positioned in trailer, detail of bulkhead.

by figure 3-147. The pallets are staggered to obtain a compact balanced load.

(3) *Pallet size for maximum utilization.* Pallets must be suitable for handling by all media of transportation for maximum utilization. The general service pallet 40 by 48 inches meets these requirements.

f. *Strapped pallet loads.* Generally, pallet loads are strapped fore and aft and are secured on all sides. Blocking and bracing is kept to a minimum as the weight of the load combined with floor blocking of the bottom tier prevents the load from shifting in transit.

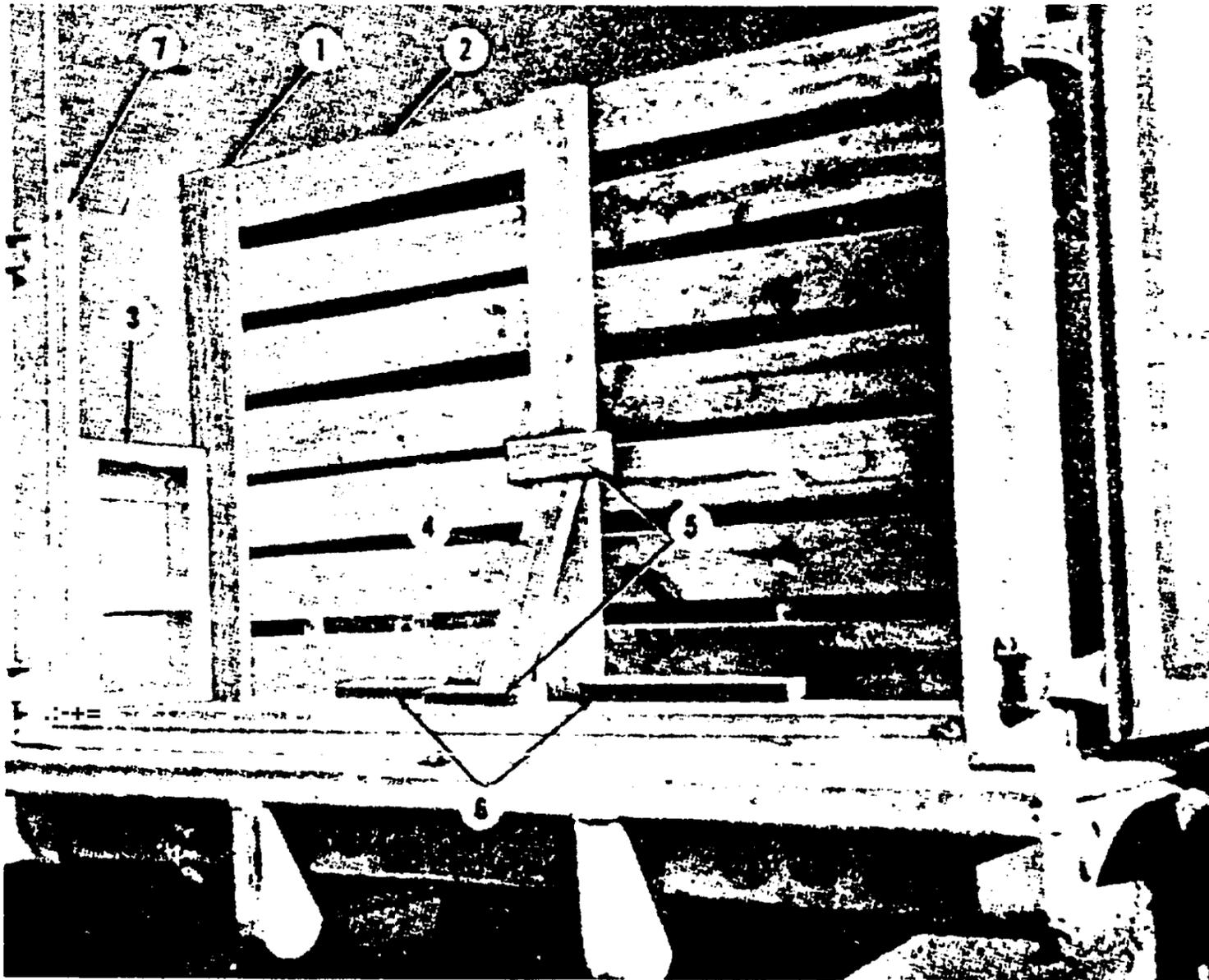
g. *Flat-bed truck and trailer loading.* The basic principles of weight distribution, tight loading, and prevention of load movement all apply to the loading of open top vehicles. Materials loaded on an open top vehicle will be secured to the vehicle to prevent any possibility of the load shifting or falling

off the vehicle, shifting and contacting other traffic, fouling underpasses, culverts, bridge abutments, and creating a hazard to pedestrians. When the trucks and trailers, either open or closed, are unitary equipment, it will be the responsibility of the driver to assure that the vehicle is properly loaded and the load secured before the vehicle moves.

### 3-918. Freight Loss and Damage

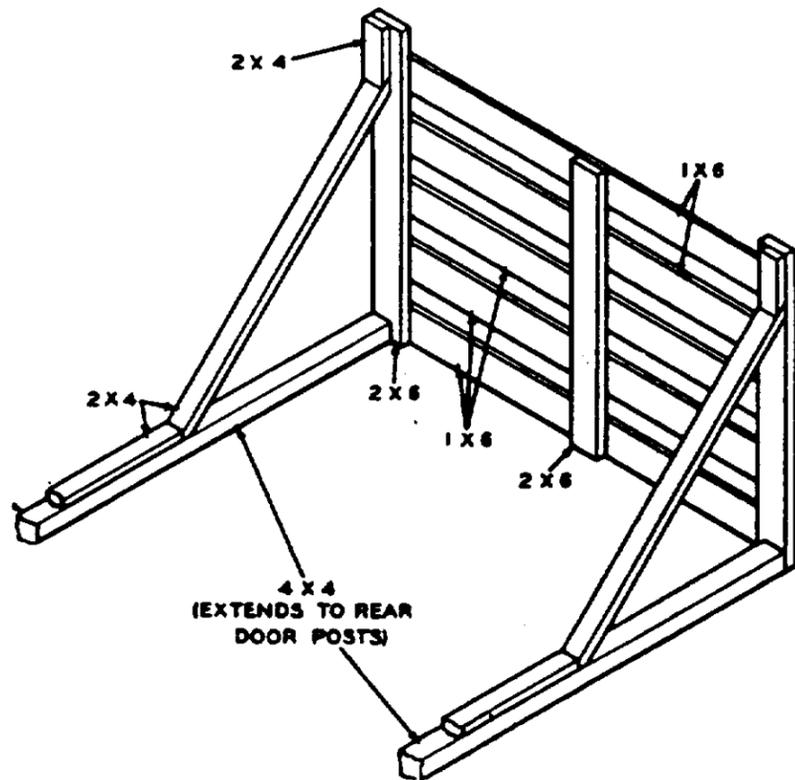
a. *Adherence to methods and techniques to prevent loss and damage.* Adherence to prescribed loading and securing methods and techniques will help reduce loss and damage to shipments in transit to a minimum.

b. *Visible loss or damage.* Visible loss or damage existing at time of receipt of a shipment should be observed and properly recorded by the receiving



- |  |                                |
|--|--------------------------------|
| 1. Upright, 2" x 6" (3).                                     | 4. Diagonal, 2 x 4" (1).       |
| 2. Facing members, 1" x 6" as required<br>by height of load. | 5. Cleats, 2' x 4" (2).        |
| 3. End brace, 2" x 4" (2).                                   | 6. Back-up cleat, 2' x 4" (2). |
|  | 7. Upright, 2' x 4" (2).       |

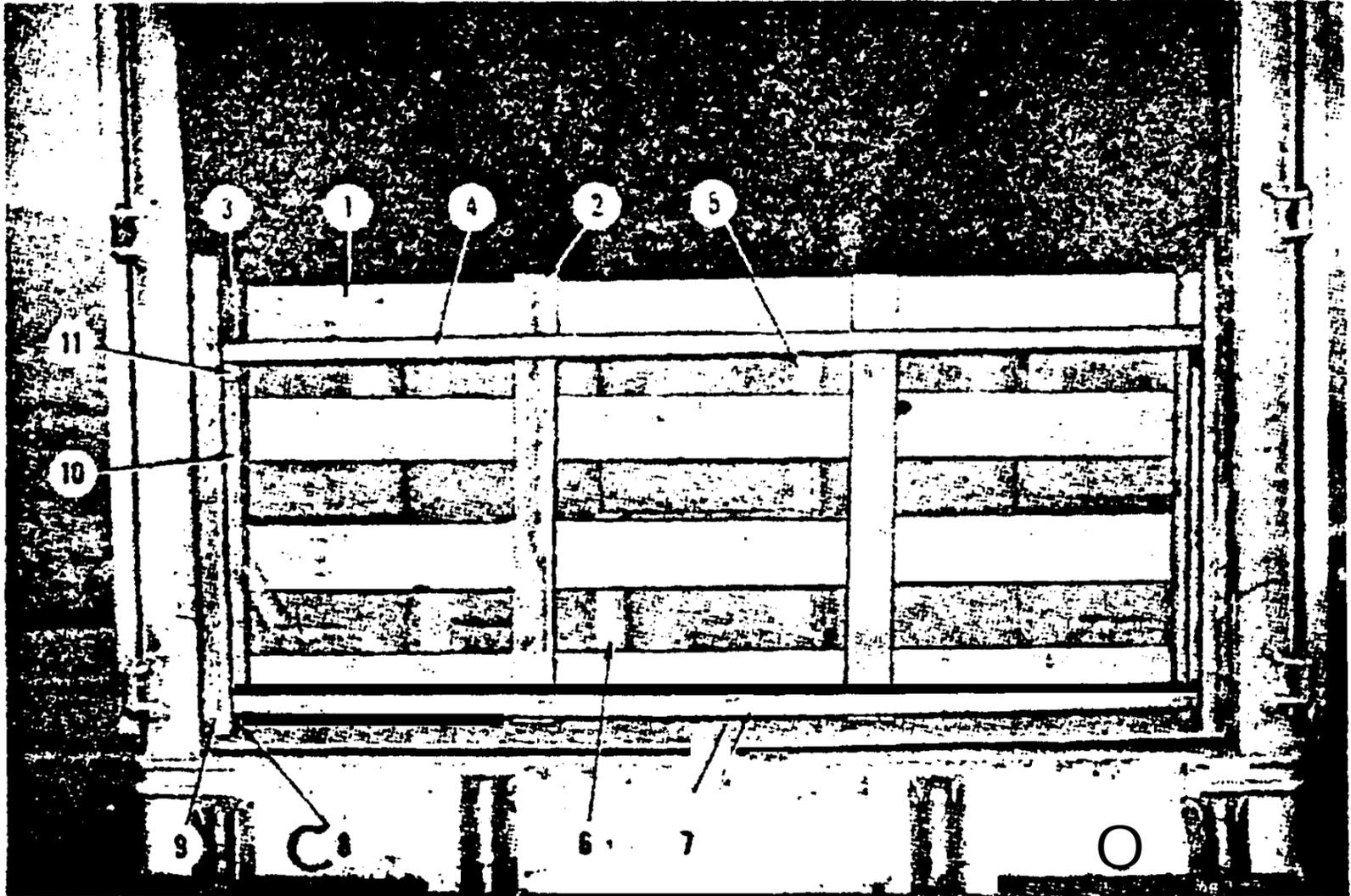
A. Positioned in trailer.



B. Rear bulkhead

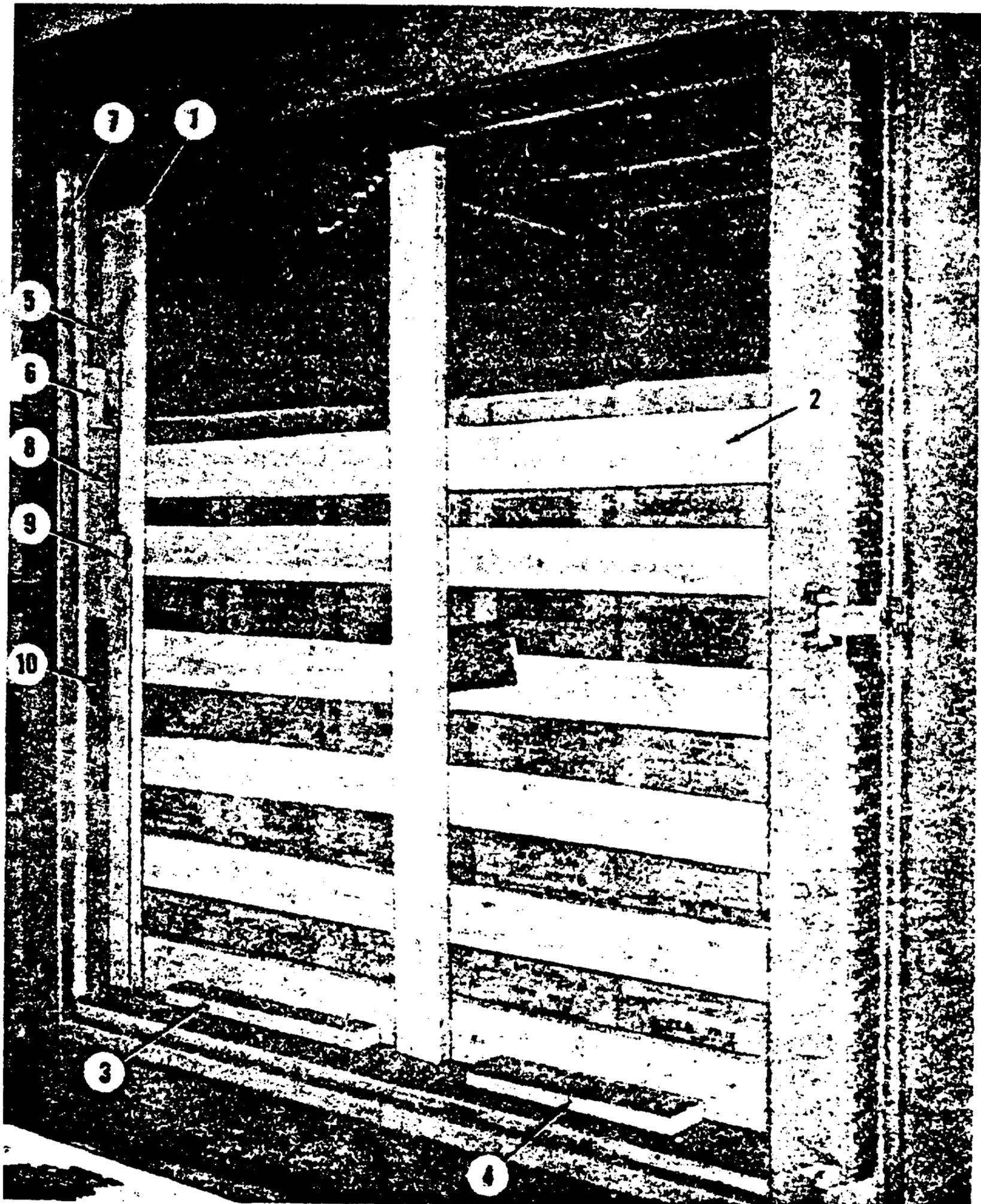
Figure 3-142. Rear gate.

51



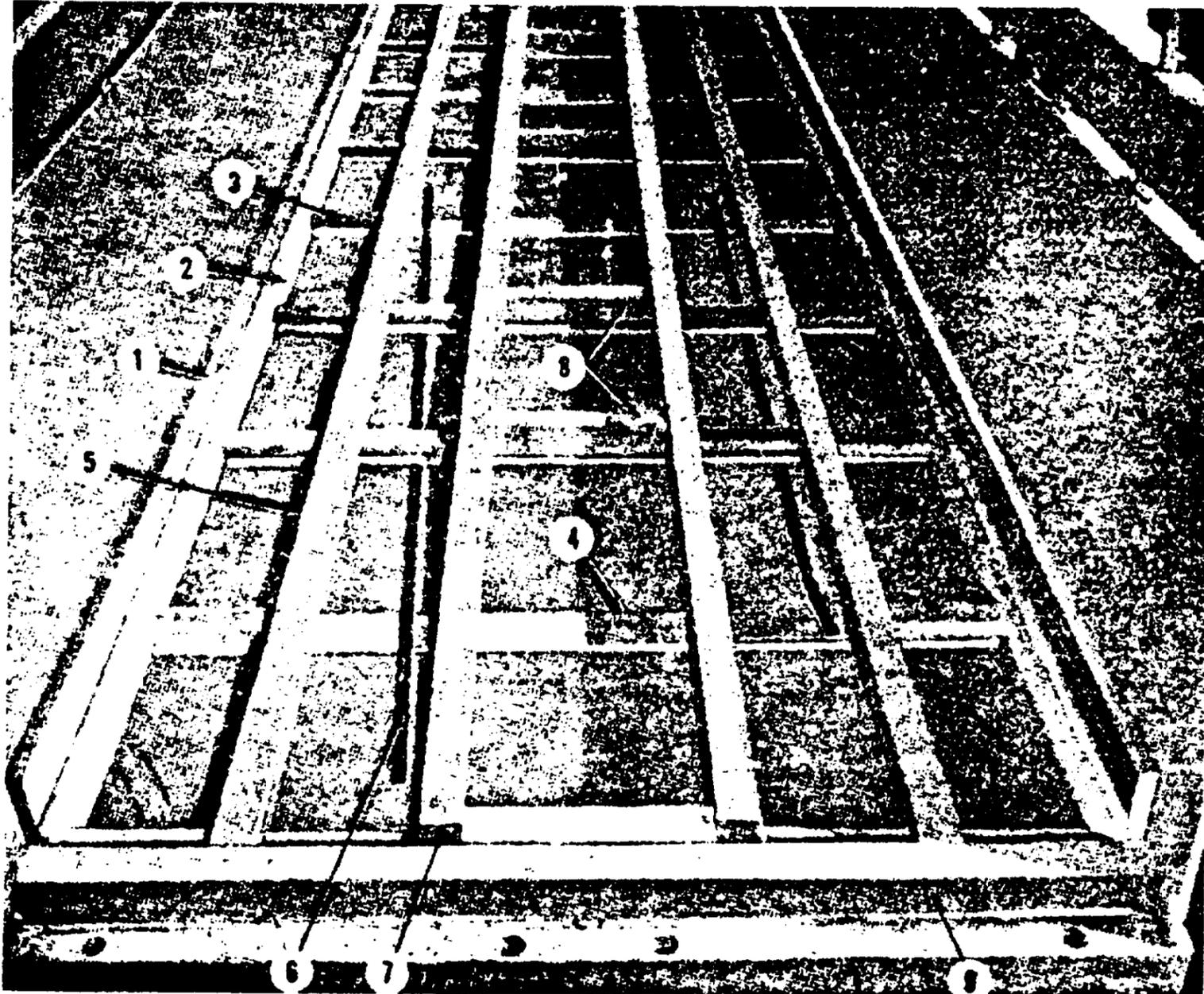
- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Rear gate face member, 1" x 6" (4).</li> <li>2. Rear gate verticals, 1" x 4" (2).</li> <li>3. Rear gate verticals, 2" x 4" (2).</li> <li>4. Cross brace 2" x 4", nailed to kickers (2).</li> <li>5. Top layer fillers, 1" dunnage as needed.</li> <li>6. Bottom layer fillers, 1" dunnage as needed.</li> <li>7. Cross brace, 2" x 4", nailed to floor kickers [1].</li> </ol> | <ol style="list-style-type: none"> <li>8. Kicker, 2" x 4" nailed to floor (2).</li> <li>9. Upright, 2" x 4" nailed to door post (2).</li> <li>10. Upright support, 2" x 4", nailed to 2" x 4" vertical (4).</li> <li>11. Kicker, 2" x 4", nailed to rear upright and upright support (2).</li> </ol> |
|--|--|

*Figure 3-143. Rear gate positioned in truck.*



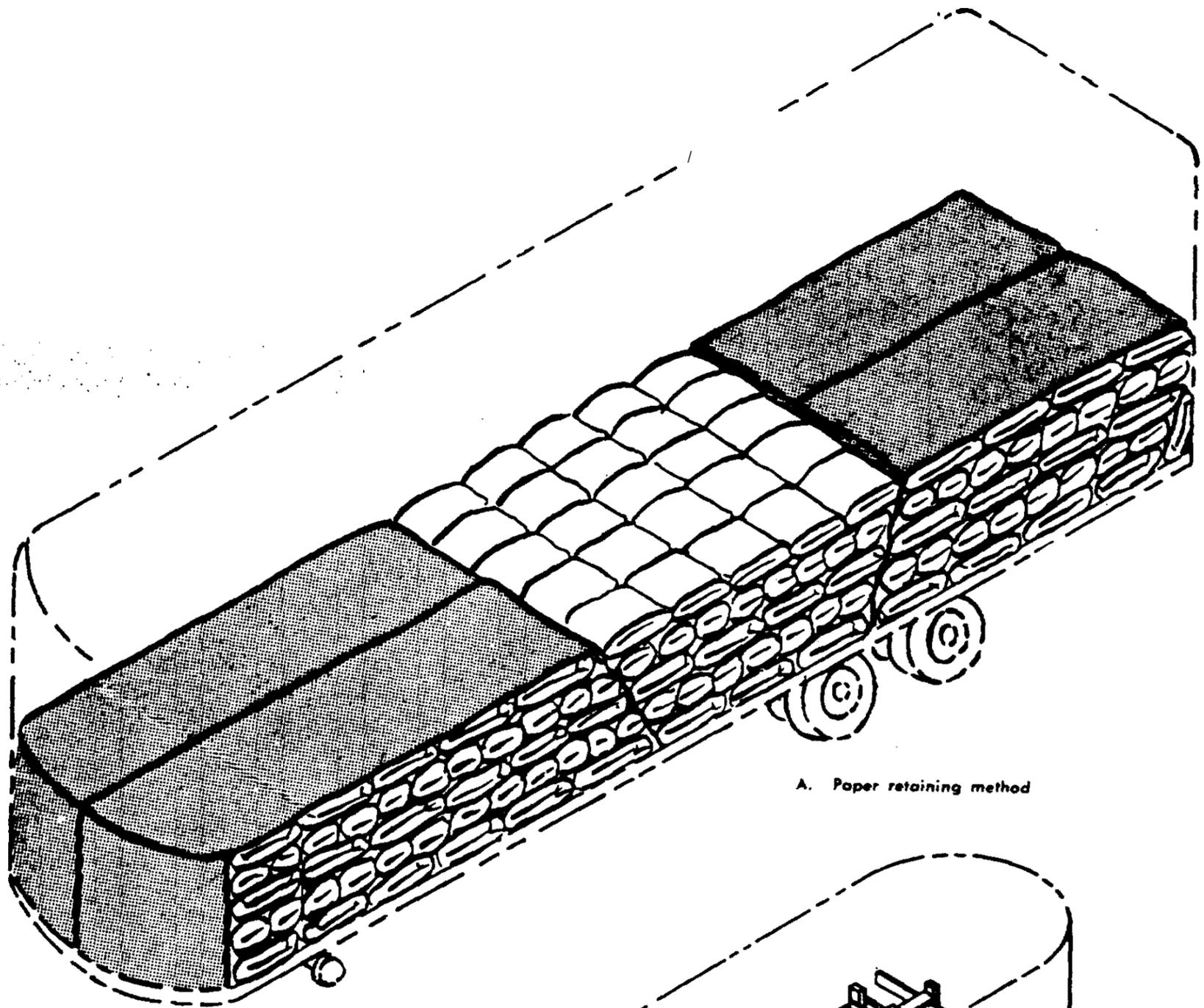
- |  |  |
|--|--|
| 1. Rear gate vertical, 2" x 6" (3).    | 6. Spacer, 2" dunnage as needed.         |
| 2. Rear gate face member, 1" x 6" (6). | 7. Upright, 2" x 4" nailed to door post. |
| 3. Backup cleat, 2" x 4" (1).          | 8. Filler strips, 1" dunnage as needed.  |
| 4. Backup cleat, 2" x 6" (1).          | 9. Filler strip, 1" dunnage as needed.   |
| 5. Upright, 2" x 4" as needed.         | 10. Upright, 2" x 4" as needed.          |

Figure 3-144. Rear gate and dunnage.

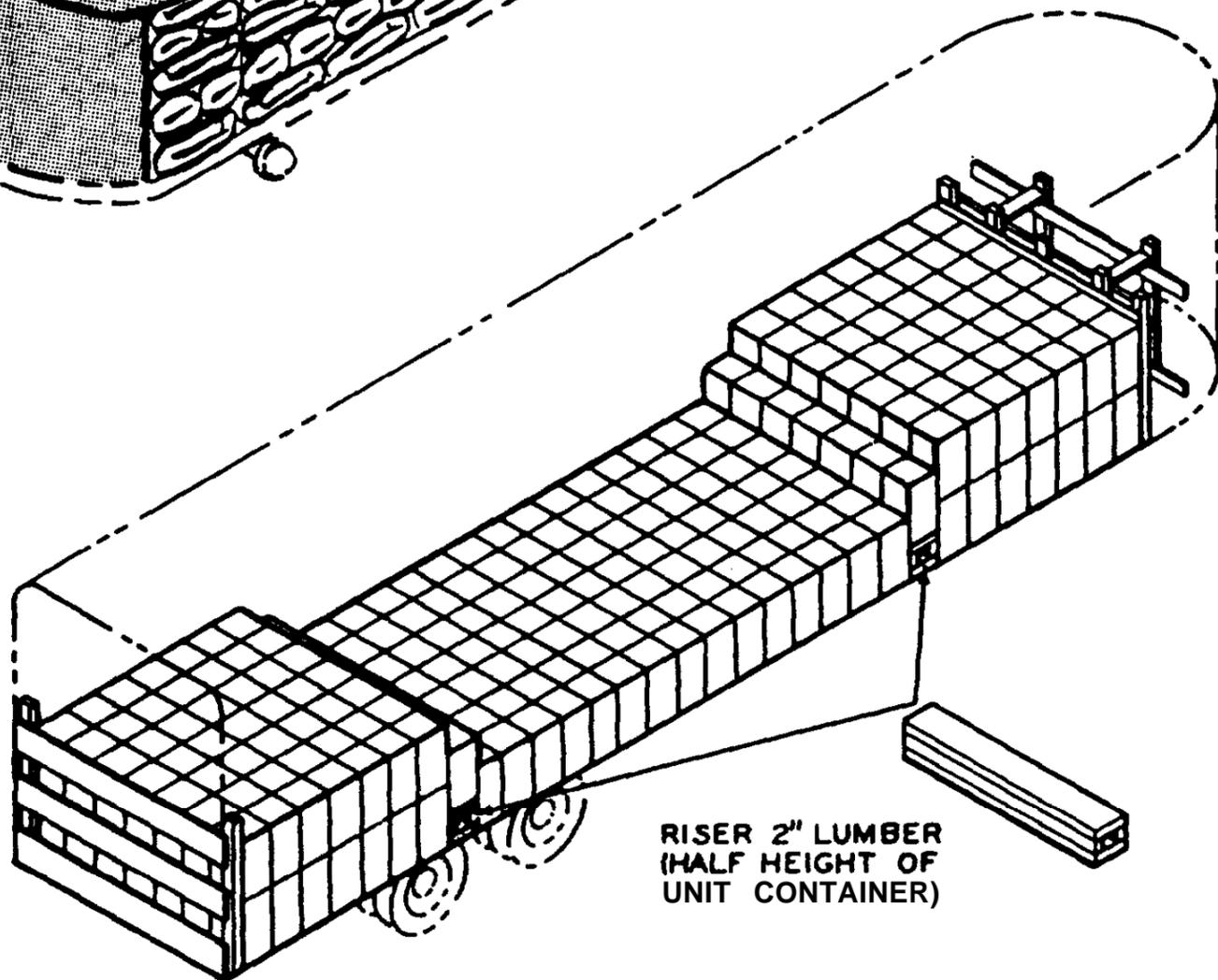


- |   |   |
|---|---|
| <p>1. Sidewall reinforcement, 2 x 12" on edge.<br/>                 2. Backup strip, 1" x 6" on edge.<br/>                 3. Spacers, 2' x 4", nailed to sleepers.<br/>                 4. Sleepers, 1" x 6", nailed to floor.<br/>                 5. Intermediate riders, 4" x 4".</p> | <p>*. Fore and aft stropping, 1 1/4" x 0.035", precut and positioned undersleepers.<br/>                 7. Center riders, 4" x 4".<br/>                 8. Center braces, 4" x 4".<br/>                 9. End cross piece, 4" x 4".</p> |
|---|---|

Figure 3-145. Preparatory shoring for cylindrical items.



A. Paper retaining method



RISER 2" LUMBER  
(HALF HEIGHT OF  
UNIT CONTAINER)

S. Stepped down

Figure 3-1.46. Loading.

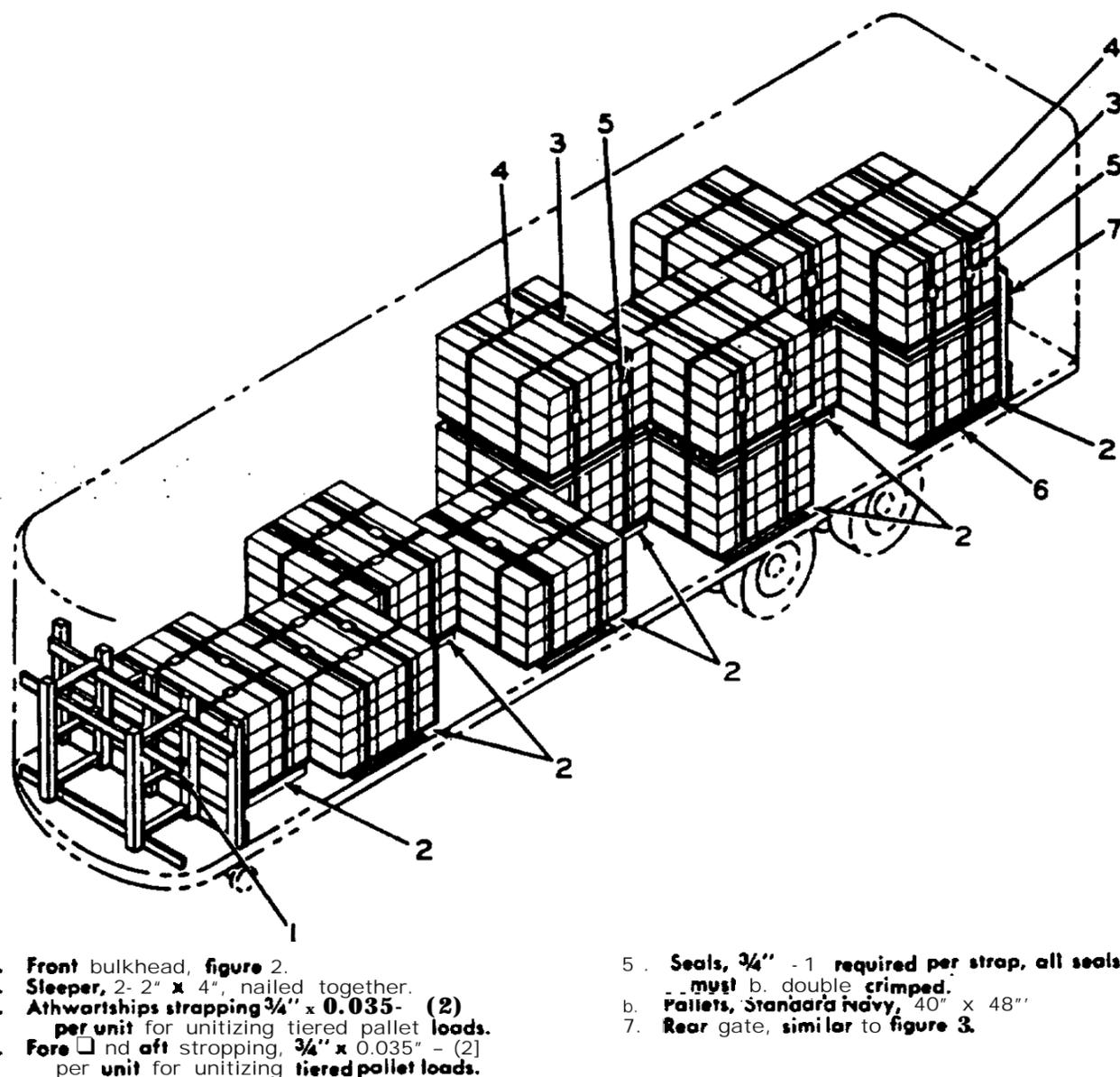


Figure 3-147. Staggered palletized loading.

personnel in accordance with the procedures of the appropriate military department.

*c. Concealed loss or damage.* A complete report of circumstances, including the time damage to or loss of shipment was observed, should promptly be made to the appropriate local military freight traffic personnel responsible for initiating basic freight claims action, when-

(1) Damage to or shortage in a shipment was not observed at time of receipt from the commercial carrier (concealed loss or damage).

(2) Damage or shortage is discovered while **being** stored, processed, or reshipped from storage.

(3) It can be shown that the loss or damage did not occur after the material left the custody of the carrier.

(4) It is indicated that the loss or damage occurred during the transportation.

### 3-919. Instructions for Securing Materials Transported by DOD-Owned Motor Vehicles

**a. General.** Every truck, semitrailer, full trailer, and pole trailer used for transporting cargo over public streets and highways will be equipped with bulkheads, tie downs, side boards, and blocking as hereinafter specified. Combinations consisting of a truck trailer and a pole trailer shall have the option of providing a bulkhead mounted either on the front of the pole trailer, or behind the **driver's** compartment of the tractor. When the bulkhead required is mounted on the tractor, the lading on the pole trailer will be securely fastened with tie downs meeting the requirements listed herein.

#### *b. Bulkhead requirements.*

(1) **Height and width.** Bulkheads will be of such height as to block the forward motion of any piece

of lading on the vehicle, or alternately, as high as the driver's compartment of the vehicle or combination. Bulkheads will be of such width as to block the forward motion of any piece of lading on the vehicle or alternately, as wide as the widest portion of the vehicle.

(2) **Strength.** The ultimate strength of the bulkhead will be such that it is capable of withstanding a horizontal forward force equal to one-half the static weight of the cargo carried when such force is distributed over that portion of the bulkhead extending from the floor of the vehicle upward to a **height sufficient** to stop the forward movement of any piece of lading carried on the vehicle or to the height of the driver's compartment of the vehicle or combination whichever is the lesser height.

(3) **Penetration resistance.** Bulkheads will be so designed, constructed, and maintained as to resist penetration by any piece of lading carried on the vehicle when such vehicle is subjected to the maximum deceleration of its service brakes. Bulkheads will not have openings large enough to pass the smallest piece of lading carried on the vehicle.

*c. Blocking and bracing requirements.*

(1) Cargoes *subject to forward shifting.* On vehicles carrying cargoes which cannot be placed **firmly** against the forward bulkhead, suitable blocking and bracing or tie downs **will** be provided in addition to the bulkhead specified in *b* above to prevent the forward shifting of such cargoes when the vehicle is subjected to the maximum deceleration of its service brakes.

(2) *Cargo subject to side shifting in transit.* Vehicles carrying cargoes of such nature as to be subject to side shifting in transit, even when equipped with sideboards or stakes as required in *e* **below**, will have in addition such cargo securely blocked or braced to the sides of the vehicle.

*d. Tie down requirements.* Every cargo-carrying vehicle will be equipped with either sideboards or tie down devices designed to prevent the falling, shifting forward, or backward motion of any lading being carried. Tie down devices will be as follows:

(1) If the vehicle is **without** sideboards or sides, it shall be equipped with a minimum of two tie down devices on load lengths of 21 feet or less. For loads over 21 feet a minimum of three tie **down** devices will be used and an additional tie down device for each 10 feet of load length over 30 feet. Additional tie down devices will be provided if necessary to secure each piece of lading being transported,

either by direct contact with the tie down device or by use of dunnage contacting sufficient individual pieces of the lading and the dunnage then **secured** by the tie downs.

(2) Each tie down device will be equipped with a load binder, Federal specification **GGG-G-325**, Binder, load. The binder chain will be attached to the tie down bar or to such other tie down devices provided by the truck manufacturer. When vehicles are not equipped with tie down devices, the binder chain will be of sufficient length to pass over the cargo and underneath the vehicle body or flat bed, stake sides, or pole trailers. Chain will be  $\frac{3}{8}$  inch steel BBB Coil Chain in accordance with Federal specification RR-C-271, Chains and Attachments, Welded, **Weldless** and Roller Chain. Binding chains will be adjusted as tight as possible.

*e. Stakes and sideboards.* Vehicles carrying cargo not secured in compliance with (1) above will be equipped with sides, sideboards, or stakes; a rear end gate; and header board. Stakes, sideboards, end gate, and header board will be of no lesser height than the load carried, and without an opening large enough to pass the smallest article on the vehicle as loaded.

*f. Long material.* When cargo, such as long lengths of pipe, piling, telephone poles, or similar material, is carried on **pole** trailers and it is of such length that the cargo must be used for connecting the front and rear bolsters, uprights, the height of the cargo will be inserted in pockets on the right and **left** side of each bolster. Such uprights will be tied together above the load. Also, the cargo will be bound together by a binding chain at the center of the load length. A red flag will be tied to the end of oversized material for safety purposes.

*g. Vehicles exempt from tie down requirements.* Vehicles transporting articles which because of size, shape, or weight require special vehicles for their carriage or special methods for their fastening, are exempt from tie down requirements stated herein. Loads on such vehicles, however, will be securely and adequately fastened to prevent any forward, backward, or sideward motion of the load when the vehicle is subjected to the maximum deceleration of its service brakes.

*h. Acceptable loads.* Department of Defense drivers will not be permitted to move a load if the load is not secured in compliance with these instructions when such loads are offered for transportation over public streets and highways.

## Subsection 3. PNEUMATIC DUNNAGE

## 3-920. Use and Maintenance of Pneumatic Dunnage

**a. Use.** Pneumatic dunnage is an airtight bag with a **valve**, or valves for inflating and, in the case of reusable types, for deflating. It is designed to occupy void spaces in loaded **rail**, highway or marine conveyances, including **intermodal** containers, to secure shipments in transit. Pneumatic dunnage is **not** for use in **aircraft**. It may **not** be used to secure **explosives** or other hazardous **articles** without prior **approval** of the Bureau of Explosives. Also, it **cannot** be used to secure loads of **military** explosives and ammunition.

**b. Types and sizes.** Pneumatic dunnage is **available** in two types-reusable (fig. 8-148) and disposable (fig 8-149). The nomenclature is "Dunnage, Pneumatic, Cargo **Shoring—Type I** Disposable and Type II Reusable." Both are covered by Federal specification **PPP-D-1427**. Units are available through normal supply channels **from** the Defense General Supply Center, Richmond, VA. Sizes of pneumatic dunnage adopted by the Department of Defense as most suitable for general use are as follows:

	Inflated size	Deflated size	Weight (approx)
Type I (Disposable)	36" x 48"	36" x 58"	12 lbs
	48" X48"	48" x 58"	18 lbs
	48" x 71"	48" X 82"	22 lbs
	48" X96"	48" x 106"	26 lbs
Type II (Reusable)	48" x 48"	57½" x 57%"	18-22 lbs
	48" X72"	57%" x 81½"	26-29 lbs

(1) Reusable pneumatic dunnage can be utilized for an indefinite number of shipments. It is fabricated from high tensile **strength**, **finely** woven, nylon fabric treated with a rubber or rubber like compound and vulcanized as a single unit. (Units equipped with a removable bladder are also currently in the system. **This** design has been outdated by the specification listed above, however, these **units** should be used until no longer serviceable.) The unit has a high-flow valve assembly which consists of a threaded valve body molded into the **dunnage** unit. On some models the inflation valve has a metal washer and special nut to anchor the valve body **to** the dunnage unit. On these models a valve stem screws into the valve body and is secured by a chain attached to the metal washer, Other manufacturers use an "O" ring type inflation valve which incorporates a valve cap and a valve insert which houses a check disc.

Reusable pneumatic dunnage units bear a serial number. This affords opportunity for control purposes. Units can normally be returned to the shipper without **significant** expense or problem. When

used for dunnaging rail shipments, most tariffs provide for the free rail return of the units by the reverse of the inbound routing. Where free return is not provided, tariffs will indicate the charges involved. Where return cannot be reasonably achieved, disposable pneumatic dunnage units may offer a cost advantage.

(2) Disposable pneumatic dunnage, which is designed for one time use, consists of an inner bag made of highdensity airtight polyethylene encased in layers of 100-pound test extensible **kraft** paper. The outer layer of **kraft** paper is coated with a weather-resistant polyethylene coating. The ends of the bag are sealed by a procedure in which the polyethylene inner bag and all layers of paper are wrapped around a 7/16-inch wooden dowel. The inner bag and paper are held in position on the dowel by a 1/2-inch-thick tubular metal sleeve. An inflating valve is heat sealed into the inner bag. This valve is not designed for rapid deflation of the unit. At destination, disposable pneumatic dunnage is deflated by cutting or otherwise puncturing the bag.

**c. Dunnage.** There are two principal **considera-**

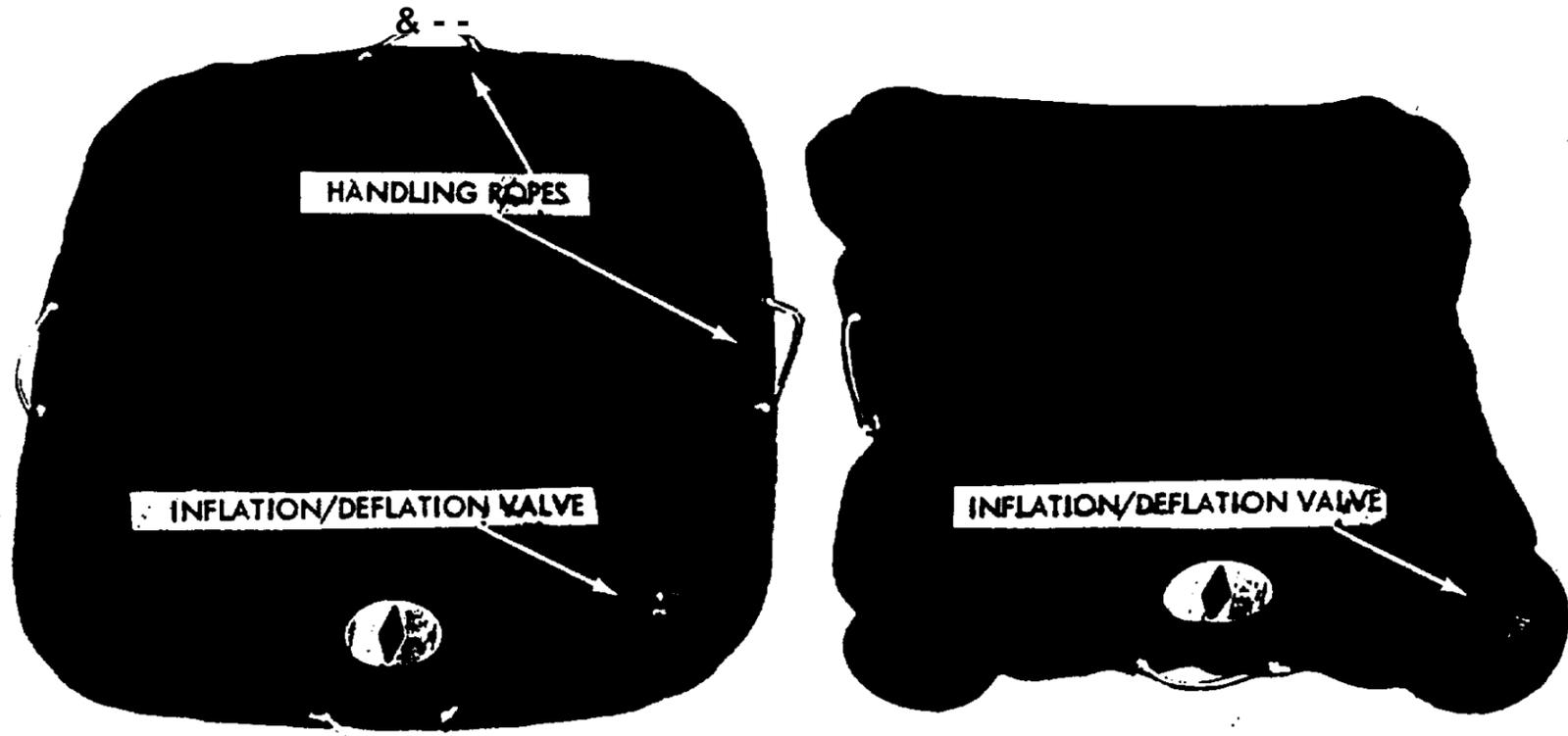


Figure 3-148. Reusable pneumatic dunnage unit complete.

tions in dunnaging of material in transportation conveyances, i.e., performance and cost. Regardless of costs, the selected methods must do the job; however, there is usually more than one method that will achieve the performance goal; hence, cost comes into clear focus. Over many years of experience, the application of fixed dunnage is well understood. This technique is explained elsewhere in this section. So that a method may be properly explored in determining the most preferable dunnage to install under a given situation, the following recount advantages and considerations in use of pneumatic dunnage:

(1) Allows more rapid installation and removal than conventional dunnage. Under many applications, this method is more economical in total than other dunnaging methods (*d* below).

(2) Provides a highly resilient load restraining method.

(3) Provides relatively low pressure bracing (2 to 5 PSI) for loads. (Inflation pressure for pneumatic dunnage units in truck trailers/containers must not exceed  $\frac{3}{4}$  PSI max.)

(4) Is capable of tightening loads in which compactness was not **sufficiently** achieved during **loading**; however, efficiency of loading procedures should not be reduced because of this corrective action of pneumatic dunnage. (There is no substitute for proper loading, regardless of type of dunnage material used.)

(5) Is capable of repositioning cargo loads

shifted by sudden impact and also will expand to take up slack developed through normal load jostling in transit. When a load does shift on sudden impact, the dunnage unit cushions the load, whereas fixed bracing does not. This cushioning action is advantageous for even slight impacts.

(6) Is capable of retaining adequate cushioning air pressure during long-distance shipments up to 30 days.

(7) Is not seriously affected by changes in temperatures and altitude encountered during surface transport (pneumatic dunnage is *not* for use in aircraft).

*d. Comparative dunnaging costs . . .*

(1) Use of pneumatic dunnage can result in substantial savings in certain applications when used in lieu of conventional type dunnage. To effectively assess the possibilities of savings by use of this method as compared to fixed dunnage in a particular situation, it is necessary to consider the following

(a) Manhours required for the dunnage operations as well as hourly rates for workers (skilled car blockers are not required for pneumatic dunnage).

(b) Cost of conventional dunnage material as opposed to the cost of reusable pneumatic dunnage. In the case of reusable pneumatic dunnage, usage cost is obtained by dividing the original cost of the unit by the number of trips expected from the unit (could range up to 100 or more trips).

(c) Miscellaneous costs to include any cost of

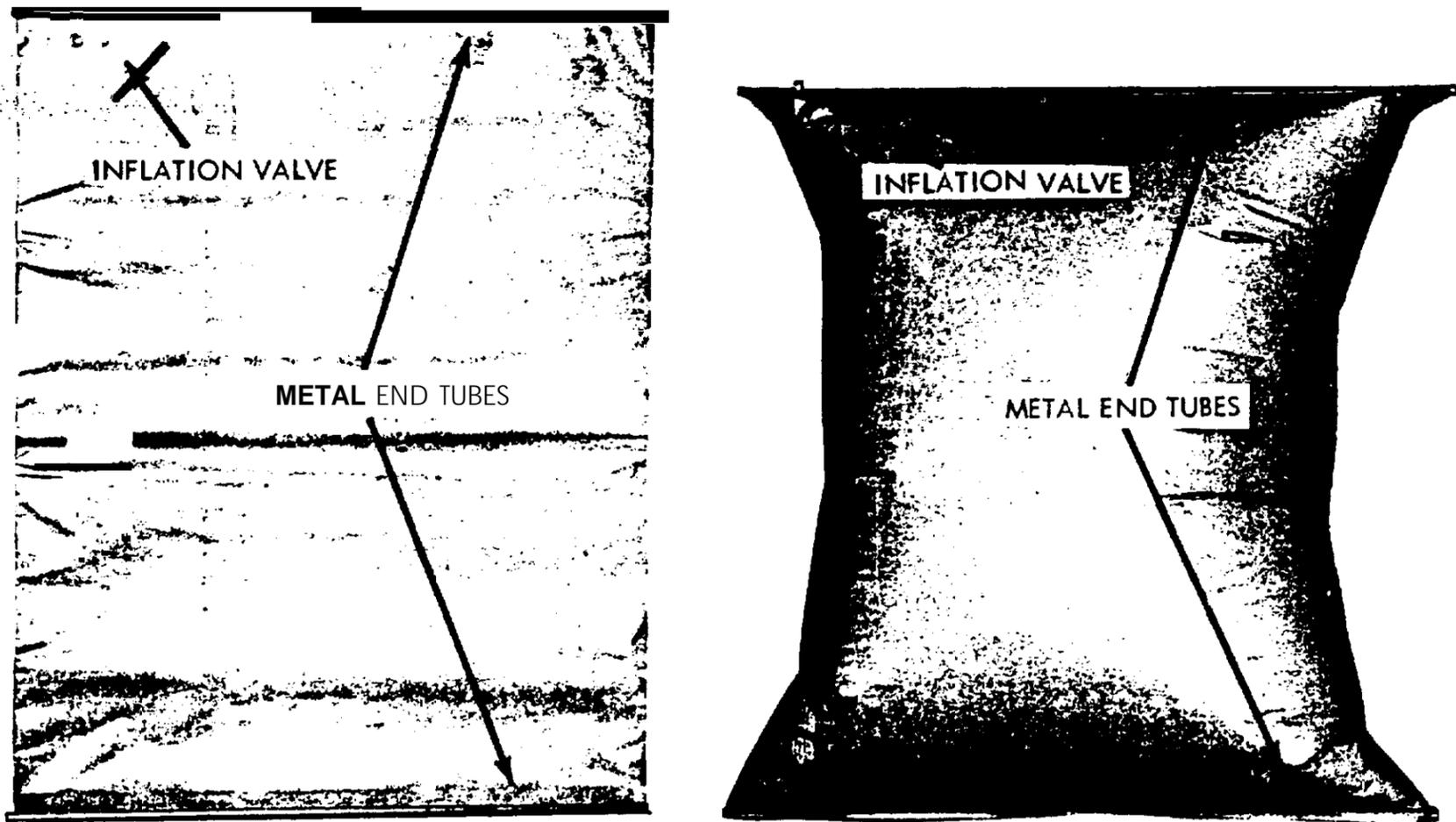


Figure 3-149. Disposable pneumatic dunnage unit complete.

return of reusable pneumatic dunnage, as well as administrative costs to control accountability. Maintenance of the reusable units is considered negligible.

(d) Salvage value of conventional dunnage.

(e) Dunnage removal costs.

(f) The choice between use of disposable or reusable pneumatic dunnage. Where the return of dunnage units can be reasonably assured, the reusable types are generally the more economical to use. The choice to be made is not solely a judgment as to whether pneumatic dunnage is more economical to use than the more conventional methods, but also a further determination must establish which type and size of pneumatic dunnage offers the greater cost advantage.

(g) *Loading pattern.* A pattern which results in the very minimum void space so as to obviate the use of any dunnage is the most economical procedure. When applied to specific dunnaging problems employing various methods for staying a load, the savings to be **realized** through application of pneumatic dunnage are in direct relation to the type and extent of conventional dunnage which would otherwise be utilized.

e. *Accessories.* In addition to a source of compressed air, an inflation kit (fig. 3-150) is required for the use of pneumatic dunnage (reusable or disposable). This kit consists of an air pressure gauge 0-15 pounds with 1 pound graduations and an inflator gun (air chuck) with a  $\frac{1}{4}$  inch inside pipe thread. The gauge and gun are each fitted with a

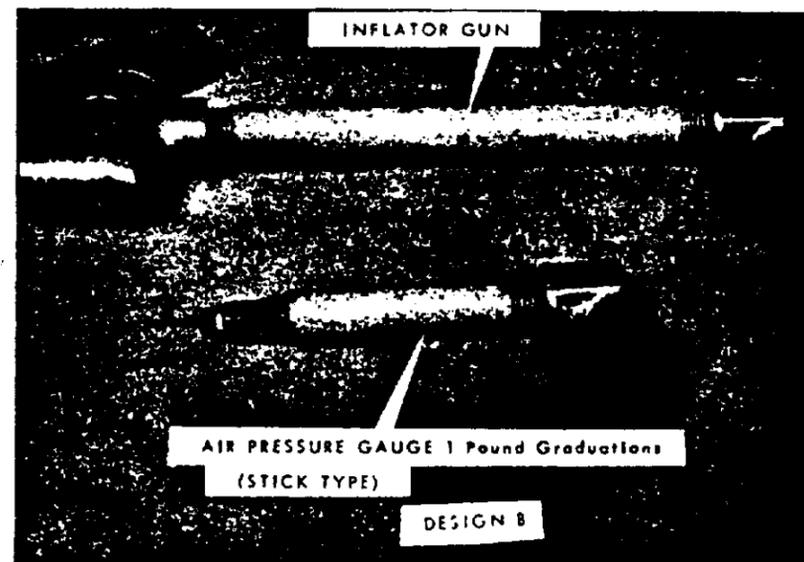
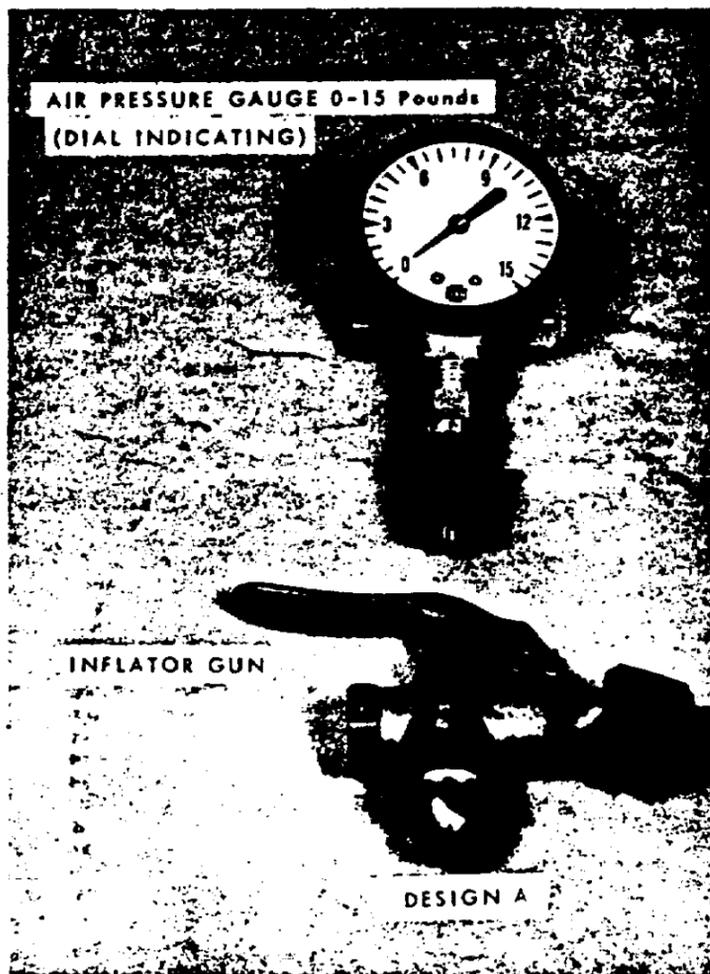


Figure 3-150. Pneumatic dunnage inflation kit.

special rubber tip that seats into the valve. On occasions where **inflation** pressures must be more finely controlled (such as use in truck trailers or when dunnage is securing **fragile** or critical items), an inflation gauge with 1-pound graduations should be used.

*f. Placement.*

(1) Consideration of the characteristics of pneumatic dunnage is required prior to use. Pneumatic dunnage units secure load contents by exerting pressure against the cargo surfaces facing the void; therefore, it is necessary that the profile and physical make-up of the surfaces be capable of accepting the pressures involved. Packaged or unpackaged items of a very irregular contour or with sharp or pointed edges may pose a problem in use or may cause damage to the pneumatic units. Rough surfaces can also cause abrasion and wear. Cargo must afford a rather solid, even surface for pneumatic dunnage contact. The use of buffer boards (plywood, fiberboard or lumber) to spread pressures over a greater area may be desirable in some cases to insure optimum results in use of pneumatic dunnage. Since cargo is loaded from the ends of a rail car to the center, void space results at the door area

in the center of the car. Unless an extremely fragile **load** is involved, there is no need to shore cargo with dunnage units at ends of a car as adequate dunnage units in center of the load will compress cargo against the ends of the car. Use of dunnage units on top of a load is not necessary since the weight of cargo and lateral pressure of dunnage units **will** restrict vertical movement. Pressure exerted by the dunnage units will also generally restrain lateral movement of cargo. Additional units may be used **for** positive insurance against any excessive lateral movement of fragile or critical material.

(2) Pneumatic units are designed to fill a 12-inch void when inflated to 2 to 5 PSI air pressure. (Pneumatic dunnage used in truck trailers/containers should not exceed  $\frac{3}{4}$  PSI as sides or ends of trailer may be deformed by greater pressures.) Where cargo loading would result in a void significantly larger than 12 inches, the load should be planned, if practicable, to provide separate smaller voids. In the interest of load security, maximum cushioning, and wear upon the units, the dispersion of dunnage units to several points in the load is usually more desirable than placing two or more

bags directly against each other to fill a large void. A point to emphasize is that the initial inflation of pneumatic dunnage within a void normally results in a 2- to 6-inch expansion of the void depending on the cargo load characteristics, hence what was a 12-inch void may finally measure 14 to 18 inches.

(3) For load configuration adaptable to pneumatic dunnage use, each conveyance with a void space of approximately 12 inches after cargo loading (across width of conveyance) can accommodate **positioning of** at least one unit of pneumatic dunnage **or a row of the** units to restrain the cargo. Figures 3-151 through 3-157 illustrate various sample patterns that may be used 'to adapt pneumatic dunnage to the various load voids and configurations. Note that dunnage arrangement must be designed to secure the entire lading. Buffer boards (may be of various types depending on lading features) should be inserted when rough surfaces of load may puncture or abrade the pneumatic dunnage units, or when pressure of the inflated units may damage the cargo, or where the load faces offer a pattern that would be difficult to stay without buffers. These figures depict either disposable or reusable units.

*g. Operational procedures.*

**(1) Instillation.**

(a) Measure void space between cargo surfaces where dunnage units are to be inserted. Determine number of units required based on horizontal and lateral void spaces, number of rows of cargo, number of tiers of cargo, and characteristics of cargo. Determine size of units required based on dimensions of surfaces facing the void. Determine the number of buffer boards required, if any.

Note. Loading practices which insure tight cargo positioning will minimize void spaces between containers and reduce cargo movements upon dunnage inflation.

(b) Position dunnage units to ensure maximum effective contact with the part of the load they are to brace. Top tier units of a 2-tier installation which must be inflated several feet above the car floor may be suspended in position for inflation by hangers attached to dunnage handles (fig. 3-158). This can be accomplished by spanning the void space with a bar across the top of the two load sections and then suspending "the bags with wire hangers hooked through the dunnage handles. Bags are then inflated just enough to secure the units in position. At this point, the suspending hangers and crossbar should be removed to prevent binding the

hangers against the bags. Care should be taken to assure that valves are positioned for ease of **inflation/deflation** and pressure readings.

(c) **Inflate each unit to proper** air pressure using air **compressor/air** supply and inflation kit. When more than one unit of pneumatic dunnage is placed in a conveyance, the inflation process should be alternated from one unit to another until all units reach desired pressures. This will assure that each unit will assume regularity in contour and size with subsequent **firm** positioning. Inflation requires only a few minutes per unit depending upon output volume of air compressor/air supply. A high volume air supply is most suitable. Each unit is designed to normally cushion within a 2 to 5 PSI range as restricted by load characteristics. Pressure may be increased to a maximum of 8 PSI, depending on load characteristics, when initially compacting cargo. (Reminder  $\frac{3}{4}$  PSI maximum in truck trailers/containers.) This over inflation must then be "bled off" to the proper shipping pressure. When inflation is completed, tighten each valve stem by hand (do *not* use a wrench or pliers to tighten valve). Properly inflated and positioned units will maintain correct contour in void space, but an unrestrained, insufficiently restrained, or overly inflated unit will tend to assume a round shape and will transfer excessive pressure to a limited area of the-cargo facing. When inflating disposable pneumatic dunnage, inflate the unit slowly until the bag has filled out; rapid inflation has a tendency to crystallize the polyethylene liner opposite the inflator valve.

(d) Measure the resultant void. If excessive void is present, deflate units. (This deflation process is more suitable for reusable units as disposable units do not provide rapid deflation using valve fixture.) Reposition cargo, if practicable, or insert additional dunnage units in the void. When dunnage units are correctly installed, they must be deflated to the normal shipping PSI, usually 2 to 5 pounds ( $\frac{3}{4}$  PSI maximum inflation in truck trailers/containers) depending on cargo characteristics. As mentioned above, deflation process is slow with disposable units so excessive pressures should not be built up.

(e) Figures 3-159 through 3-165 illustrate various application patterns in use of disposable or reusable pneumatic dunnage units. Observe that figures 3-162, 3-163, and 3-164 depicting marine carrier application show multiple dunnage units positioned side-by-side for void filling. In this area

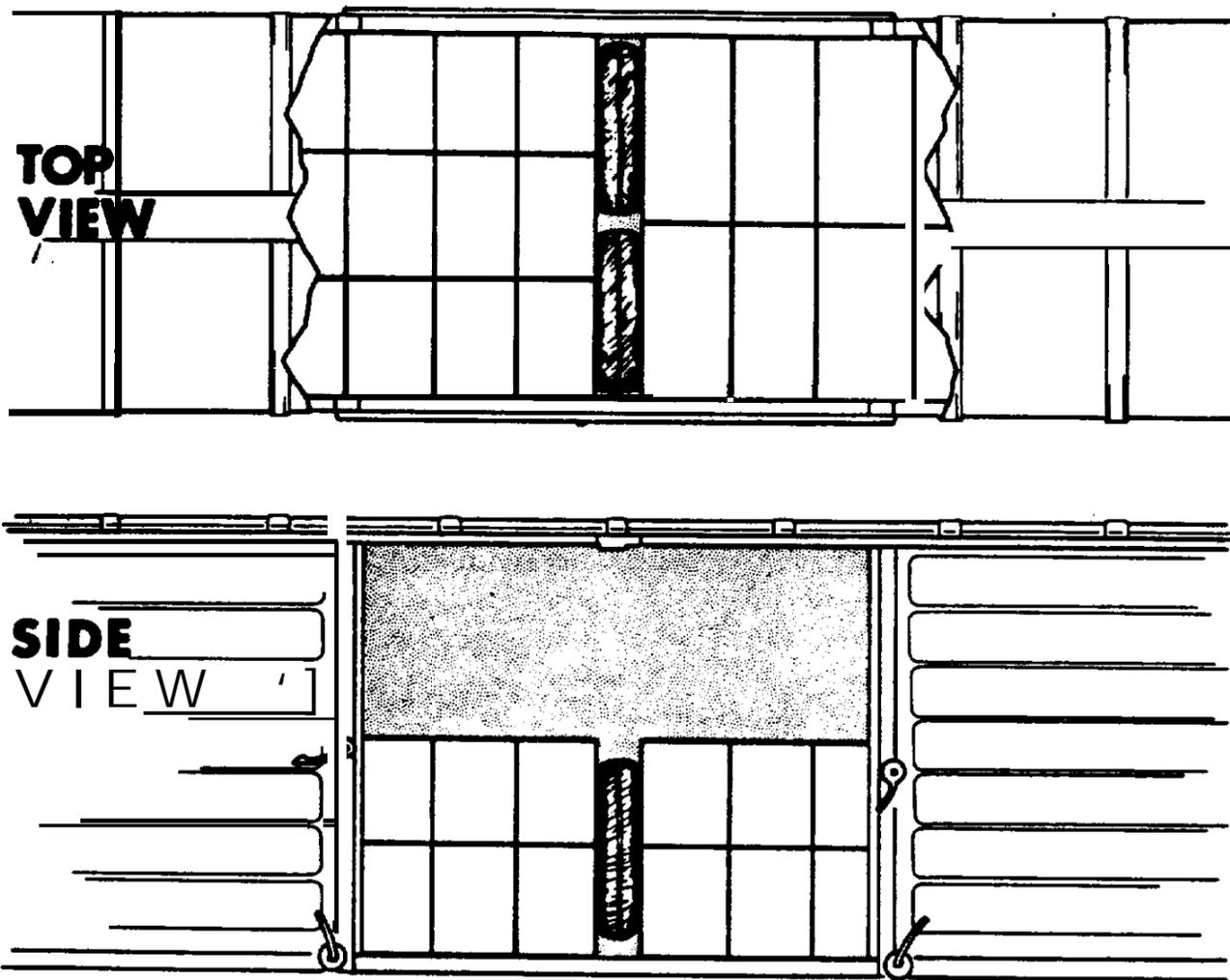


Figure 3-151. Single void pneumatic dunnage bracing pattern.

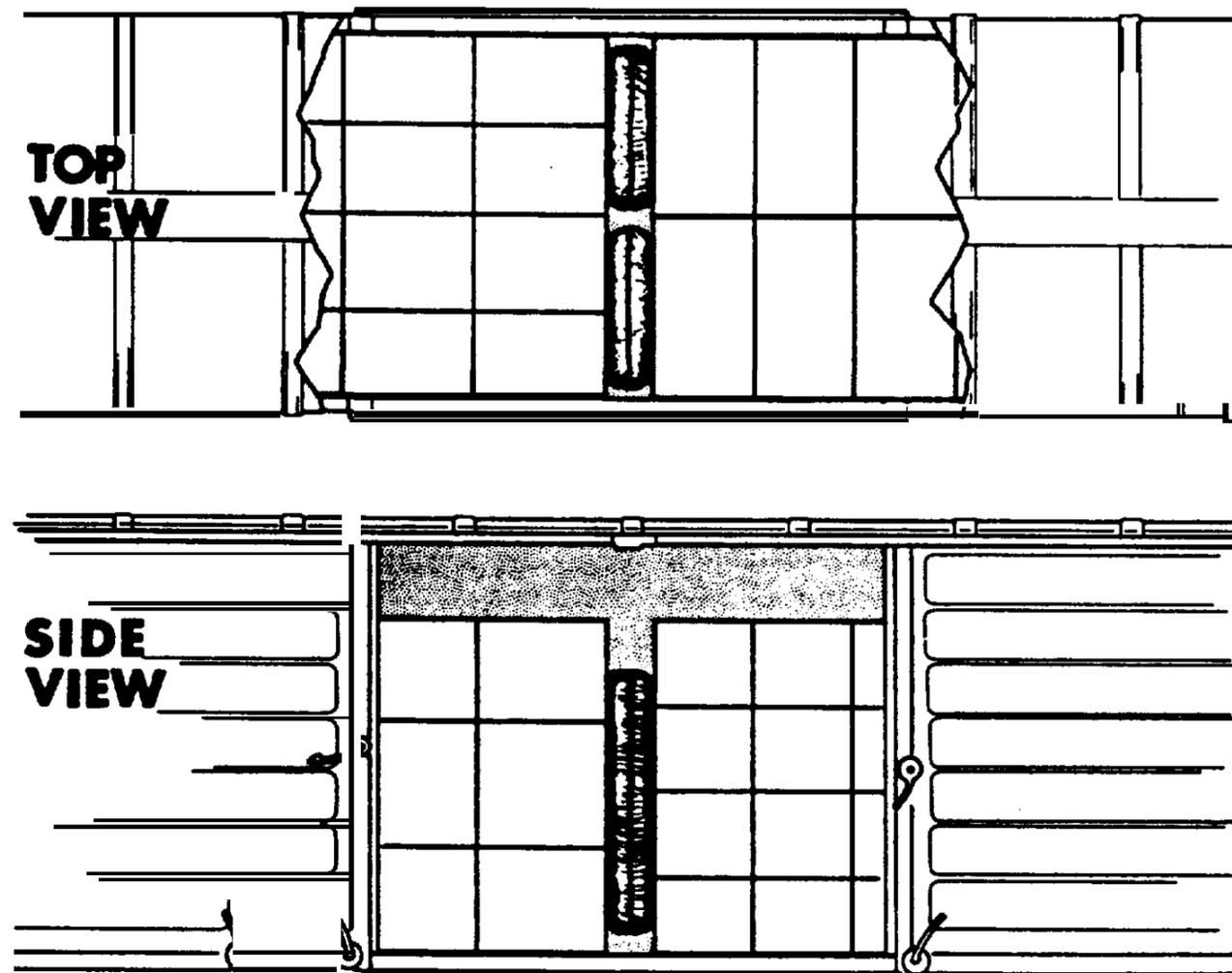


Figure 3-152. Larger dunnage units bracing higher loads.

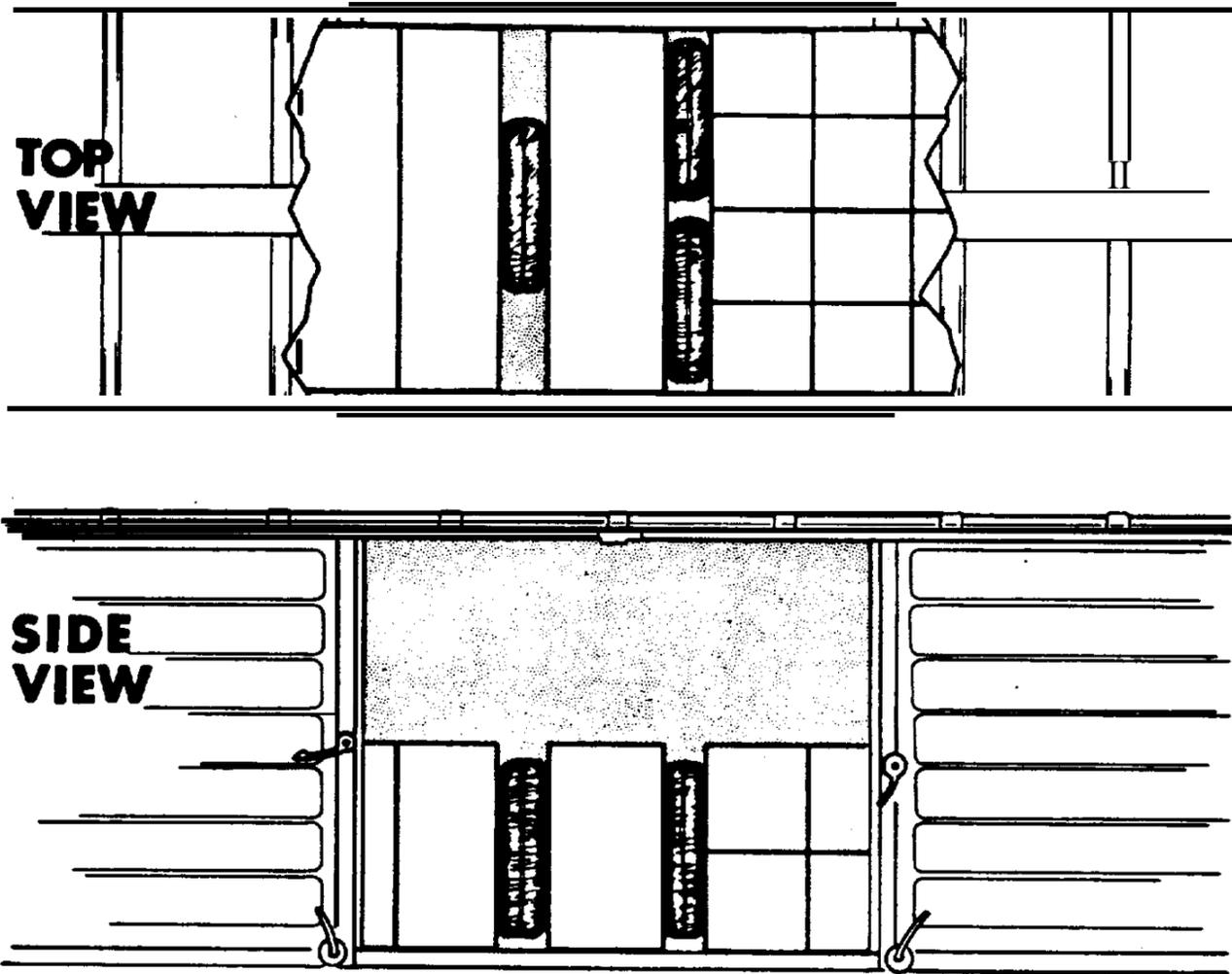


Figure 3-159. Multiple void bracing with pneumatic dunnage units.

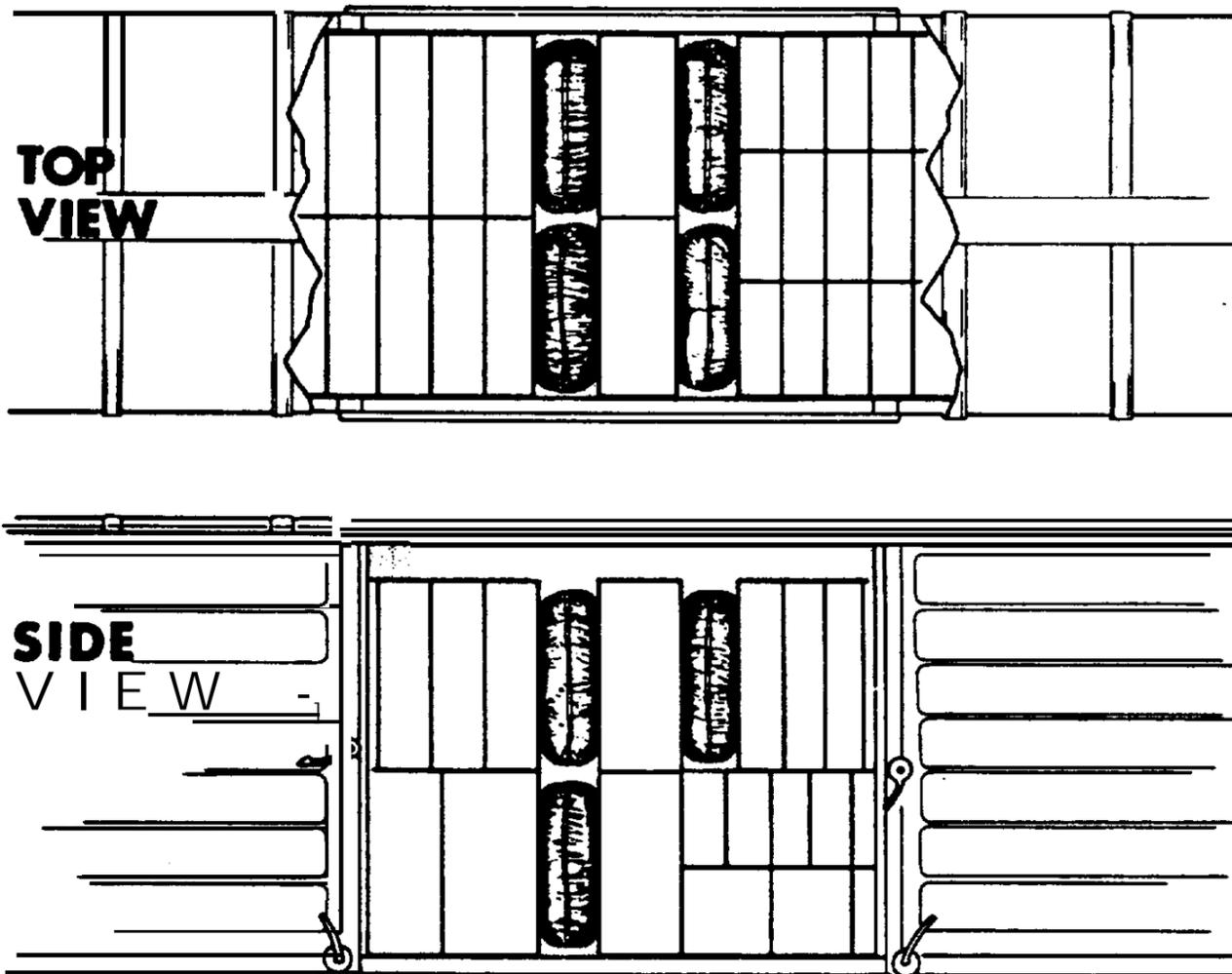


Figure .?-154. Pneumatic dunnage units in varied void arrangement.

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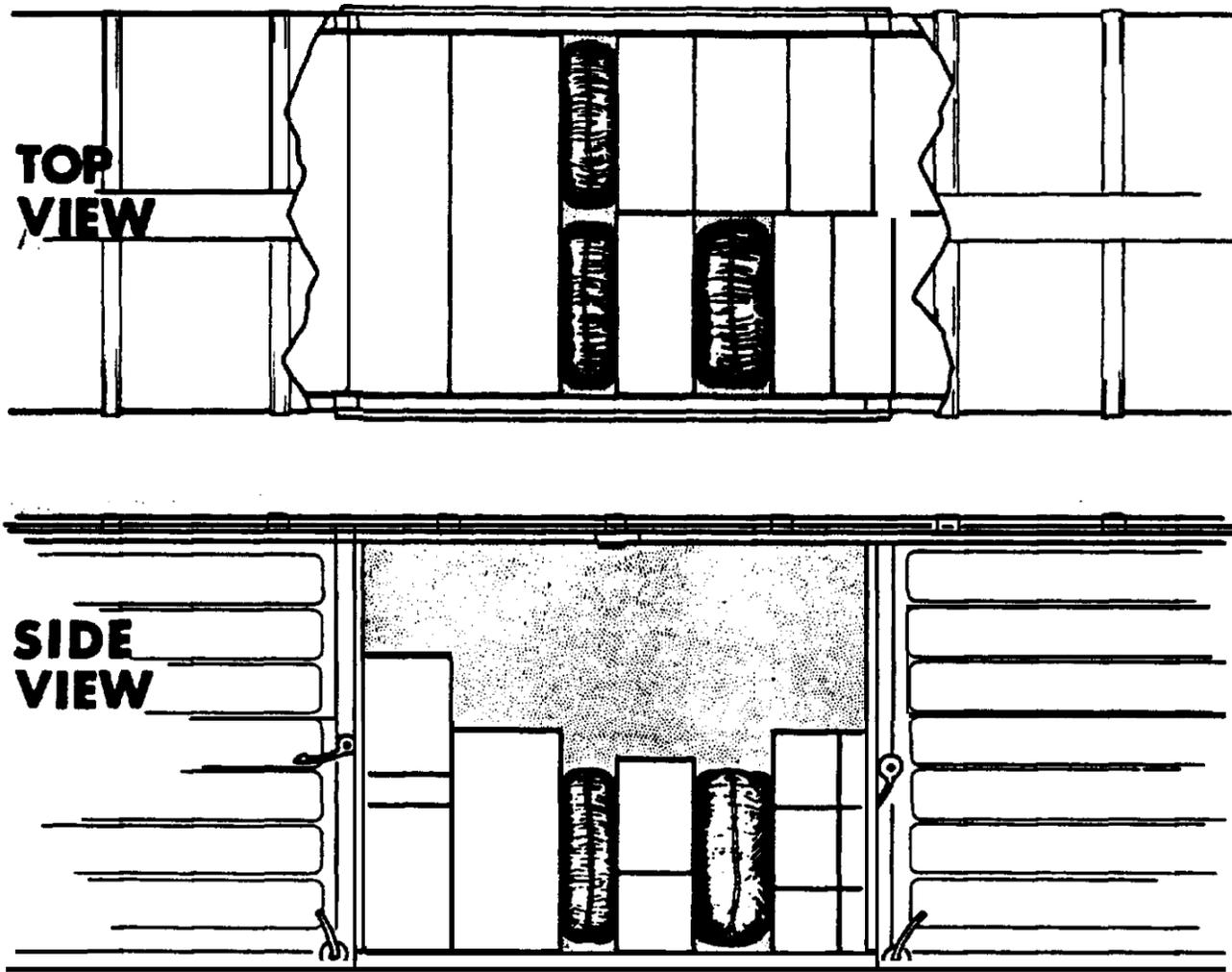


Figure 8-155. Pneumatic dunnage units staying load of various package sizes.

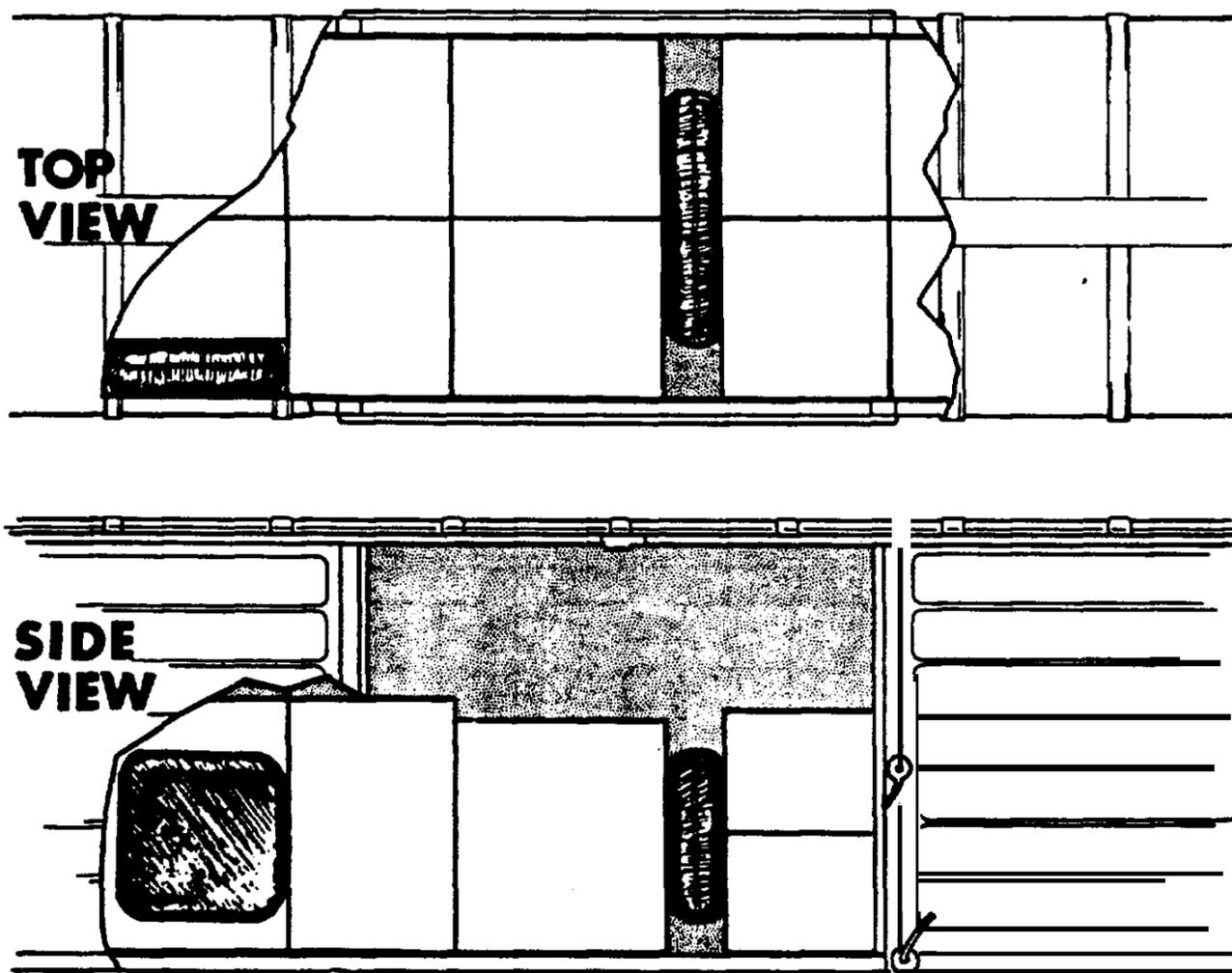


Figure 3-156. Pneumatic dunnage stays load laterally and longitudinally.

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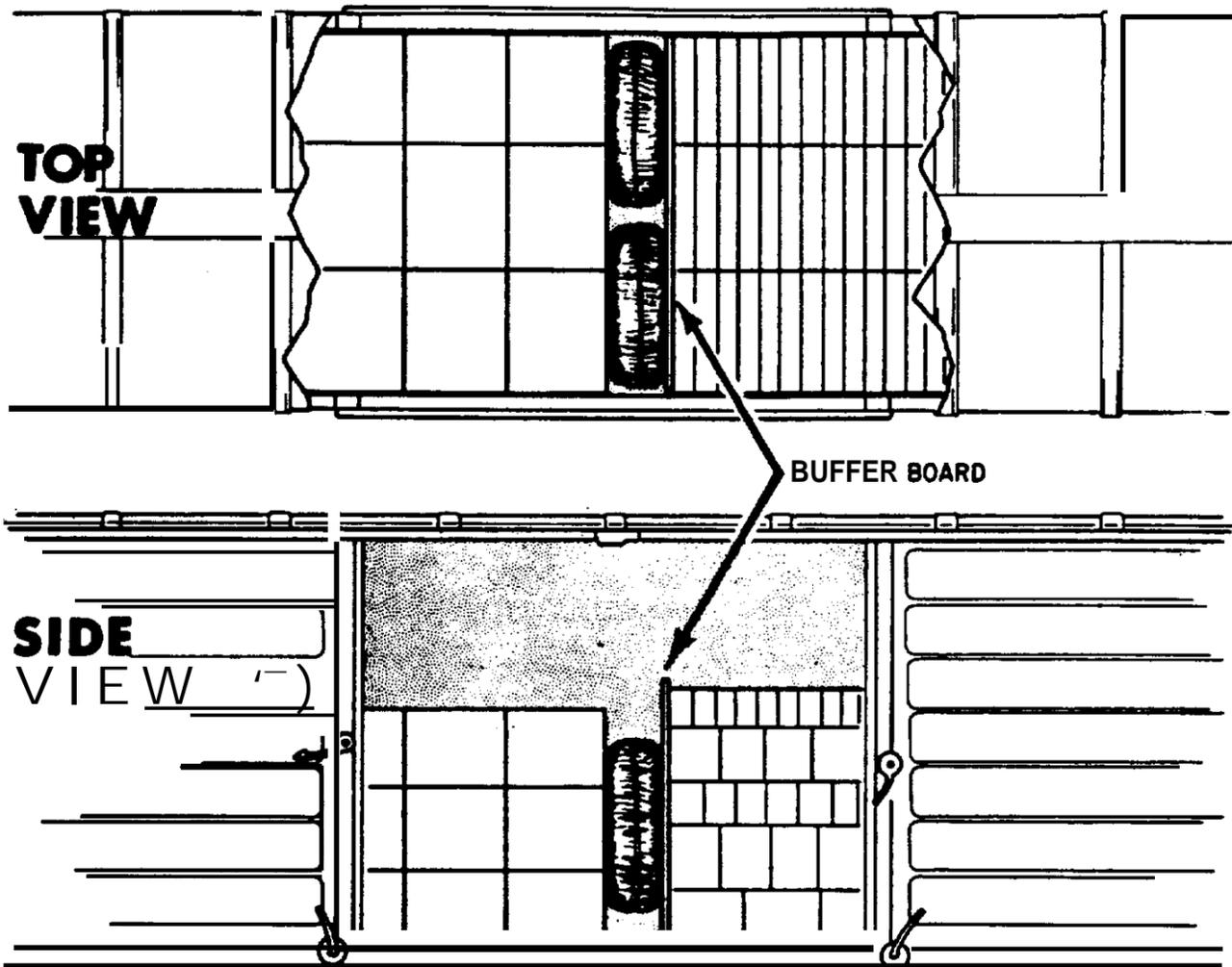


Figure 3-157. Buffer board insertions.

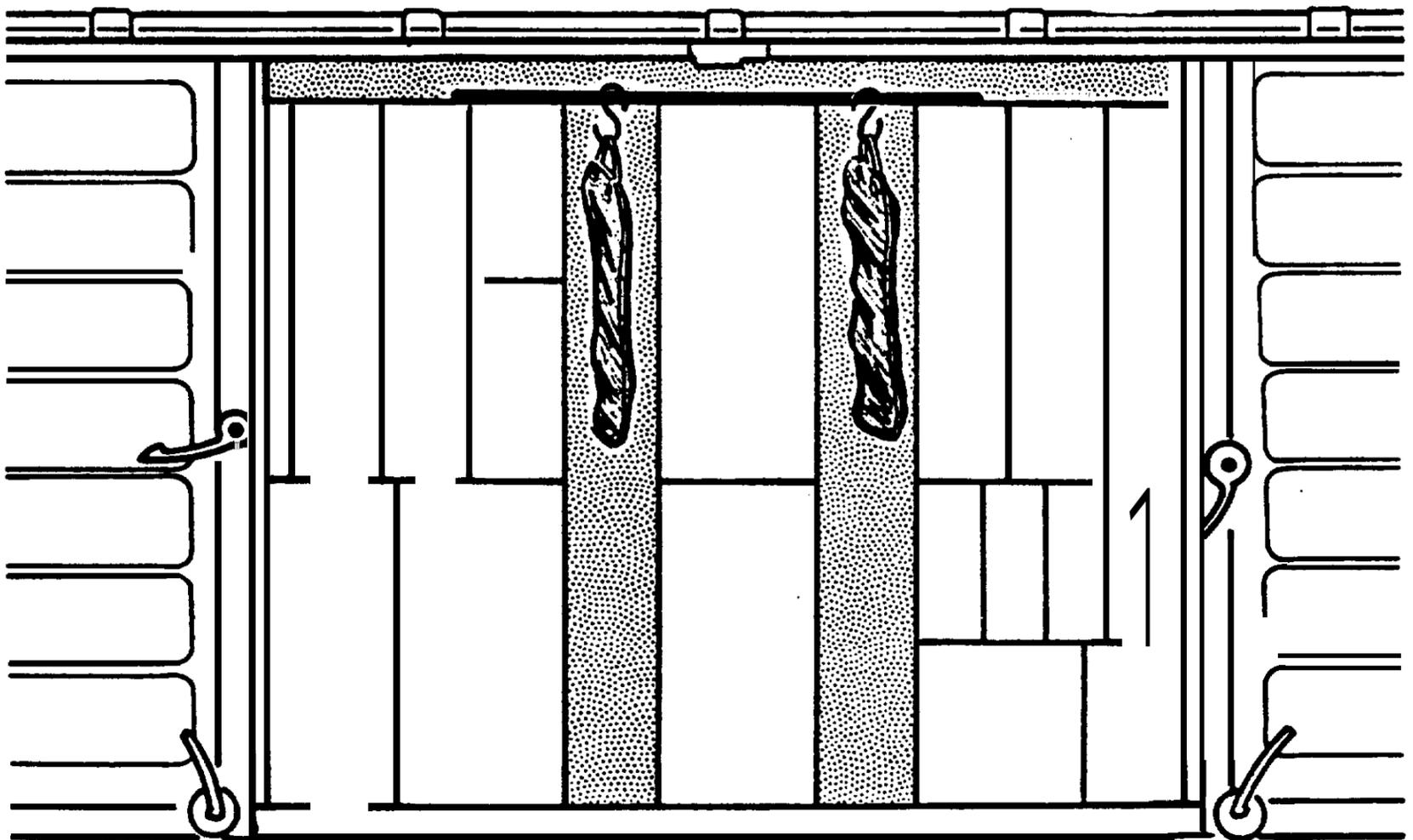
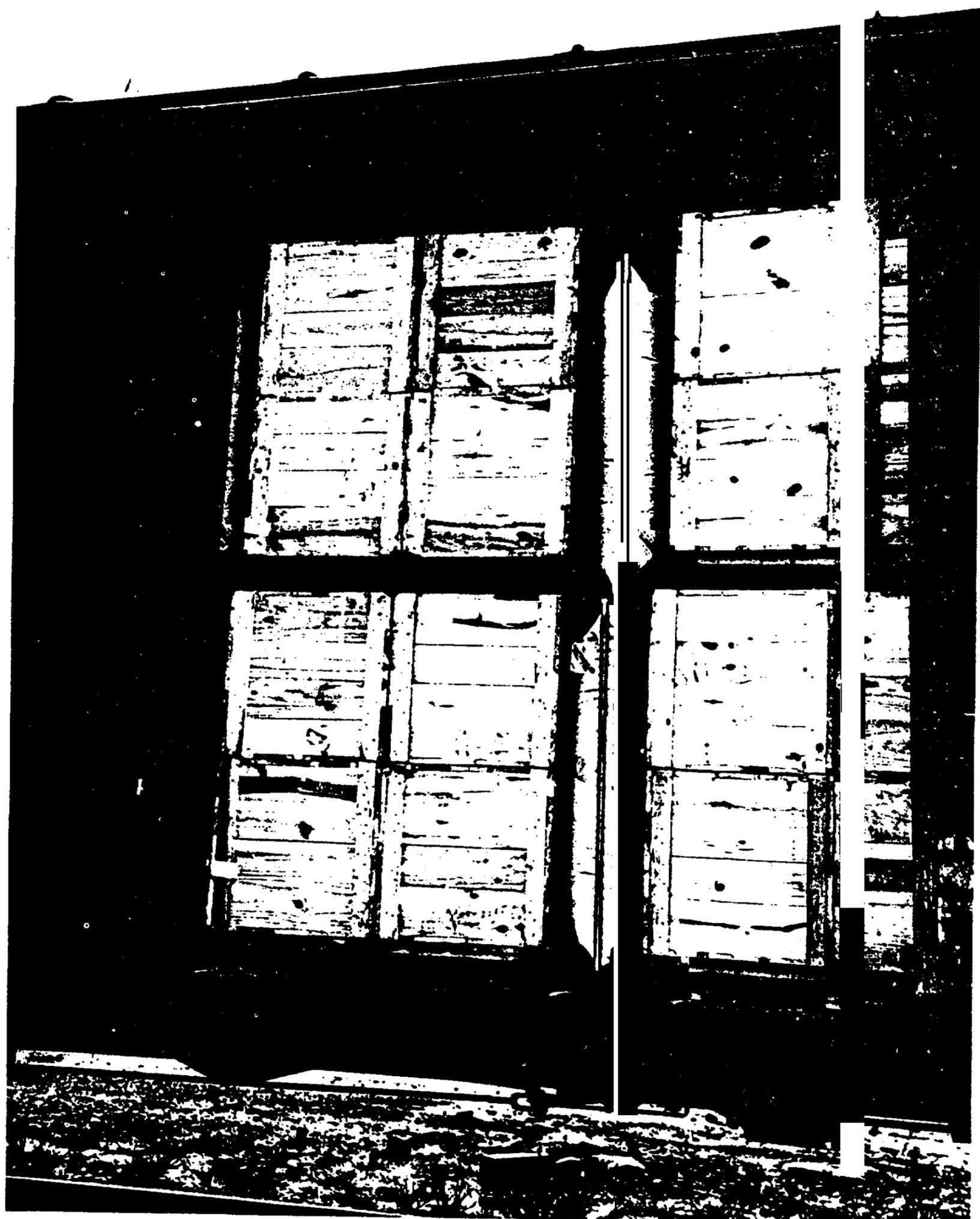


Figure 3-158. Technique for hanging dunnage units preparatory to inflation.

AS



*Figure 3-159. Load stayed with multiple rows of dunnage units, size 48 by 48 inches,*

10

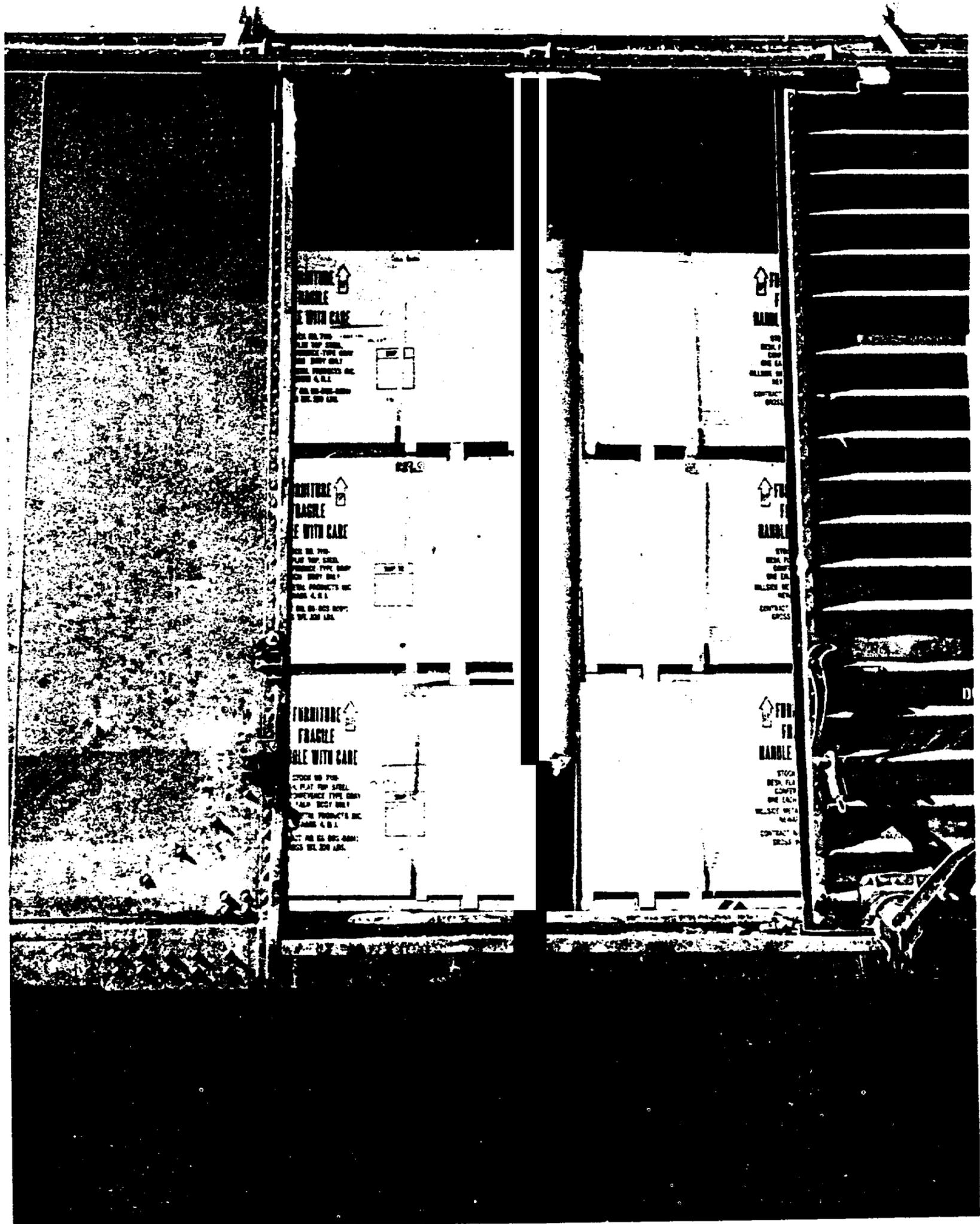
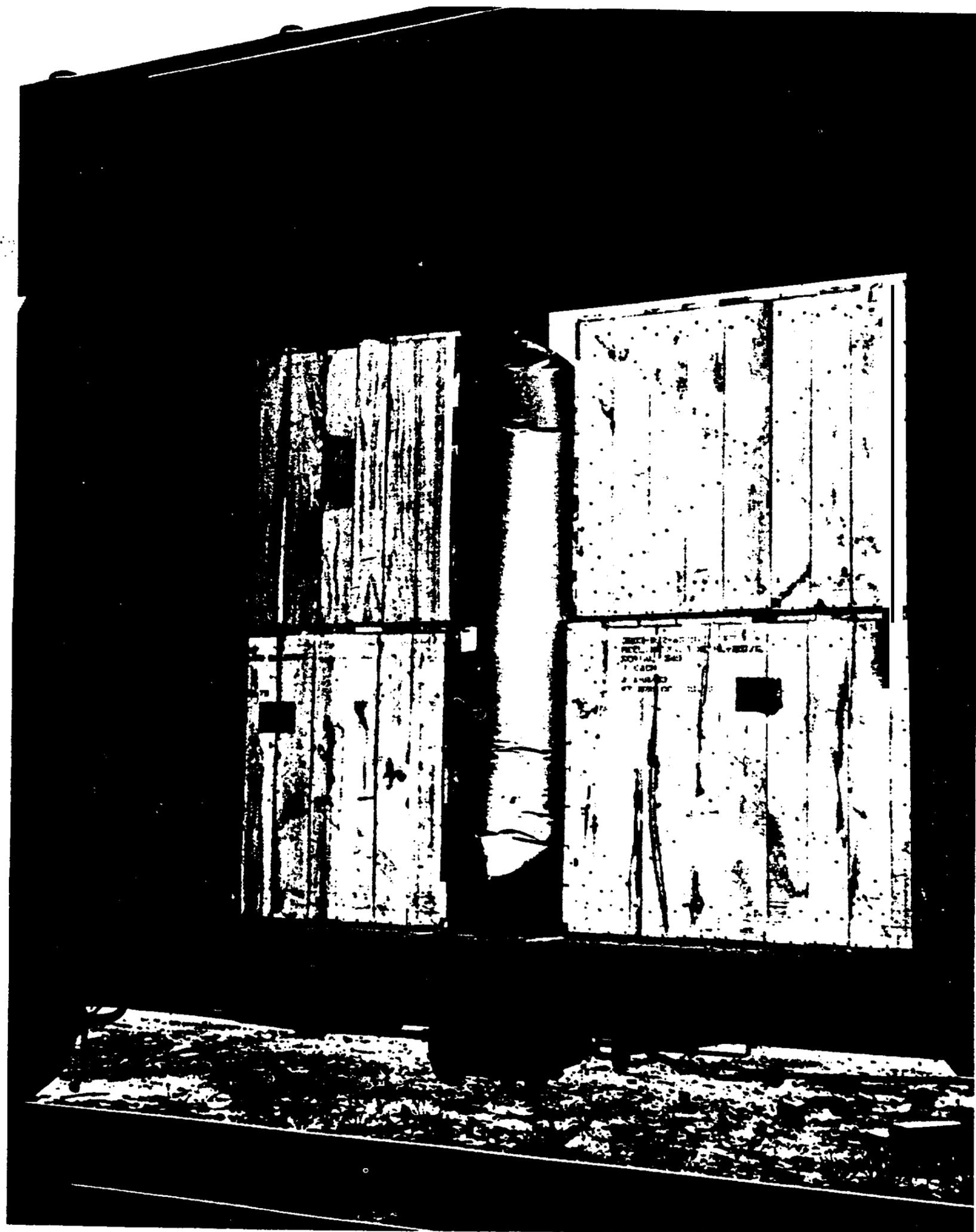


Figure 3-160. For load protection, buffer boards complement 48- by 96-inch dunnage units.



*Figure J-161. Load stayed with 48- by 72-inch units.*

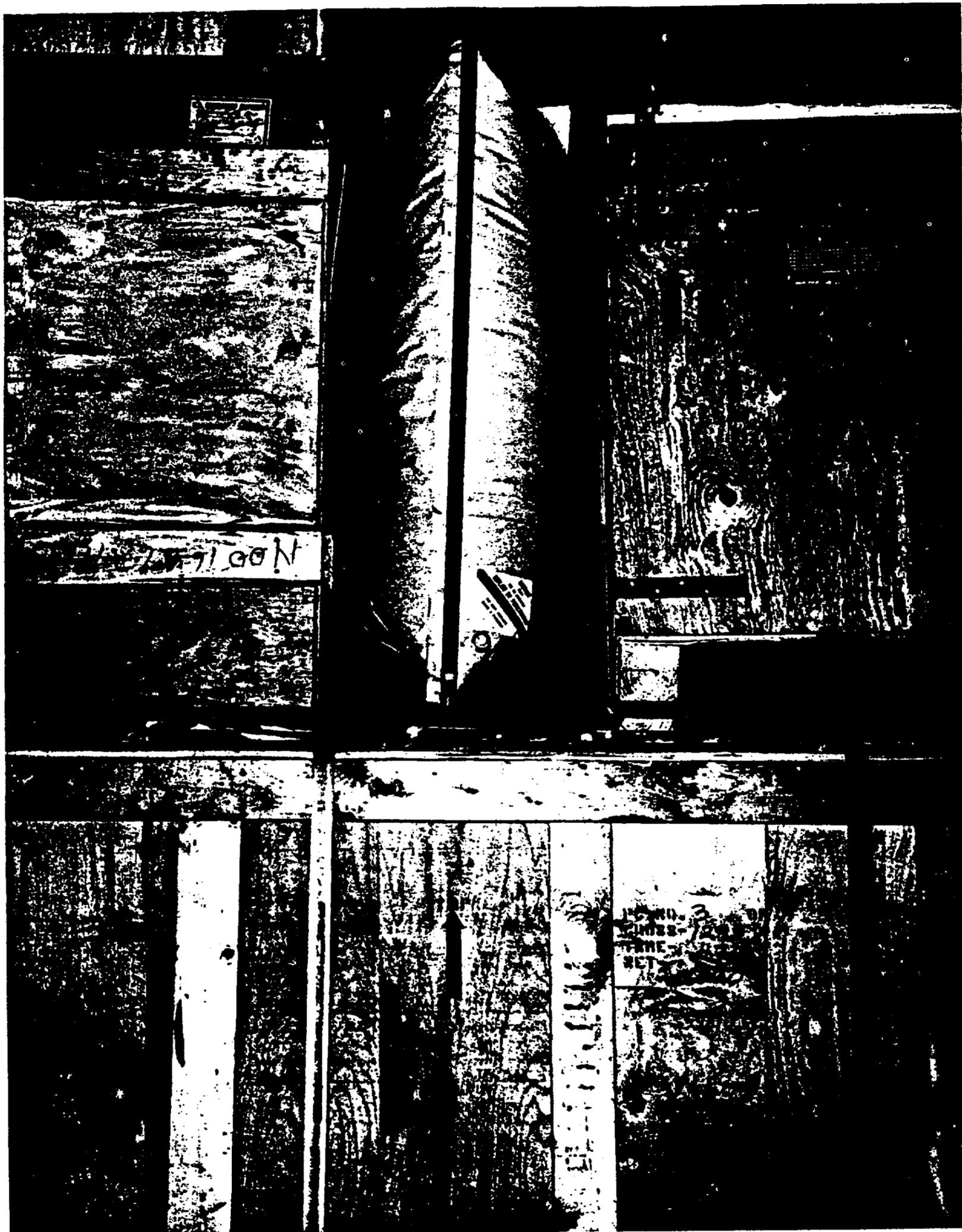
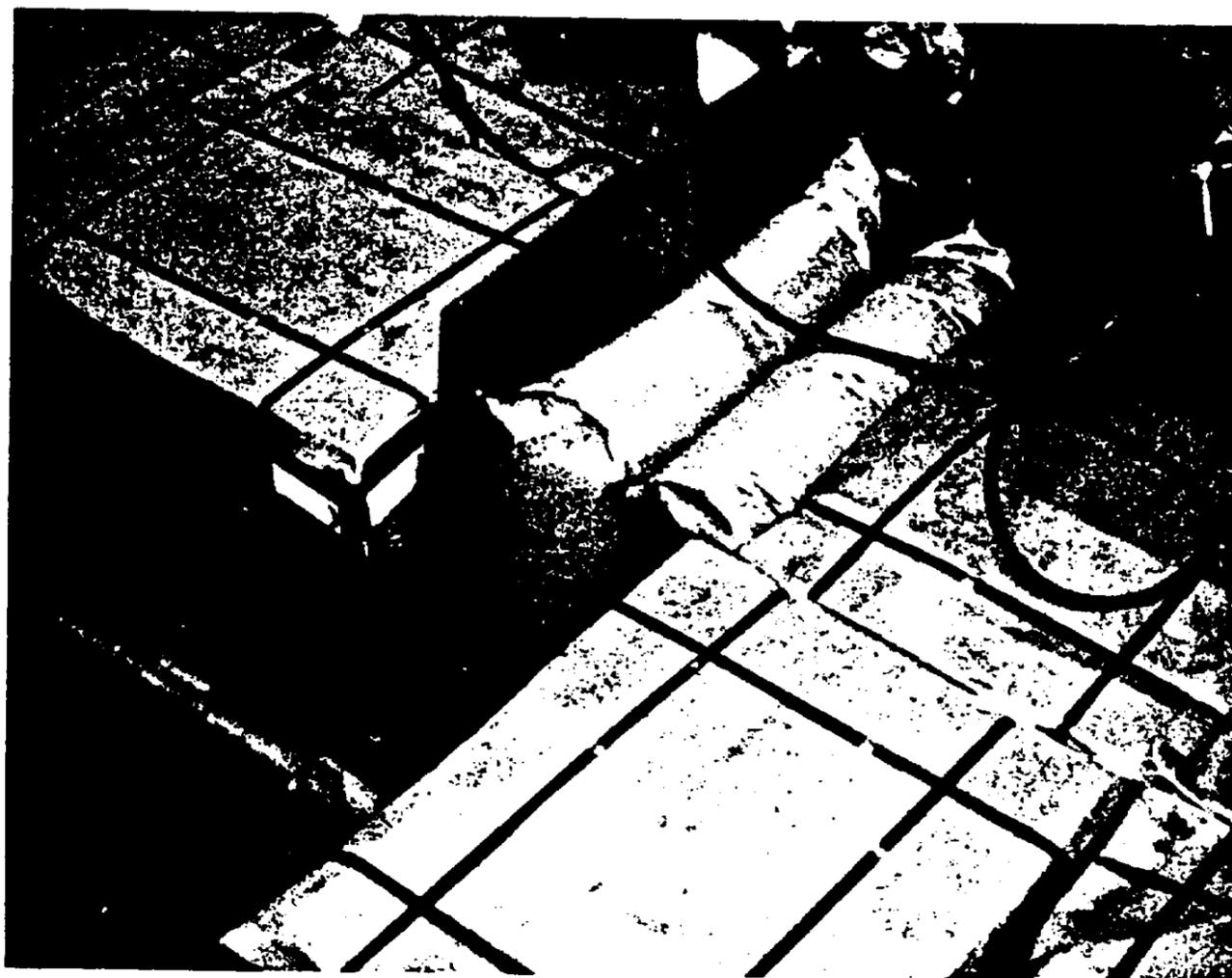


Figure 3-1 62. Load void in vessel hold occupied by 48- by 48-inch unit.

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*Figure S-169. Two units placed side-by-side occupy load void in vessel hold.*



*Figure 9-164. Dun nage units in process of inflation in vessel lower hold.*

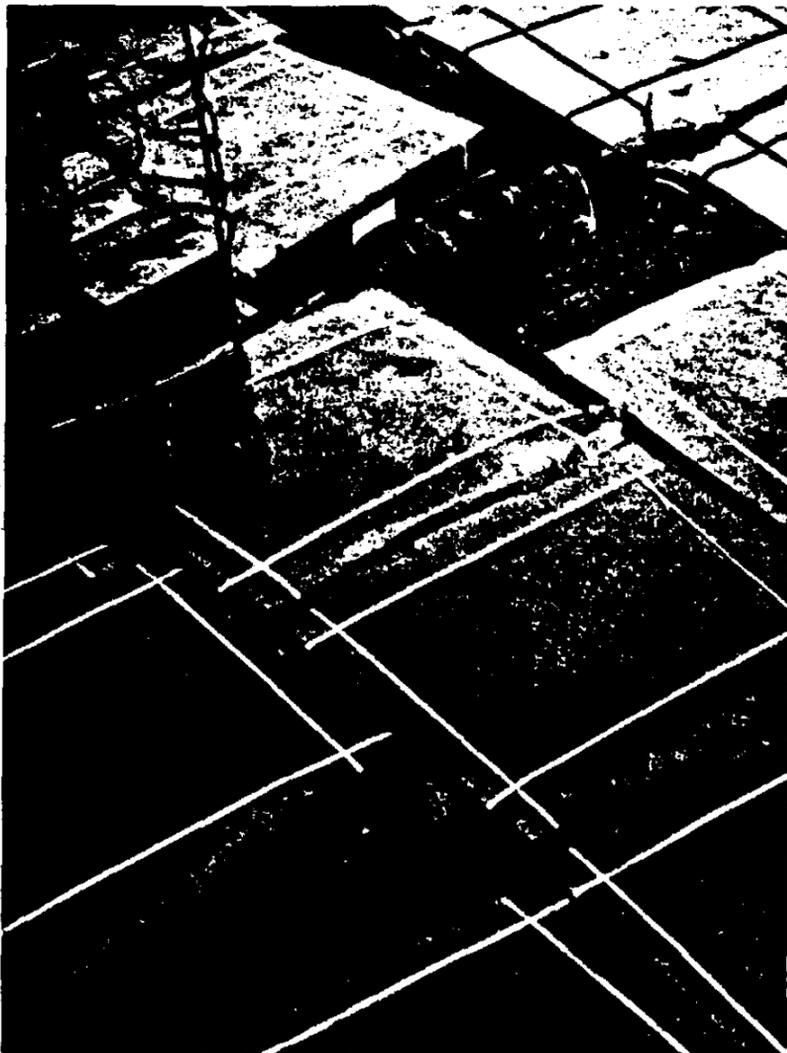


Figure 3-165. Van-able sized voids occupied by dunnage units in stowage.

of use (marine), this procedure has proven acceptable, notwithstanding the comments in f(2) above.

(2) *Removal.*

(a) Cut or otherwise puncture the disposable pneumatic dunnage units at any desirable location on the bag and remove **from** conveyance.

(b) Deflate the reusable pneumatic dunnage units by releasing the valve. Make sure that deflation of unit(s) will not permit any unsupported cargo to fall or shift to an unsafe position. Upon removing unit **from** conveyance, roll up toward the valve end to force the exit of any remaining air. This should be done immediately upon removal and the valve components retightened to prevent valve damage or entry of foreign material. Units removed at destination should be marked for inspection and repair, as appropriate. Dunnage units should be placed in a protected storage area if not to be immediately returned to shipper. See b(1) above on return of units. Keep buffer boards for **further** use, if practicable, upon removal from carriers.

*h. Care and handling of pneumatic dunnage units.*

(1) Reusable pneumatic dunnage units should be stored in areas that are relatively cool and not exposed to excessive sunlight. A convenient means of storing the units is to lay them out on pallets equipped with superstructures so as to avoid excessive superimposed weight. Normally, not more than 25 units should be contained within such a storage aid. The units, with male valves securely **fixed** in closed position, are to be laid flat. Folding of the units for storage will tend to cause deterioration of the unit at the fold area should they remain in such position for extended periods, especially with weight imposed on them. Disposable pneumatic dunnage units do not require any more protection in storage than given to other paper products. They can be stored in the receiving container. Disposable units have a recommended shelf life of 12 months.

(2) A reusable pneumatic dunnage unit must be inspected and repaired, as necessary, when puncture, abrasion, valve failure, or other defects are evident.

(a) **Inspectors** should consider valve components and surfaces of casing, mark areas **requiring** patching; if punctures cannot be detected by visual inspection, inflate unit to 6 pounds pressure, brush soap suds over the valve area and other areas of the bag to test for suspected leaks. Bubbles indicate leaks and these **leaks** should be clearly marked for repair. A sure way to determine the pressure retention capabilities of the units is to inflate them to 4 to 6 pounds PSI; then set aside for 24 to 48 hours. A fired check would then be made before use to assure that they are holding adequate pressure.

(b) **Repair** of reusable pneumatic dunnage units can be accomplished as follows:

(1) Install new valve parts, if inspection indicates a leaking valve.

(2) Patch punctures or tears. The damage area must not exceed 6 inches in length nor be within 3 inches of valve **or** bag seam. Repairs will be accomplished with repair kit (available from dunnage **unit** manufacturers). The instructions included with the kits should be carefully followed. Reusable dunnage units with major damage such as valve deformation, seam damage, or any damage within 3 inches of the seam or valve should be returned to the manufacturer for repair if the projected remaining life of the unit justifies such action.

*Note:* For bladder type units remaining in system, the repair considerations above will also apply to the bladder.

(3) Since disposable pneumatic dunnage is for one-time use, there is no inspection for repair nor any processing for return to shipper.

## Section 10. UNIT LOADS

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Types of unit loads .....	3-1003
Advantages of unit loads .....	3-1004
Unitizing methods .....	3-1005
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### 3-1001. Policy

Maximum use will be made of unitized loads where such use will result in an overall economy to the Department of Defense. To conserve time, manpower, equipment and reduce the possibility of pilferage, unit loads will be used in receiving, storage, and shipping operations wherever practicable. Items which can be **palletized** will be formed into unit loads as soon as received and handled as units throughout the entire storage and materials handling operation. Individual procedure publications/drawings will be issued by the Military Services to cover palletization of explosives and ammunition commodities. It is mandatory that these publications/drawings be used when **palletizing** explosives and ammunition.

### 3-1002. Principles of Unit Loads

a. The combining of numerous items into a unit load of appropriate size which can be handled with available equipment and within existing facilities is most economical. The larger the number of items handled as a unit, the smaller the handling cost per item. The savings by this method can offset the initial cost, operation, and maintenance of the mechanical equipment required to lift and transport the heavier loads.

b. To minimize double handling of material, non-palletized items which are received in quantities suited to **palletization** will be **palletized** at the earliest practicable point during the receipt process (fig. 3-166).

c. Practical limits to the application of unit loads include the physical characteristics of the items, size of pallet, storage area, elevators (size and **capacity**), size of doors, capacities of available materials handling equipment, and aisle widths.

d. Generally, large rigid items (such as lumber,

pipe, and **bar** stock) need not be **palletized** but can be bound into unit loads for mechanical handling. As much tonnage as possible will be hauled in a single trip.

e. The unit load principle can also be applied to the design of the container for individual units or items. For example, a 50-pound unit can be handled in less time and at less cost per pound than two 25-pound units. However, the weight of any unit or container that must be eventually manhandled will be limited by the strength of the average man. For this reason the gross weight of these containers or units should be limited to no more than 70 pounds where possible.

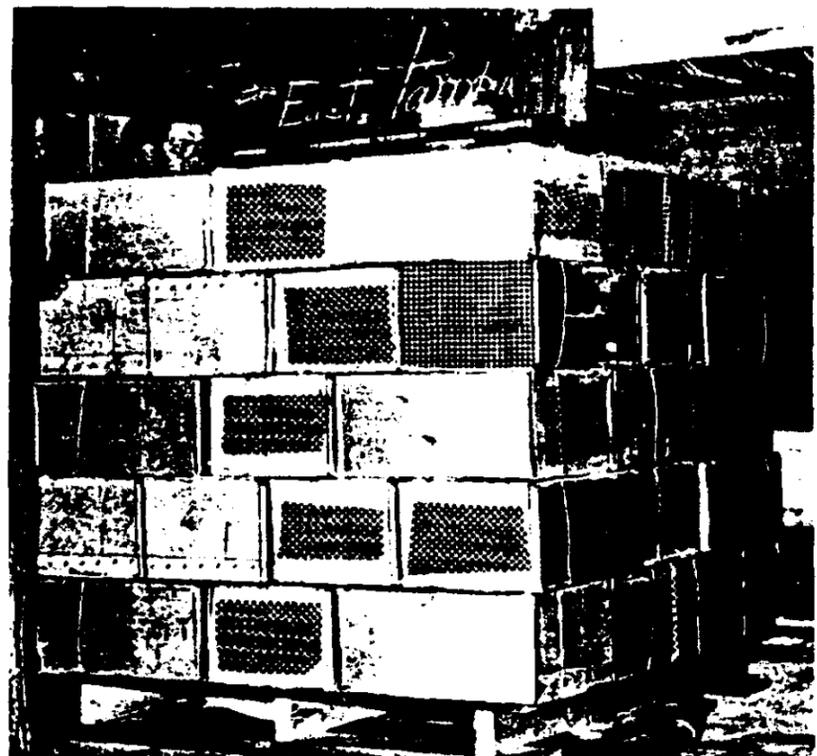


Figure 3-166. Cartons palletized close to stock for unit handling.

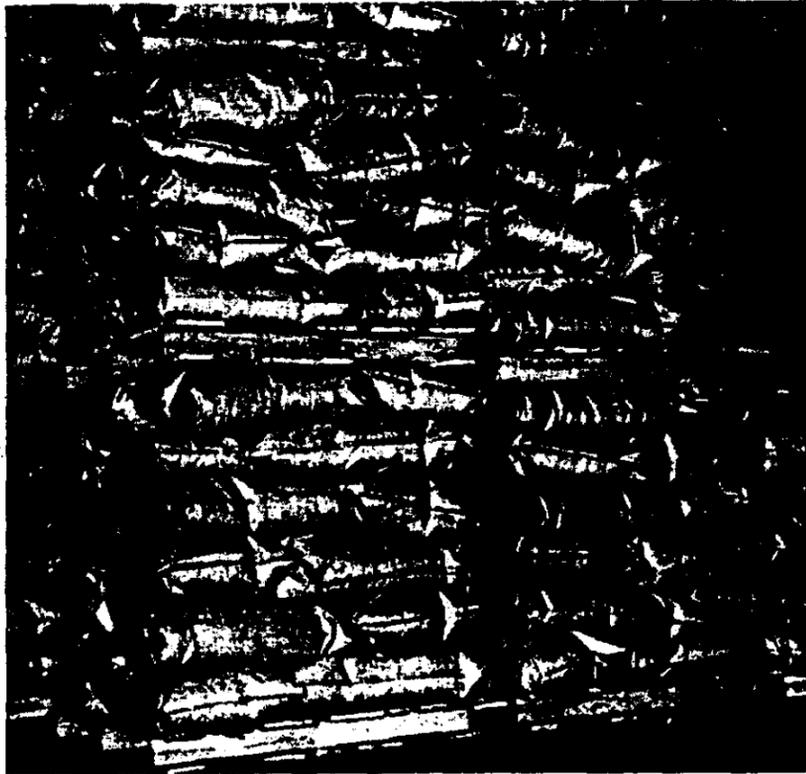


Figure 9-167. Nonbonded unit loads.

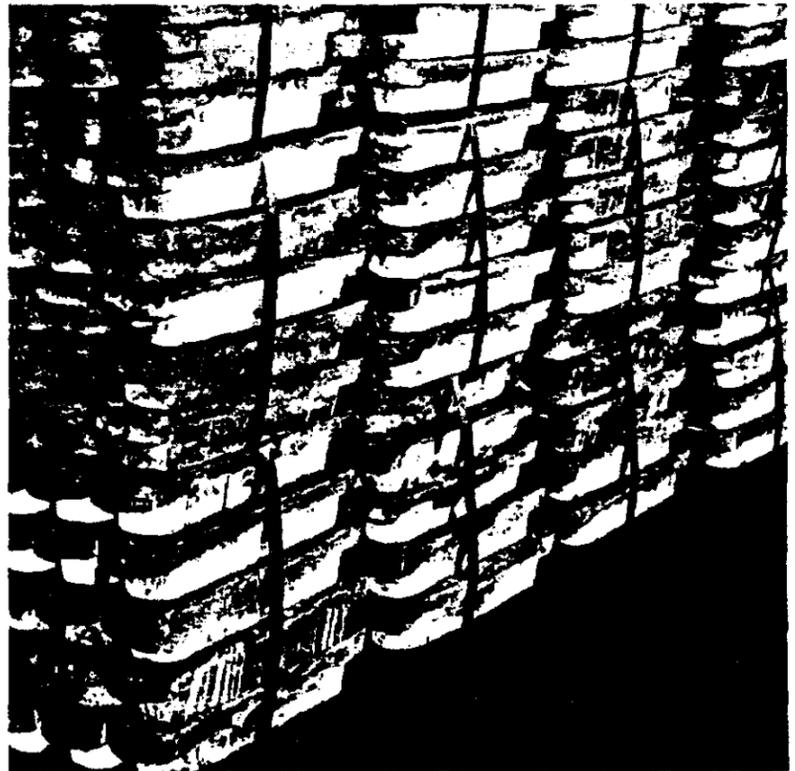


Figure 3-168. Bonded unit load.

### 3-1003. Types of Unit Loads

a. *Unit load.* A unit load is normally composed of two or more pieces or containers handled as a single unit. Generally, the unit load will be supported on a pallet or on a base so designed that the load can be picked up from any direction by mechanized handling equipment. When a special base is not provided, the material will be arranged and tied in such a manner that handling as a unit load will be possible.

b. *Palletized and containerized unit loads.* Definitions, methods, materials, and techniques concerning palletized and containerized unit loads on standard general purpose pallets, skids, runners, or pallet-type base will be in accordance with MIL STD-147 (palletized and containerized unit loads for 40 x 48" pallets).

c. *Bonded unit load.* Frequently, because of the type of material or items to be transported, or because of shocks and movement which may occur while in transit, it will be necessary to bond the items comprising the unit load. The items will be formed into a bonded unit load (with or without a pallet) by means of adhesive, strapping, edge protectors, or other storage aids designed for this purpose (fig 3-168). The bonded load will be designed to remain as a unit, from the place of assembly to

the ultimate place of use, throughout all phases of storage, handling and shipment.

d. *Nonbonded unit load.* Nonbonded unit loads will be a type or shape that can be deposited, without bonding, on a load base and transported as a unit during normal handling and storage operations (fig. 3-167).

### 3-1004. Advantages of Unit Loads

a. *Economy.* Unit loads provide an economical means of handling, storing, and transporting by eliminating manual handling of individual items and minimizing the incidence of pilferage.

b. *Speed in handling.* With unit loads, more tonnage can be moved in less than is possible with other handling methods.

c. *Utilization of cubic space.* Material in unit loads can be mechanically stacked to greater heights, thus utilizing a greater percent of available cubic storage space. Covered space is expensive; therefore, increased utilization will decrease the overall cost of storage. During periods of increased receipts, the demand for storage space frequently exceeds the supply. Utilization of cubic space is even more important at this time.

d. *Decreased damage to material.* Incidence of damage to material handled under the unit load

concept will be much less than for material handled as individual containers through all steps of storage and transportation.

e. **Safety.** Handling of material in unit loads is safer for **personnel**. Many of the accidents most common to storage operations occur where individual container handling is involved.

### 3-1005. Unitizing Methods

a. **Nonpalletized unit loads.** Usually, nonpalletized unit loads, (including lumber, steel and bar stock) whether assembled for storage or shipment will be much larger in length than the normal palletized unit load. However, the dimensions of nonpalletized unit loads should not exceed 48 inches in either width or height (figs. 3-169 and 3-170).

b. **Use of storage aids.** Storage aids such as dunnage, collars, spacers, separators, strapping, and others should be utilized when necessary to secure, holster, or protect unit loads in storage as well as loads prepared for shipment. For details in the use

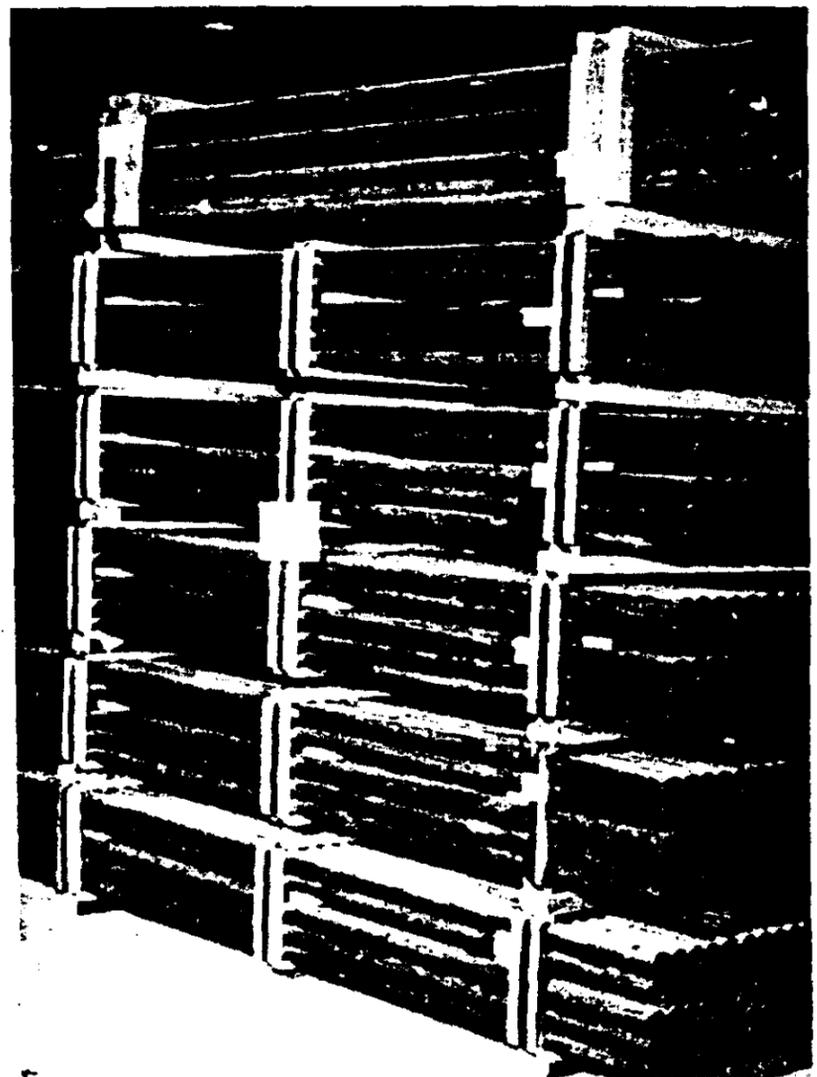


Figure 9-169. Nonpalletized unit load of boiler tubes.

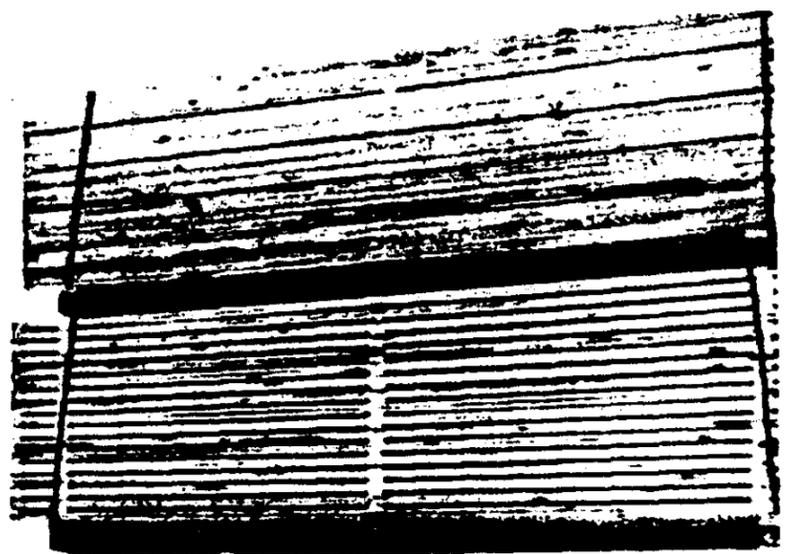


Figure 3-170. Nonpalletized unit load of lumber.

of these aids for storage purposes refer to chapter V of this regulation. For their use in shipping functions refer to MIL STD-147.

c. *Cube dimension and weight requirements of unit loads.*

(1) The detailed requirements concerning unit load cube dimensions and weight are contained in MIL STD-147.

(2) Palletized unit loads made up for storage and not for shipment may exceed the height and weight limitations specified for unit loads designed specifically for shipment. Deviations will be limited to the following:

(a) Capacity of the materials handling equipment.

(b) Stacking height of the unit.

(c) Unusual shape or size of items.

(d) Storage capacity of the building or storage area.

### 3-1006. Unitizing Loads by Shrink Wrapping

a. *Definition. Shrink wrapping.* A process of enclosing a load (usually pallet size) in a preformed polymer bag or polymer roll stock and with the application of heat, a reduction of the enclosure size

occurs thereby creating a firm, form fit about the load.

b. *Types of shrink equipment.* The major types currently available are-

(1) *Shrink chamber.* This is a heat chamber or oven (heat source can be gas or electricity) having a single door for entrance and exit, and a conveyor or movable platform to transport the load. The operating temperature is automatically controlled and the time the load is subjected to the heat is either automatically or manually controlled. Length of load time in chamber depends on film thickness and film type. Approximate capacity is 30 pallets/hour.

(2) *Shrink tunnel.* This equipment has operating characteristics similar to the shrink chamber with major differences being in feed mechanisms and feed rate. With the exit door being a separate opening and opposite from the entrance, a continuous feed of pallet loads is possible handling a capacity of 35 to 60 pallets per hour depending on type of equipment. Heat loss through the entrance and exit openings can be contained either by actuated doors or air curtains. The tunnel is the method necessary if a high rate of output is required (fig. 3-171).

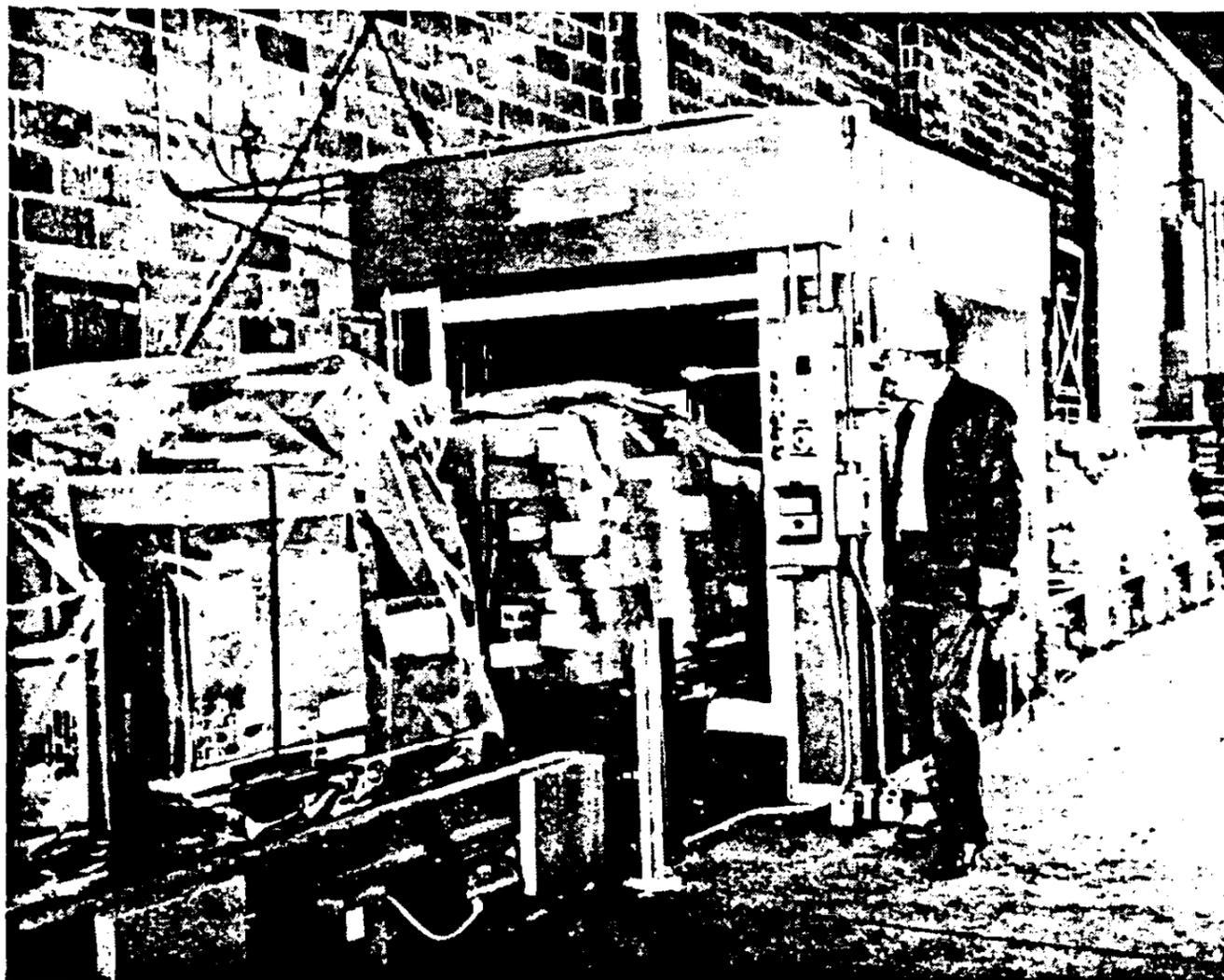


Figure 3-1 71, Shrink tunnel.

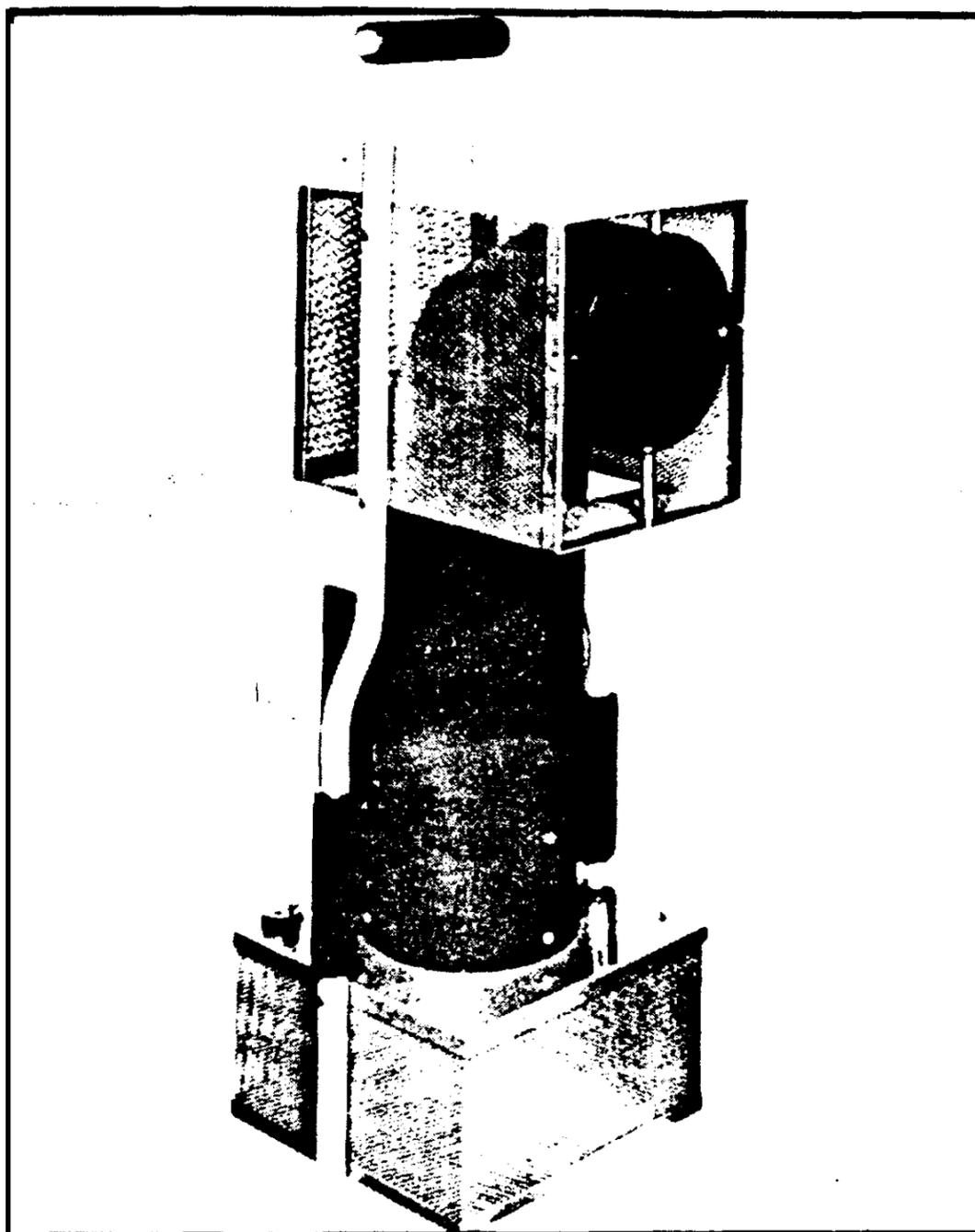


Figure 9-172. Hand-held, portable heat cannon.

(3) *Rotary tower*. This type uses electrically heated hot air to shrink the film as the load rotates a full 360° in front of the heat source. As only part of the film is subjected to the heat at one time, a slower output results.

(4) *Ring type*. This type uses a gas or electric heat source contained within a square or rectangular framework which is regulated to lower gradually around the load. This method heats all four sides as the heat source passes over the load. The operation is automatic with cycle time again varying with the gauge and type film used.

(5) *Hand-held portable heat cannon (fig. 3-172)*. This is designed for sample load preparation and limited quantity production. It is the smallest and least costly piece of equipment available.

*c. Types of shrink film available.*

(1) A variety of shrink films is available and

the user must assess his particular requirements to determine the density and type of film to be used. There are two general categories of film, sheets (figs. 3-173 and 3-174) and preformed bags (figs. 3-175 and 3-176).

(2) The preformed bags are more widely used, each type being available in a wide range of thickness, construction, and sizes. Some of the shrink films available are listed below.

- (a) Polyethylene.
- (b) **Polyvinylchloride.**
- (c) Polystyrene.
- (d) Polypropylene.
- (e) Polyester.
- (f) **Polyvinylidene chloride.**
- (g) Rubber hydrochloride.

*d. Shrink film characteristics.*

(1) Polyethylene film because of its perform-

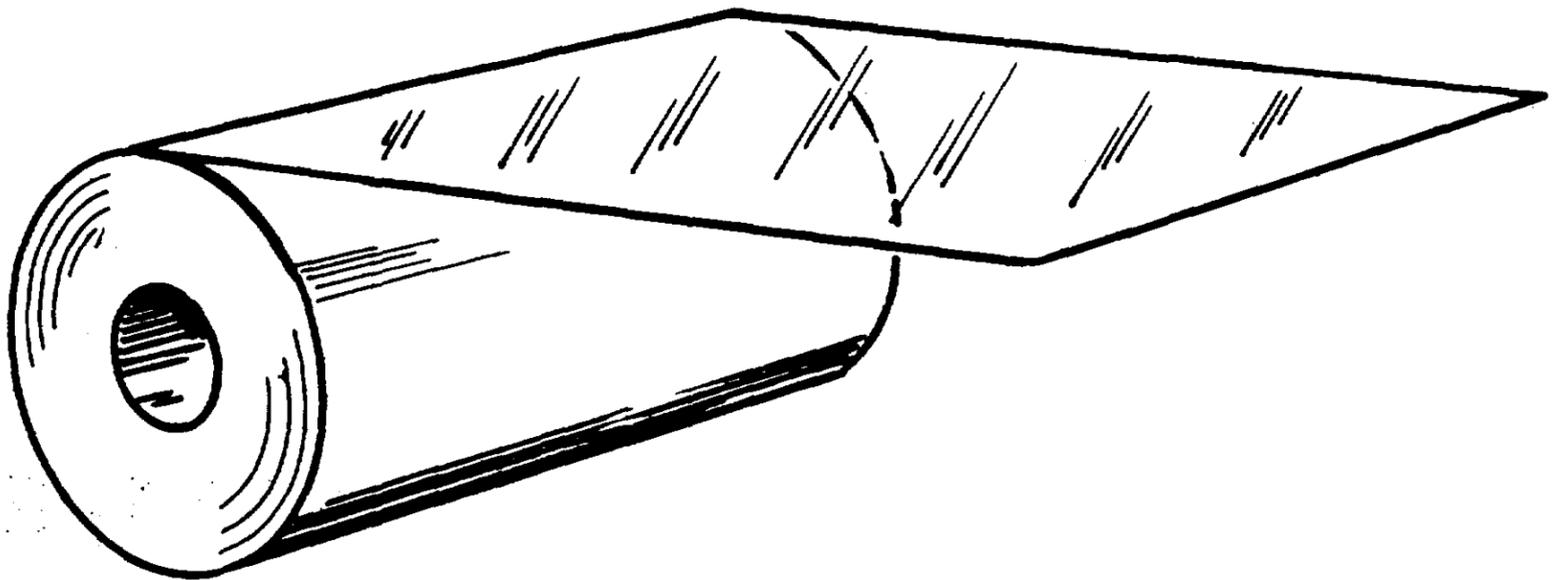


Figure 3-173. Flat sheeting.

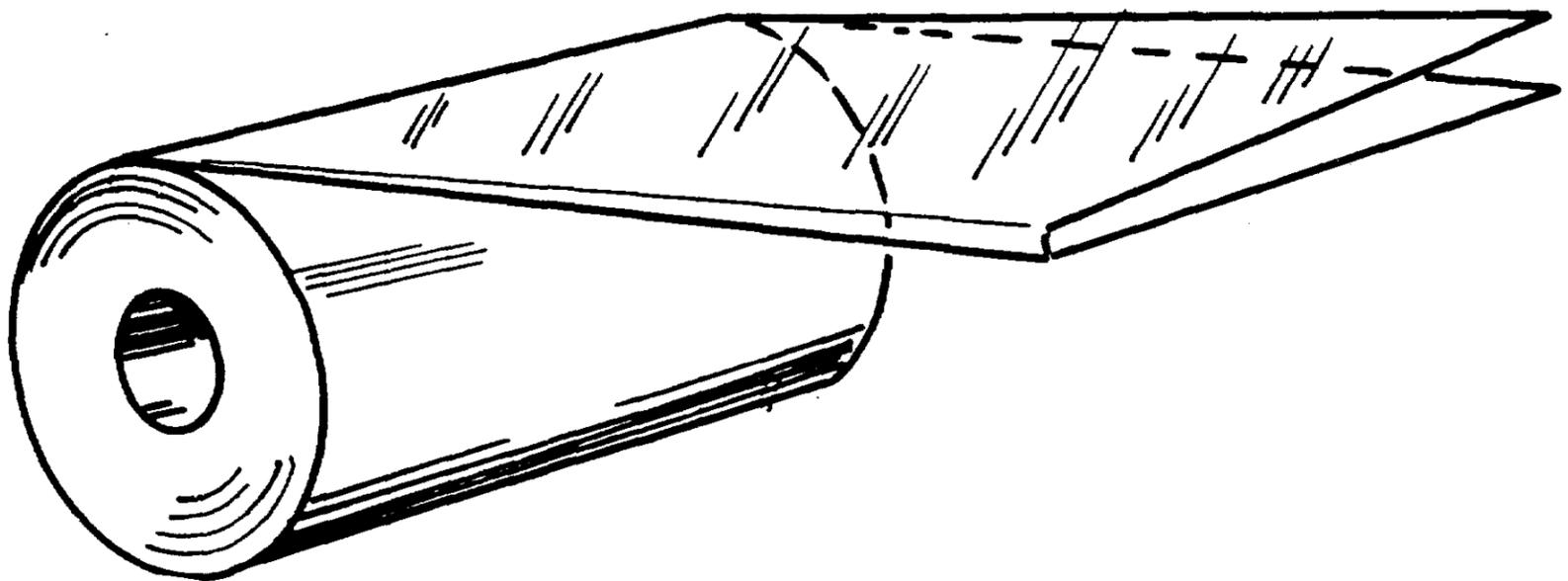


Figure 3-174. Centerfold sheeting.

ante characteristics and low cost is the most widely used. The ability to stabilize heavy loads becomes apparent when it is realized that the applied **shrink-film** surface area is approximately 10 percent greater than the surface area of the palletized load. Shrink tension is thus applied after this 10 percent has been shrunk to fit the contour and allows the film to become a structural part of the package.

(2) In film production, controlled stretching builds stress characteristics into the **film**. Heating the film releases the built in stresses causing it to shrink. The film shrinkage can be controlled in two directions, either in the circumferential direction or height of the load.

(3) Thickness of polyethylene shrink film used varies depending on the restraint requirements.

Most industrial applications use film 2.5 to 8 mils thick. The ability of film to stabilize a heavy load is easy to visualize when one realizes that a restraining force of 2,000 psi sometimes occurs over the entire area of the load surface. This "factor together with the inherent elasticity of film makes it an outstanding containing medium.

(4) Shrink-film bags can be either centerfold or gusseted types (figs. 3-175 and 3-176). The **centerfold** bags are rolled, sealed, and perforated from centerfold film and have their primary shrink around the circumference of the load. This type of shrink direction gives a more consistent shrink and tends to keep film from pulling away from the bottom of the pallet. This factor is extremely important since the purpose of the application is lost if the film

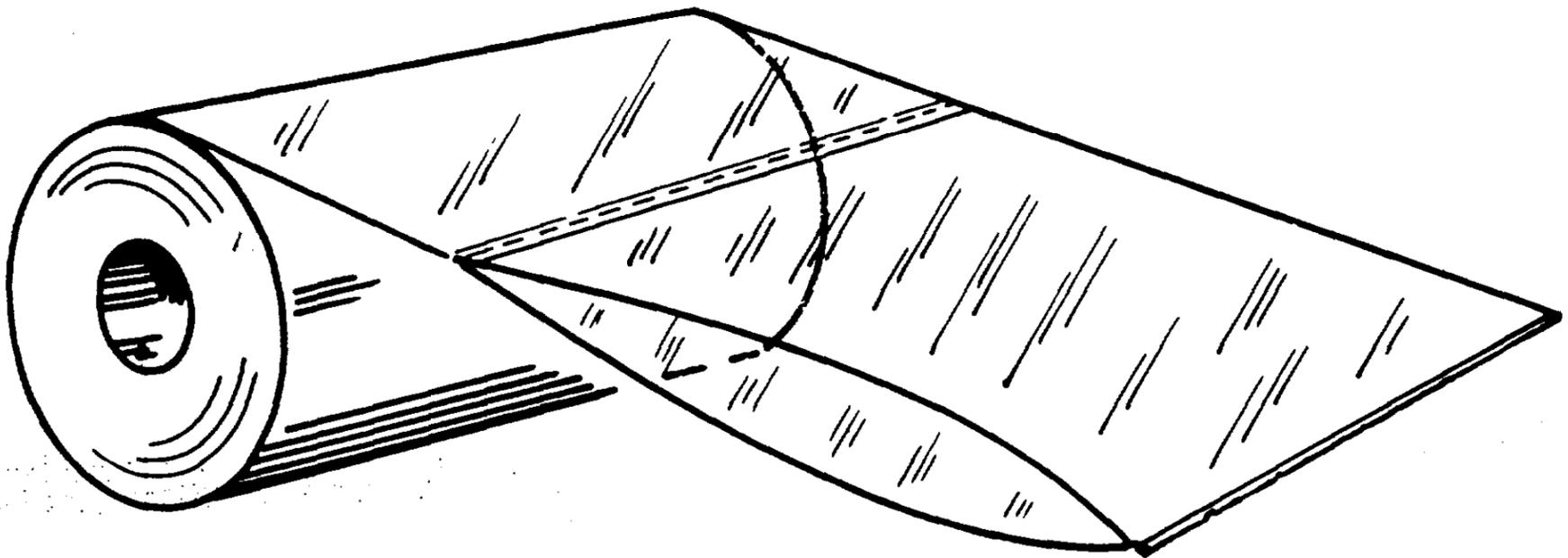


Figure 9-175. Centerfold bags.

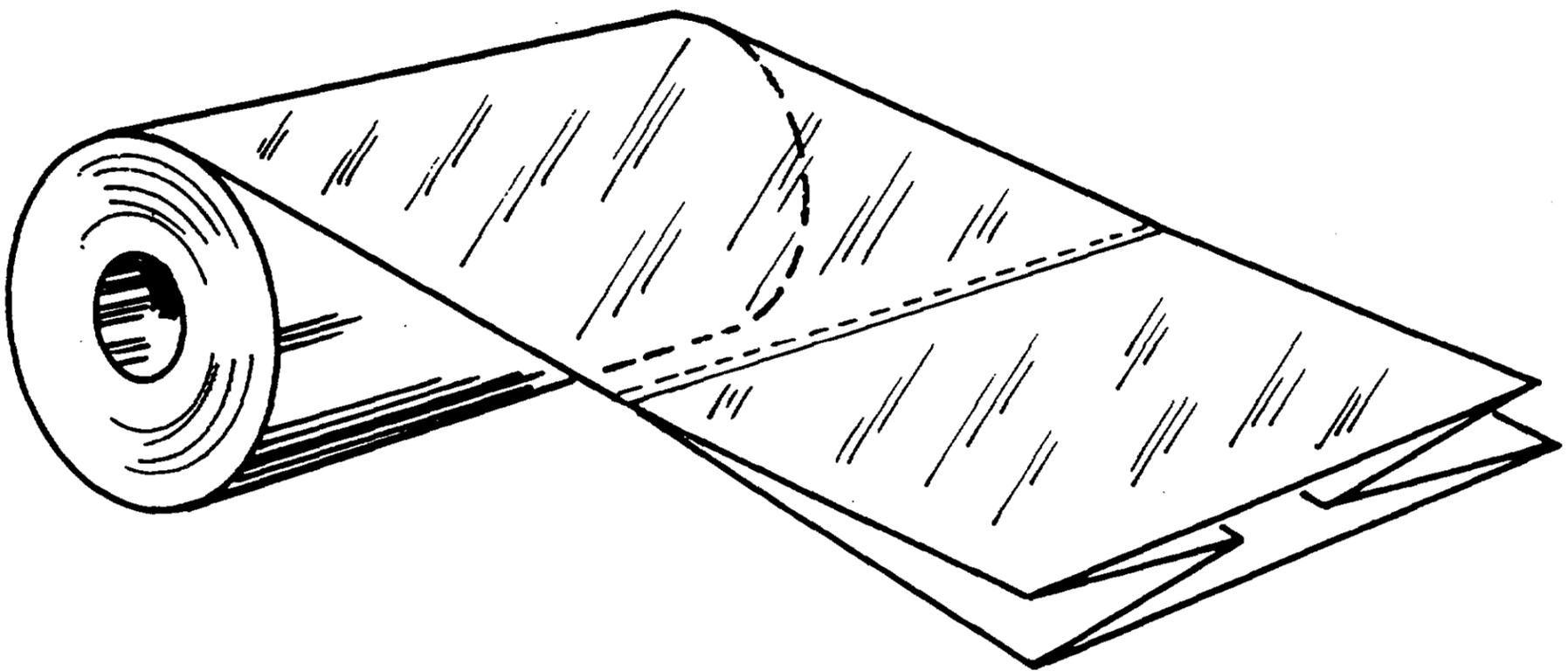


Figure 9-176. Gusseted bags.

does not tightly grasp the pallet. The gusseted bags are rolled, sealed and perforated from gusseted tubing. The primary shrink here is in the vertical direction rather than the circumferential. This type of shrink direction tends to cause the film to pull away from the bottom of the pallet. This can be controlled by guiding the heated tunnel air primarily to the bottom of the pallet.

e. *Determining film bag size and thickness.* Bags are specified by width, depth, length and gauge.

(1) Bag size determination is based on the following:

(a) Width—approximately 4 inches more than load width.

(b) Depth—approximately 4 inches more than load length.

(c) Length—one half of depth of load plus height of load (including pallet) plus 4 inches.

(2) Thickness (gauge) of the film material needed is determined by the weight of the pallet load and type of film to be used (para 5.1.2.3., MIL STD-147).

f. *Advantages of shrink wrap.* The advantages of shrink wrap palletizing make it desirable for many load bonding applications.

(1) Shrink films conform to odd shapes and sizes thereby offering greater versatility in package size reduction than conventional strapping.

(2) Strapping impressions and product abrasion are eliminated.

(3) The overwrap of shrink film shields the load from outside moisture conditions and also prevents dust collection on the material. The load will frequently lend **itself** to temporary outside storage thereby easing warehouse problems.

(4) Shrink-film overwrap deters pilferage by making entry obvious when it has occurred. Opaque **film** is also available **which** prevents ready **identification** of specific contents of the pallet.

(5) **Shrink film** is more safely removed from the pallet load than conventional metal strapping.

(6) Shrink wrapping is more economical than the standard combination of corrugated triple-wall containers and steel strapping.

*g. Disadvantages.*

**Note.** Many of the disadvantages listed below also apply to conventional metal strapping methods.

(1) Shrink wrap does not add stacking strength. Stacking strength of noncartoned loads depends upon the strength of the commodity.

(2) Shrink wrap provides no protection from impact forces on sides or top of load.

(3) Interlocking pallet patterns are particularly important in order to take advantage of the frictional forces of the package surfaces to provide load integrity.

(4) For best results, outside dimensions of the load should be close to or slightly less than the size of the pallet to allow the **film** to cling to the pallet. (Film will perform adequately in most cases even with a material overhang.)

(5) Plastic film is elastic in varying degrees. Thickness and density of film must be carefully selected to provide sufficient tension to maintain load integrity.

(6) When pallet loads are stacked, nail heads, splinters, or rough surface of upper pallet can abrade or tear film. (Such abrasions or tears, however, will not spread further by themselves.)

(7) Most films are adversely affected by **sunlight**. (Ultraviolet inhibitor **film** can be used where this protection is desired. )

(8) Satisfactory application of film requires precise control of temperature and time during the shrinking process.

(9) Shrink ovens occupy more space than conventional strapping equipment.

(10) Some minor heat loss occurs in most convection type shrink ovens. This must be considered if such units are to be used in refrigerated areas.

(11) Shrink equipment for high speed operation is more expensive than conventional equipment. (This can be offset by labor savings and increased production.)

(12) Film envelope provides poor ventilation. However, since film use is not a method of packaging protection but a device to bond loads for movement from shipper to customer, this is not a serious problem.

(13) Some types of film may pose disposal problems. However, polyethylene is the most commonly used and can be easily recycled. If recycling is not feasible incineration or disposal in sanitary landfills is preferred.

*h. Safety.* Shrink wrapping operations will be inspected at least every three months by installation fire prevention, safety or health personnel. Matters such as ventilation, use of protective equipment and clothing, and potential fire conditions should be included in this inspection.