TM5-265

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

BRIDGE FLOATING M4

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TECHNICAL MANUAL
No. 5-265

DEPARTMENT OF THE ARMY
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BRIDGE, FLOATING, M4

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CHAPTER 1

INTRODUCTION

1. Purpose

This manual is for officers and noncommissioned officers and provides instruction in the assembly and maintenance of the floating bridge, M4. The manual is to be used for reference and training.

2. Scope

The manual presents a general description of the floating bridge, M4; describes the component parts; the methods of loading, transporting, and assembling the bridge. Since the components of the bridge can be assembled as either a fixed or floating bridge or as ferries, the manual describes in detail the methods, equipment, and men used in each case.

3. General Design

a. General. The M4 floating bridge equipment is used to assemble floating bridges, fixed bridges, and ferries. In general terms, the floating bridge consists of a deck built of hollow aluminum sections supported on aluminum pontons.

b. Floating Bridges. Floating bridges can be assembled entirely as floating spans or as a combination of fixed and floating spans. The deck of M4 floating bridges is supported on aluminum pontons (fig. 1), pneumatic floats, or combinations of both.

c. Fixed Bridges. Fixed bridges (fig. 2) can be assembled with or without intermediate supports, with single spans as great as 45 feet, depending on the class required.

d. Ferries. Ferries of various sizes and capacities are assembled with the same M4 bridge equipment as M4 floating bridges. Bridge erection boats are normally used for propulsion; outboard motors can be used in slow water. Figure 3 shows a four-ponton shortened ferry.

e. Deck. The deck (fig. 4) consists of hollow aluminum alloy deck balk which acts as stringers and floor. The deck of the M4 floating bridge is continuous between the abutments and is made up of individual deck balk, which are staggered and pinned at three points to give continuous beam action. At trestles and other fixed supports, hinge joints are normally used. These joints are made by using short and/or tapered balk and normal balk. The bridge deck is assembled 22 balk

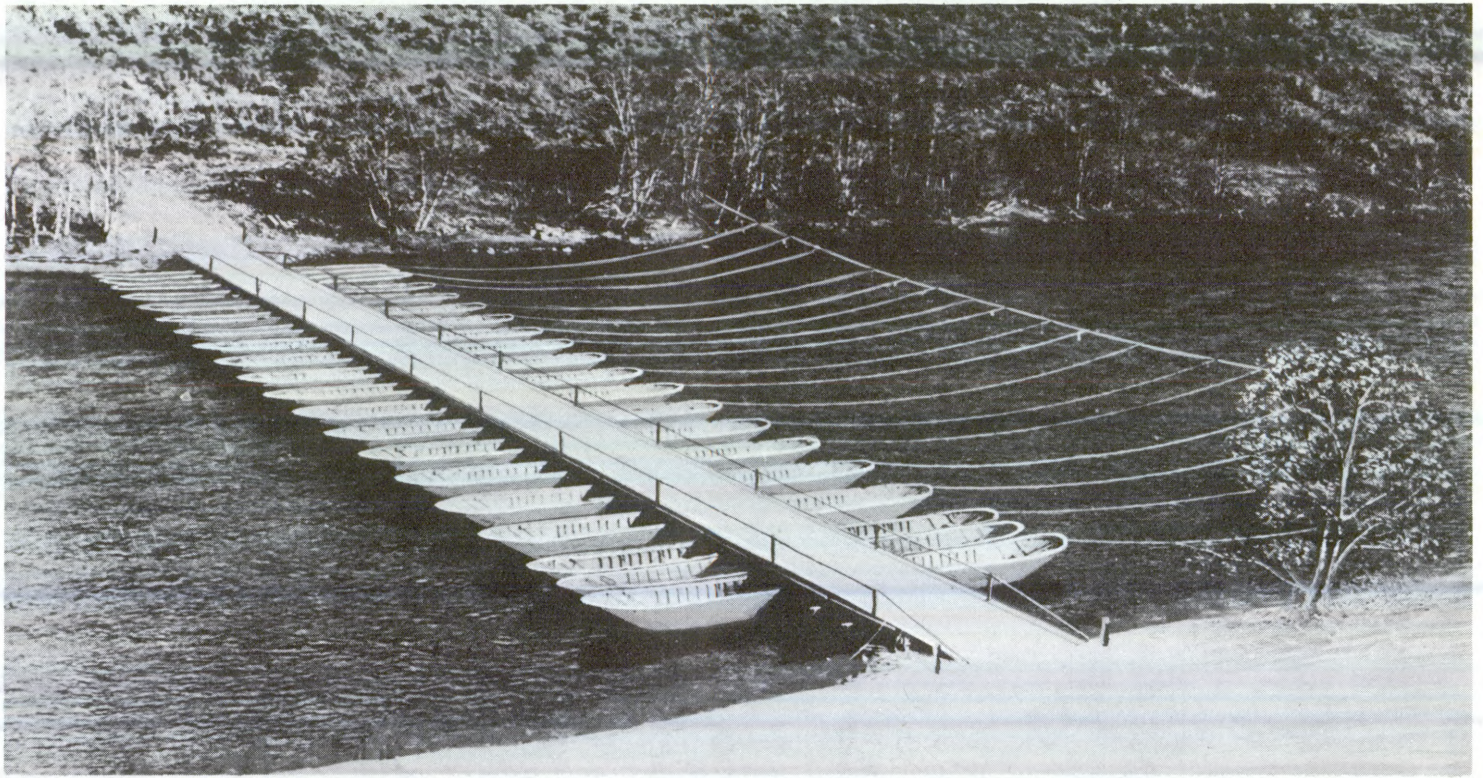


Figure 1. Partially completed M4 floating bridge.

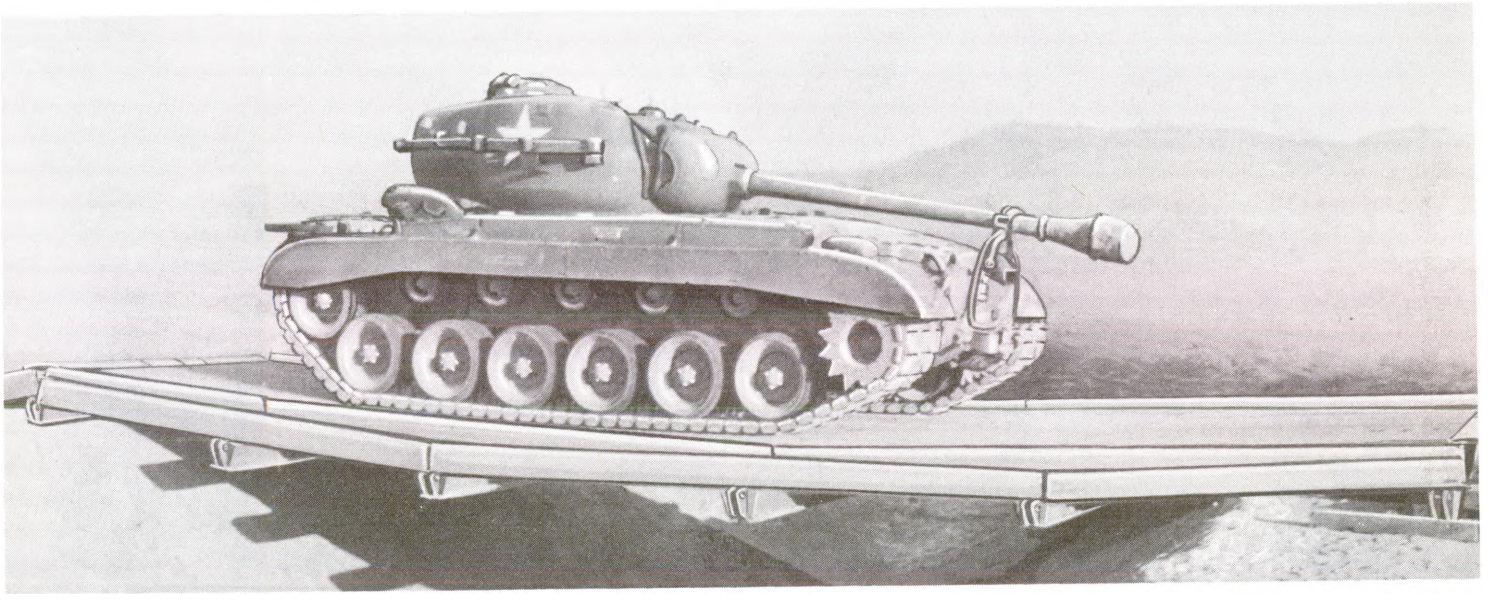


Figure 2. M26 medium tank crossing 38-foot span.

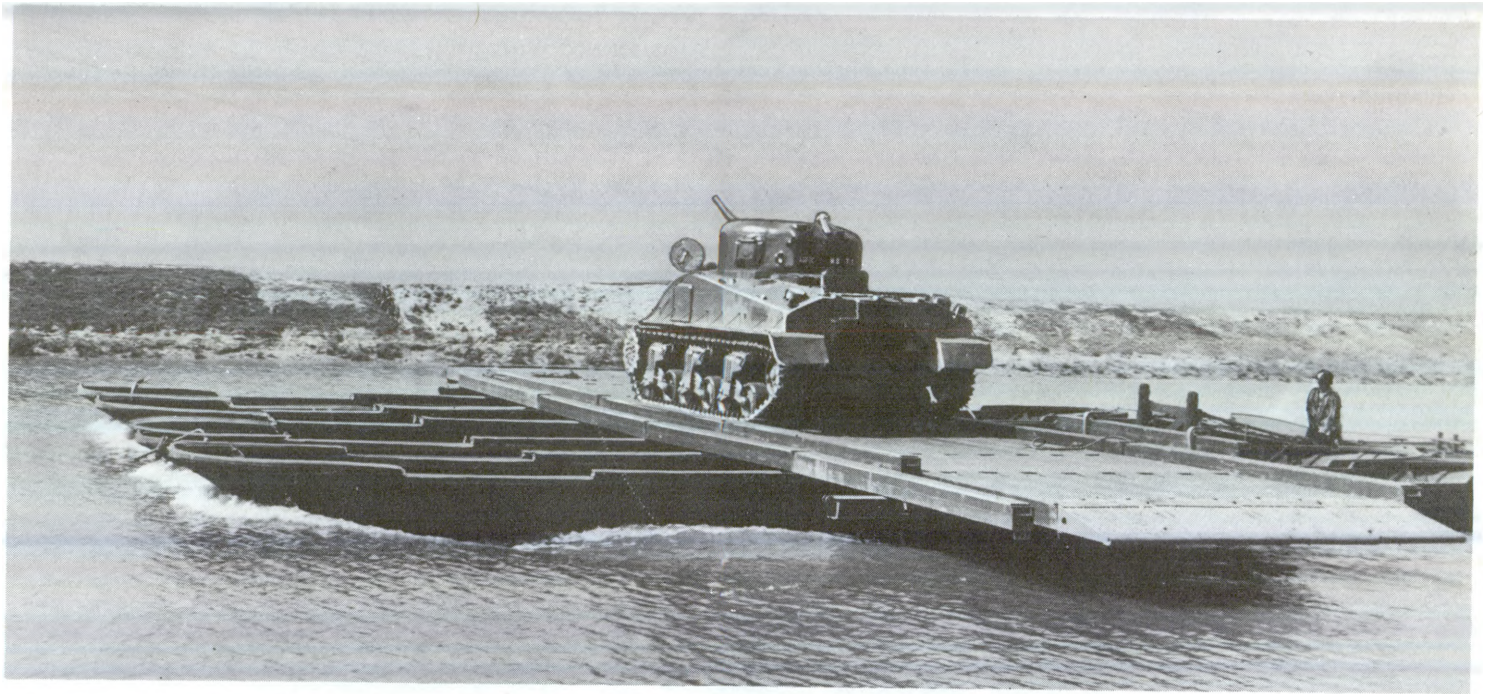


Figure 3. Four-ponton M4 ferry, shortened.

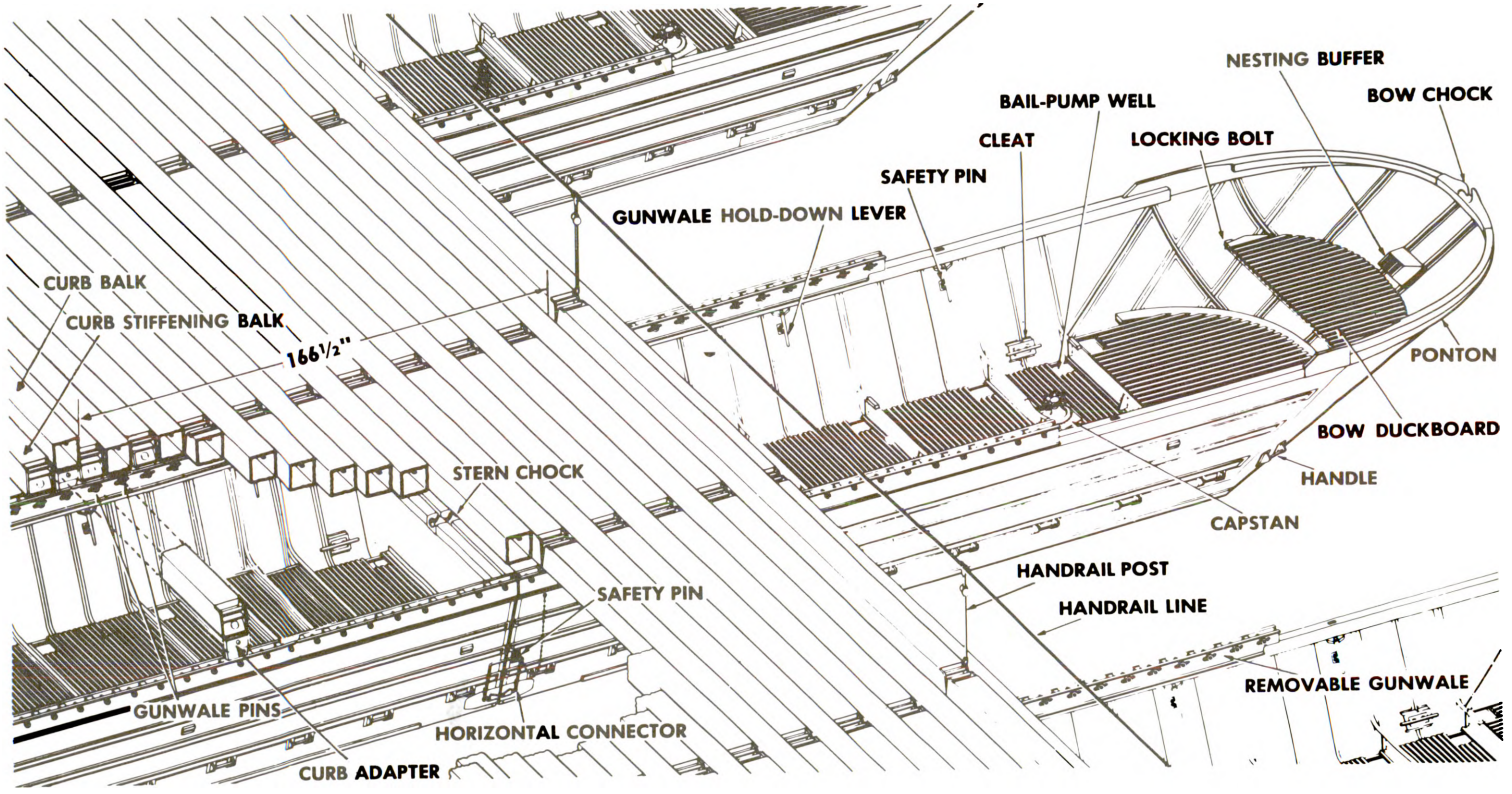


Figure 4. Nomenclature of deck and pontons, floating bridge, M4.

wide which provides a roadway 166½ inches wide inside-to-inside of curb balk.

f. Floating Spans. Floating spans of the normal bridge are supported on whole pontons which are formed by fastening half-pontons together stern-to-stern. Normally whole pontons are spaced 15 feet apart center-to-center, except at each end of the bridge where three pontons are 7 feet 6 inches center-to-center as shown in figure 5. In the fully reinforced bridge, reinforcing whole pontons are placed between all whole pontons of the normal bridge, thus producing a spacing of 7 feet 6 inches between centers of floating supports. The bridge may also be only partially reinforced, as shown in chapter 5. The end span is reinforced by a superimposed span in order to utilize the capacity of the reinforced floating bridge (fig. 6).

g. Shore Connections.

(1) The type of assembly used between the ends of floating spans and the shore connection depends primarily upon the variation in river stages to be provided for, steepness and length of bank at point of landing, and characteristics of stream bed along the shore at place of crossing.

(2) Continuous-deck connections must always be used between shoreward floating supports and fixed supports at the shore (figs. 5 and 7).

(3) Aluminum pontons cannot be grounded safely under load because of the probability of being punctured. However, pneumatic floats may replace aluminum pontons (fig. 8), because they can be grounded under load without damage, provided sharp objects are not present or are removed from the stream bed. When pneumatic floats are used, the stillwater classes given in table I are reduced by 10. The bottoms of grounded pneumatic floats wear through after long continuous use and require replacement. The use of floating type supports in shallow water areas of shoreward ends of floating bridges frequently may be eliminated in bridges being used for extended periods by placing a shallow fill or by using a standard or improvised trestle.

(4) Trestles are used where the shore connection is made to a high bank, where moderate variations in water level are anticipated, or where long shallow-water approaches must be crossed. The number of trestles required for grade adjustment is determined by the range of water-level fluctuation and maximum permissible slope of the deck. If trestles are used, every precaution must be taken to provide adequate bearing under trestle shoes. A minimum of two trestle-bracing struts is used at each trestle column. Cross-bracing (fig. 7) is the most satisfactory trestle bracing. When long spans requiring trestles are used, additional trestle-bracing struts

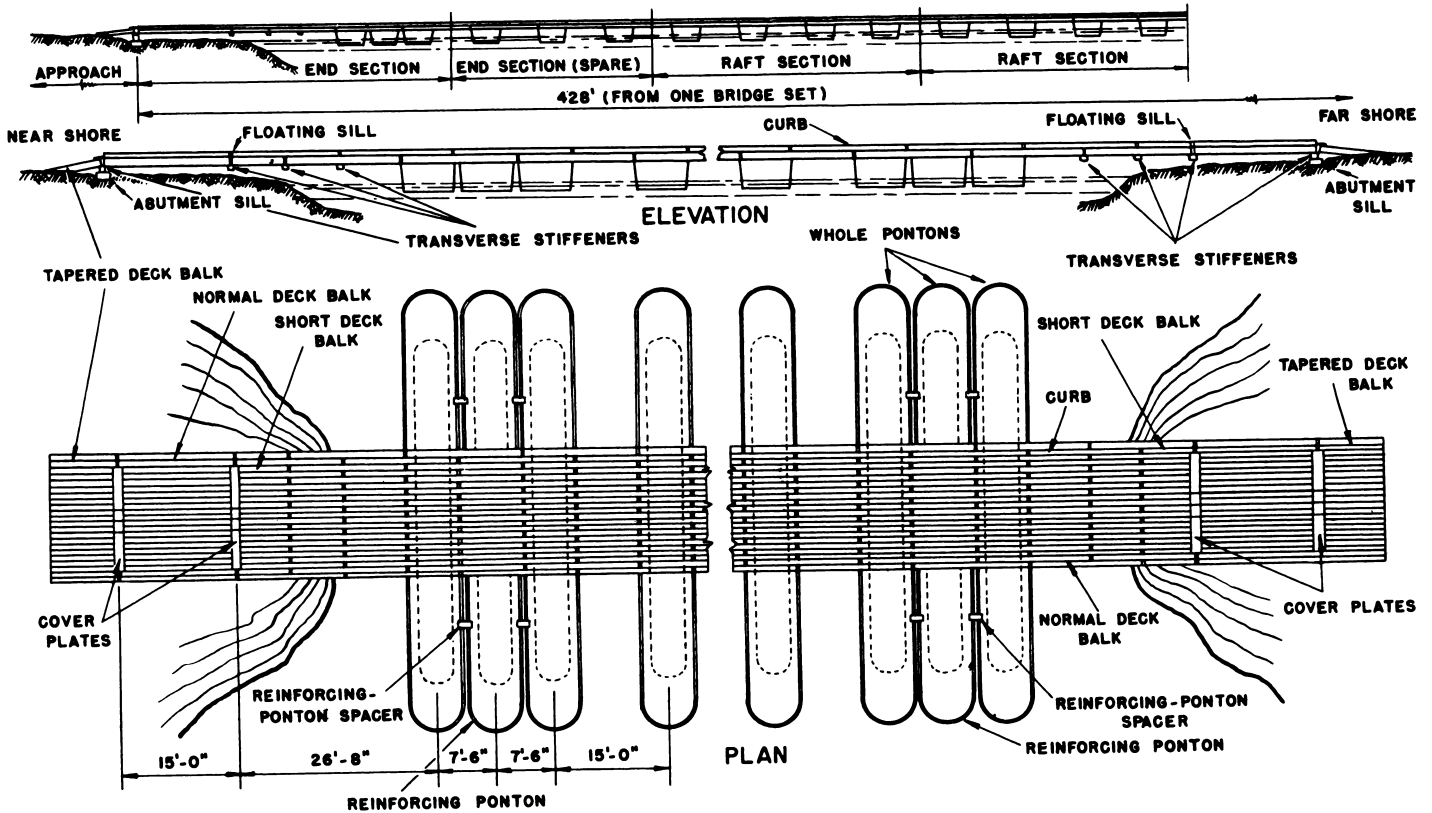


Figure 5. Floating bridge, M4.

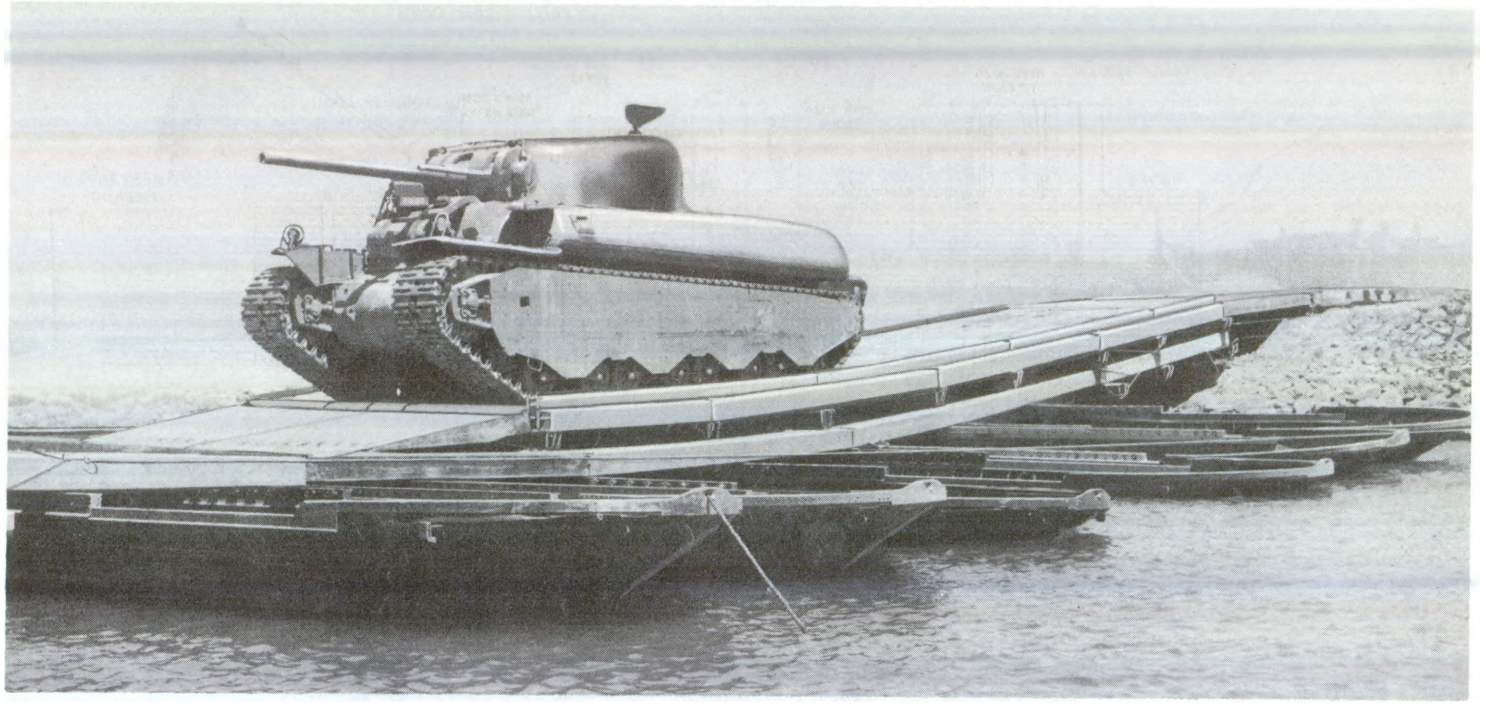


Figure 6. Superimposed end span for reinforced bridge.

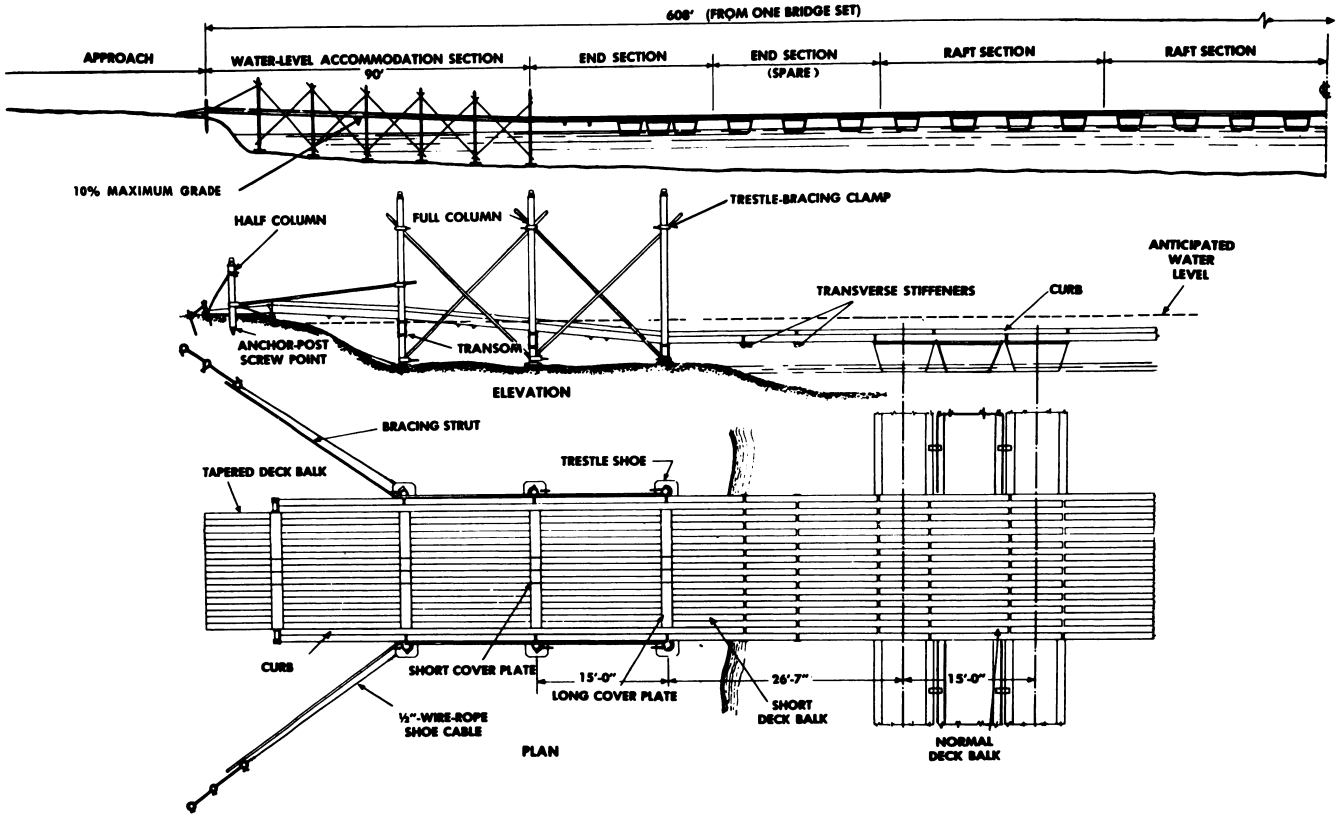
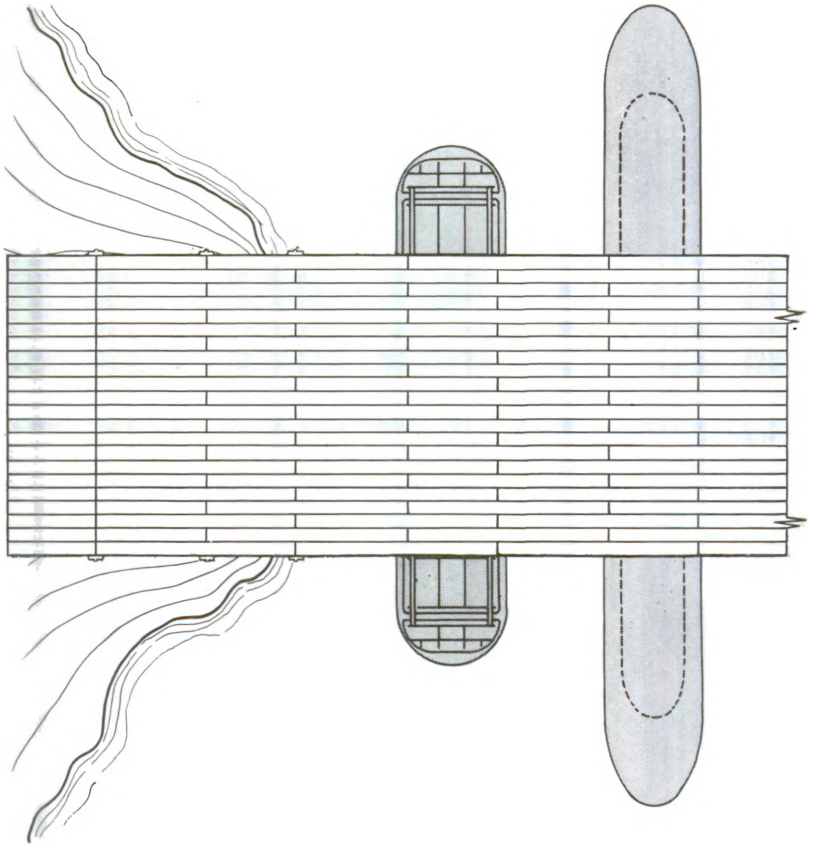
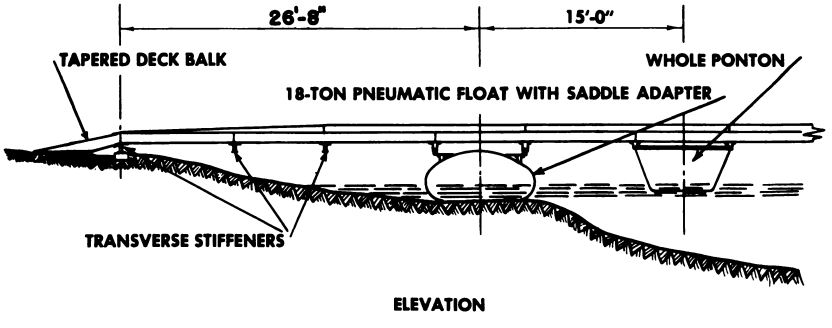


Figure 7. Floating bridge, M4, with trestles used in shore connection.



PLAN



ELEVATION

Figure 8. Floating bridge, M4, with grounded 18-ton pneumatic float in end section.

and bracing clamps will have to be requisitioned. Typical arrangements for adjusting end spans are shown in figure 7. For large, rapid fluctuation in stage, such as on tidal estuaries, the equipment available in the standard bridge set is inadequate. The change in height of the stage usually determines whether trestles are used or whether changes in end spans are made.

4. Classes

a. Floating Bridges. Table I indicates the classes of the floating bridge, M4, for normal and reinforced assembly in various current velocities.

Table I. Classes of Floating Bridges, M4, in Various Current Velocities

Type of assembly	Stream velocities in fps for specified crossings														
	Normal					Caution					Risk				
	3	5	7	9	11	3	5	7	9	11	3	5	7	9	11
Normal [a]	60	60	50	35	20	65	65	55	45	30	70	70	60	50	40
Reinforced [b]	100	100	100	70	40	105	105	105	85	55	110	110	110	100	70

[a] Bridge assembled with 23-foot end span with reinforcing ponton. Abutment elevation range is minus 10″ to plus 20″ (elevation of deck at abutment in relation to deck in floating section under no load). Deck consists of 22 balk with an 18-balk roadway. The 280-mm gun, T-131, on carriage T-72 and transporter T-10 can safely cross the M4 floating bridge when the bridge is assembled for class 50 loading.

[b] Bridge 100 percent reinforced with full pontons. Bridge assembled with a 23-foot end span with a 38-foot superimposed deck. Abutment elevation range is minus 10″ to plus 20″. Deck of the floating bridge is 24 balk with a 20-balk roadway. End spans are 22 balk with an 18-balk roadway.

b. Ferries. Table II indicates the classes of different types of ferries, in various stream velocities. Considerable care is required in

Table II. Ferry Classes, M4 Ferries (18-Balk Roadway)

Type	Stream velocities in fps for specified crossings									
	Normal					Risk				
	3	5	7	9	11	3	5	7	9	11
4 pontons (fig. 72):										
Load class	55	55	55	55	45	60	60	60	60	50
Number of 27-foot bridge erection boats required	1	1	1	1	2	1	1	1	1	2
6 pontons (fig. 75):										
Load class	75	75	75	70	55	80	80	80	80	60
Number of 27-foot bridge erection boats required	1	1	1	2	2	1	1	1	2	2
7 pontons (fig. 76):										
Load class	90	90	90	85	60	95	95	95	95	70
Number of 27-foot bridge erection boats required	1	1	1	2	3	1	1	1	2	3

loading and unloading vehicles weighing more than 50 tons. Vehicles are loaded on centerline of ferry or slightly downstream (maximum eccentricity is 6 inches).

c. Fixed Bridges. Table III indicates the classes of different fixed-bridge spans.

Table III. Classes of Fixed Bridges [a]

Overall span (ft)	Total number balk in width	Class		
		Normal	Caution	Risk
23 (fig. 84)	22	100	100	100
30 (fig. 85)	22	[b] 60	[b] 80	90
38 (fig. 87)	22	35	55	60
45	22	25	40	45

[a] Classes are for an 18-balk roadway. Transverse stiffeners are used at the abutments in place of abutment shoes and curbs must be effective for the full span.

[b] The 280-mm gun T-131, on carriage T-72 and transporter T-10, is a class 98 vehicle but can safely cross spans having a length of 30 feet.

5. Assembly

a. Ferry Assembly Times. Ferry assembly times are given in table IV. These values are based on the experience of engineer bridge and construction units under advanced field training conditions. Since there are numerous variables involved in the assembly of any ferry, the values in table IV should be used as a guide only.

b. Bridge Assembly Times.

(1) The assembly time required for any floating bridge may be affected by any of the following conditions, none of which is constant for all situations: approach road work; site preparation; abutment preparation; near-or far-shore end sections; installation of trestles; installation of anchorage system; state of training, physical condition, and number of troops; enemy interference; weather; mechanical or operational difficulties; blackout conditions; current velocity; length of bridge.

(2) Time must be allotted for the initial preparation of access roads, abutments, and assembly sites. This time will vary greatly, in most cases from 1 hour to as much as 12 hours or more, depending on applicable factors from those given above.

(3) In order to determine a total time required for the assembly of an M4 floating bridge, appropriate time must be allowed for each of the many items given above. These items include all time-consuming actions except the actual assembly of the floating bridge. For this, a normal rate of assembly for

experienced troops is about 4 feet per minute for normal assembly (assuming a sufficient number of raft assembly sites are operated). The value of 4 feet per minute is not to be used alone in estimating the time required for assembly of floating bridges.

(4) An experienced floating bridge company assisted by an engineer combat or construction company can prepare the sites and assemble the M4 floating bridge approximately as follows:

150 feet— 3 hours.
250 feet— 5 hours
500 feet— 8 hours
1000 feet—14 hours

Table IV. Time and Manpower Required for Assembly of M4 Ferries

Type of assembly	Assembly unit	Time required* (hr)
4-ponton ferry, 15-foot spacing	1 platoon	2
4-ponton ferry, short deck	1 platoon	2
Normal ferries, reinforced:		
(1) 5-ponton	1 platoon	2½
(2) 6-ponton	1 platoon	3
(3) 7-ponton	1 platoon	3½
5-ponton ferry, short deck	1 platoon	2½

*For night assembly, increase time 50 percent.

6. Composition and Issue

The unit of issue of the floating bridge, M4, is a set which provides sufficient material for the assembly of approximately 600 feet of bridge using pontons, pneumatic floats, and trestles. This same bridging equipage is used in assembling fixed bridges and ferries, or a combination of fixed and floating bridges. Appendix II lists the component parts of a basic bridge set. Equipment and materials required for the transportation, assembly, employment, and maintenance of the bridge are provided in the authorized equipment of the Engineer Ponton Bridge Company, T/O & E 5–139A.

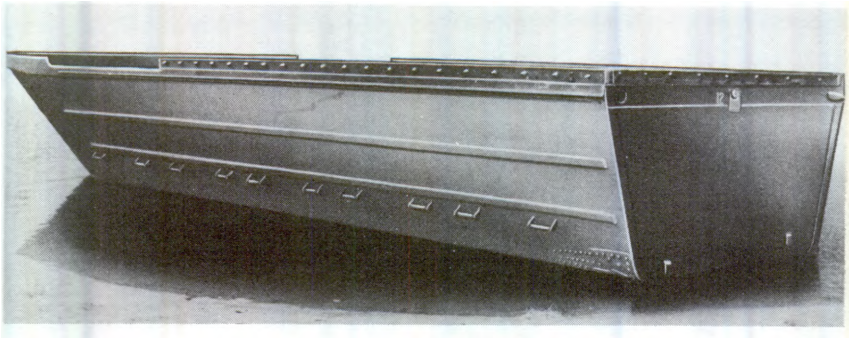
CHAPTER 2

DESCRIPTION OF EQUIPMENT

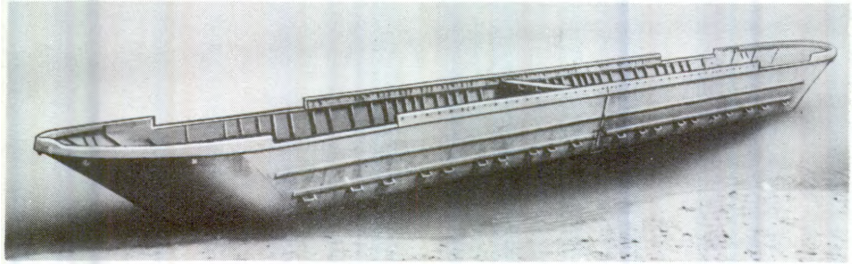
Section I. COMPONENTS OF THE BRIDGE SET

7. Half-Ponton

a. General Description. The aluminum-alloy half-ponton (fig. 9) is 29 feet 7⅝ inches long overall, 6 feet 11 inches wide at the gunwales, and 3 feet 4½ inches deep except at the bow where the gunwale is raised 3½ inches. Gunwales are 6 feet 8 inches center-to-center. At 6 inches freeboard the half-ponton has a displacement of 26,500 pounds. Sides and bow of the half-ponton slope inward, permitting two or more to be nested for transporting or storing. The stern of the half-ponton is square and carries fittings which permit two half-pontons to be joined stern-to-stern, forming a whole ponton. Each half-ponton weighs approximately 1,750 pounds.



① Half-ponton



② Whole ponton

Figure 9. Ponton.

b. Duckboards. Light removable duckboards cover the bottom of the half-ponton. Openings in some sections of the duckboard permit use of bail pumps. During transport, all duckboards except those at the bow remain in place; bow duckboards are removed and carried on the bed of the transporting vehicle in order to permit nesting of the half-pontons.

c. Chocks. There is one anchor chock at the bow and one at the stern of each half-ponton.

d. Capstan. A capstan in the bottom of the half-ponton near the bow is used to tighten anchor lines or bridle lines (fig. 10). Holes in the capstan receive rack-sticks for turning the capstan. When not in use, rack-sticks are carried in spring clips on the bulkhead nearest the capstan.

e. Cleats. Each half-ponton has four cleats in the bottom, two near the bow and two near the stern, for securing anchor lines or mooring ropes and for lifting the ponton.

Figure 10. Capstan.

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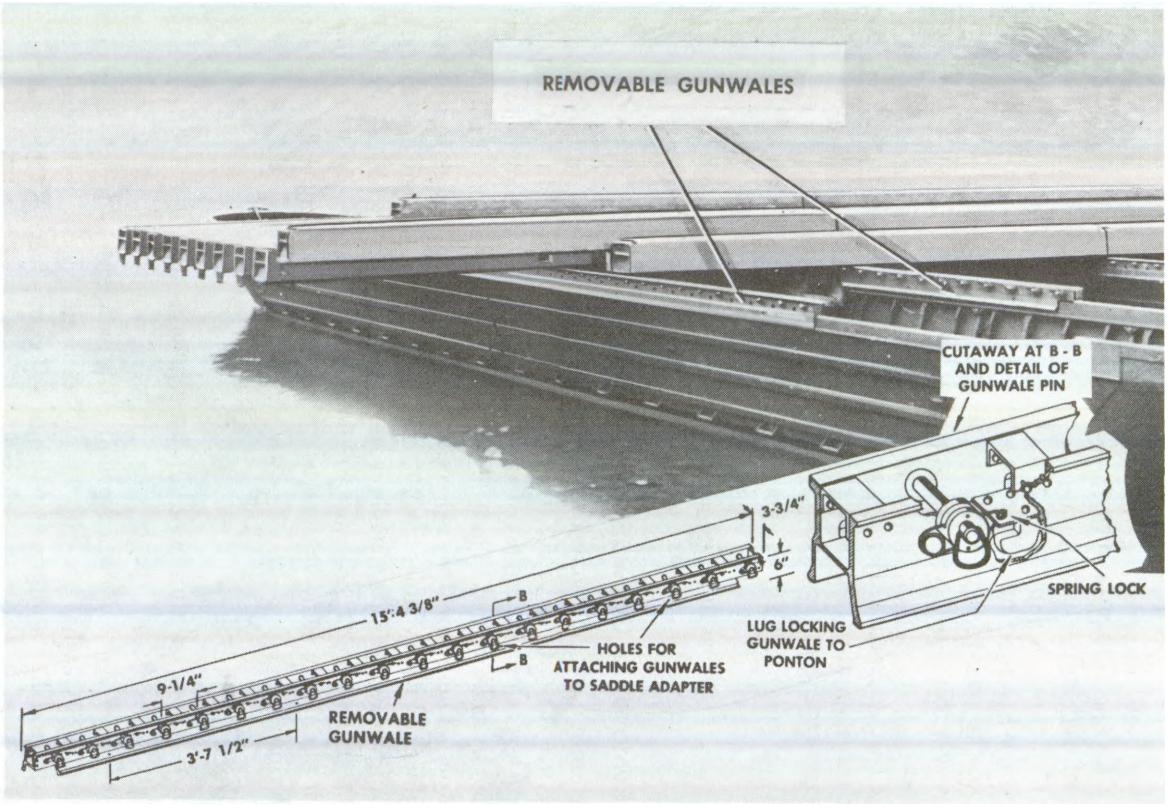

Figure 11. Removable gunwales.

f. Ponton Connections. Half-pontons are locked together stern-to-stern by fittings at the top of the transoms and along the sides.

(1) *Upper connections.* There is a stud near the upper right corner and a matching recess near the upper left corner of the stern of a half-ponton (fig. 9). When two half-pontons are brought together stern-to-stern, the stud and recess of one half-ponton fit those of the other. A pin chained inside each half-ponton on the recess side is dropped vertically through holes in each recess and stud to lock the half-pontons together.

(2) *Lower connections.* Half-pontons are joined near the bottom by a double-headed horizontal connector which joins lugs on the sides of the ponton. (See fig. 54 (step 4).) The connector has a U-shaped handle. Stop lugs on the handle and ponton hold the connector in the connecting lugs, and a safety pin holds the connector handle against the side of the half-ponton. The connector and its safety pin are attached to the half-ponton by a chain. During transit, the connector is carried in spring clips on the inside of the ponton. A spare connector is attached to the inside of each half-ponton.

8. Removable Gunwales

Aluminum-alloy removable gunwales, which are 15 feet 4⅜ inches long, are fastened to each fixed gunwale of a half-ponton by two hold-down levers on the inside of the ponton. The hold-down levers are locked by safety pins. These levers permit quick release of a damaged ponton. The gunwales are recessed to permit balk lugs to be seated in place. Twenty holes on 9¼-inch centers are drilled horizontally through each gunwale to receive steel gunwale-pins, which secure balk to the gunwale. These pins are locked to the gunwale by springs. Each removable gunwale weighs approximately 135 pounds complete with pins (fig. 11).

9. Deck Balk

Three types of aluminum-alloy deck balk are used in the bridge (fig. 12).

a. Normal Deck Balk. Normal deck balk are 14 feet 11¾ inches long, and 8¾ inches wide by 9¼ inches high. Each balk weighs 225 pounds, and has a volume of about 8½ cubic feet. It has carrying handles at each end. Four lugs on the underside enable the balk to be fastened to removable gunwales, transverse stiffeners, and abutment shoes. Balk are watertight and float with a net displacement of approximately 300 pounds (the difference between the gross displacement of 525 pounds and the balk weight of 225 pounds) and thus will

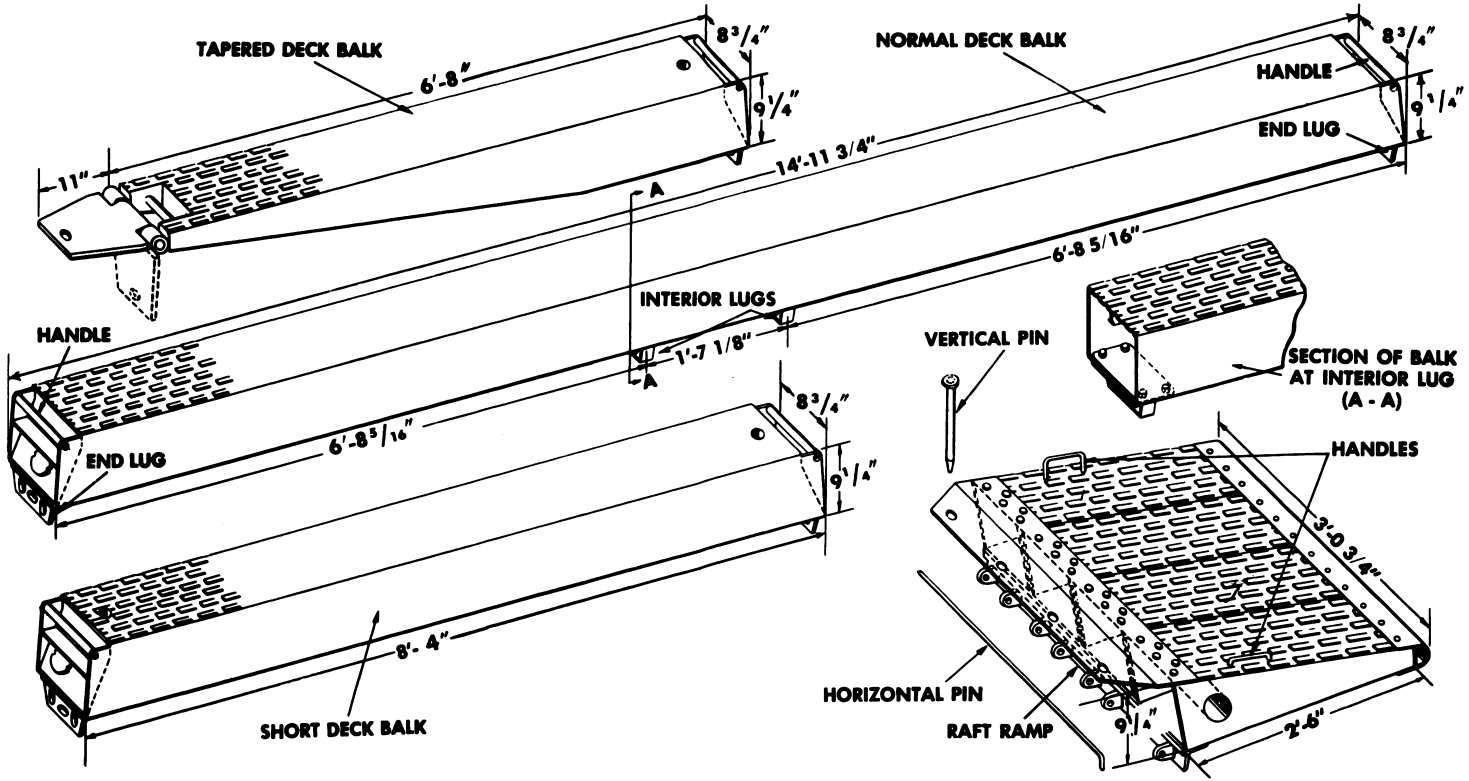

Figure 12. Deck units.

support a superimposed load of that weight. Twenty-two normal balk are used in each 15-foot span of the normal bridge.

b. Short Balk. Short deck balk are 8 feet 4 inches long, have the same cross-sectional dimensions as normal balk and occupy a position in the bridge deck 8 feet 4 inches in length. One short balk weighs 122 pounds and has a net displacement of 160 pounds. Carrying handles are the same as on normal balk. Short balk have lugs on the underside near each end, but have no interior lugs. Short balk are used in the end spans of the bridge and in spans adjacent to trestles to fill the gaps in the deck caused by the staggered formation of the normal balk; and their length is the difference between the 15-foot normal balk and the 6-foot 8-inch distance between centers of ponton gunwales.

c. Tapered Balk. Tapered balk are 6 feet 8 inches long and weigh 110 pounds each. The fittings and cross section at one end are the same as for the normal and short balk. The underside of the balk tapers upward from a point 1 foot 11 inches from the end with normal cross section to the opposite end where the balk thickness is 2⅜ inches. The tapered end has a hinged plate which can swing downward for attachment to a transverse stiffener, abutment shoe, or trestle, thus enabling the top of the balk to remain flush with the roadway surface. Tapered balk are used on the shore side of the bridge abutment to provide a sloping approach to the bridge deck and to fill gaps in the deck caused by staggered normal balk under certain conditions.

10. Transverse Stiffener

Transverse stiffeners (fig. 13) are built-up aluminum-alloy beams 17 feet 9 inches long which serve to tie together the deck balk in end spans or in fixed spans more than 15 feet long, and are also used at the ends of bridges and ferries. Deck balk are fastened to transverse stiffeners by pins identical to those used with removable ponton gunwales. Each transverse stiffener is issued complete with pins and weighs 388 pounds.

11. Curb Adapter

Steel curb adapters (fig. 14) are used to raise a normal deck balk about 6 inches above the level of the basic deck to provide curbing. Three adapters are used for each normal balk on all types of bridges and ferries, except where the balk is the end member of a bridge or ferry, and then only one adapter is used at the high end. These adapters are anchored by pins to the gunwales of each ponton or to a transverse stiffener. Each adapter weighs about 15 pounds.

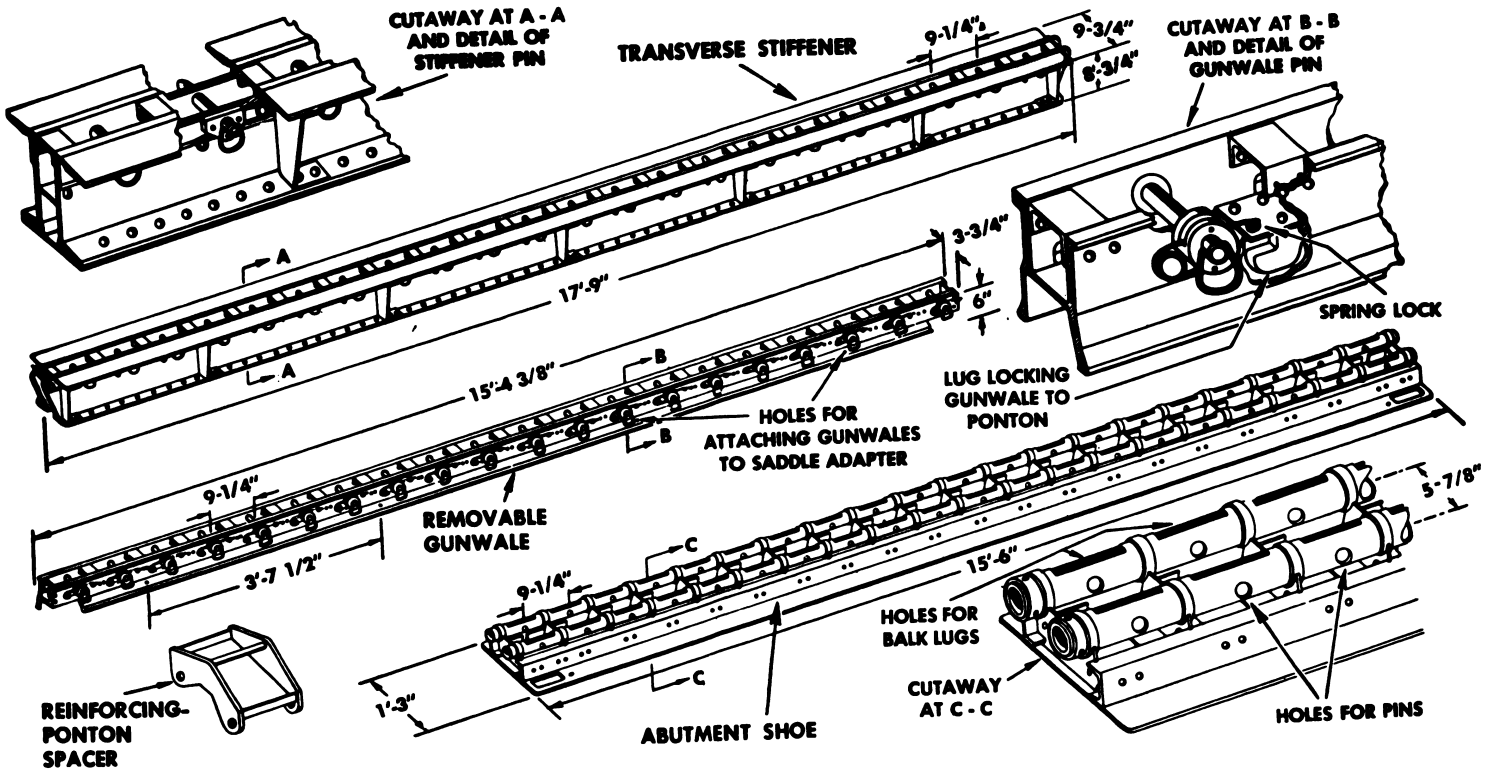

Figure 13. Deck connecting members.

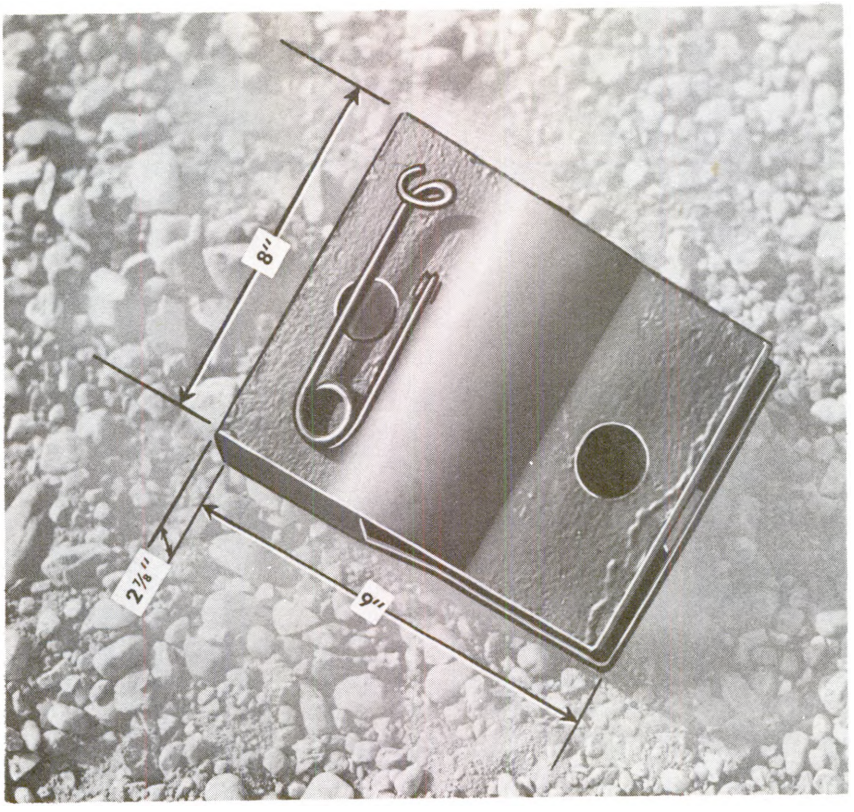

Figure 14. Curb adapter.

12. Abutment Shoe

a. Abutment shoes (fig. 15) are 15 feet 6 inches long. The shoe is fabricated into a structural member, the principal parts being a bearing plate 15 inches wide, two stiffening channels, and two perforated tubes. An abutment shoe weighs about 390 pounds. Usually this shoe does not provide sufficient bearing and should be set on a prepared footing or timber sill.

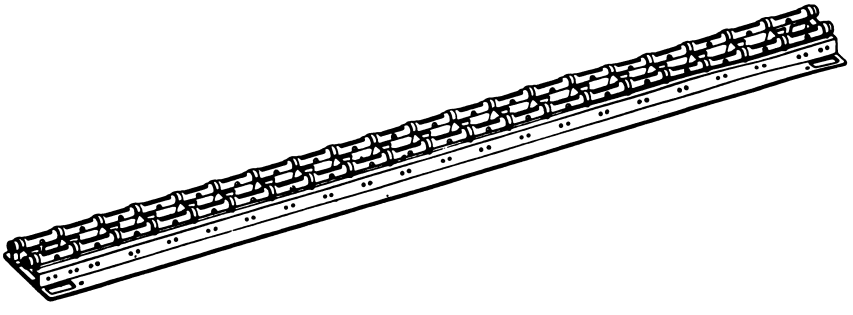

Figure 15. Abutment shoe.

b. Since the abutment shoe has recesses for only 20 balk, it can be used only by omitting the end balk outside the curb. When this is done the classes given in table III must be reduced by 15 percent.

13. Cover Plates

Aluminum-alloy cover plates (fig. 16) are used over joints in the deck at abutments and trestles to protect balk handles from being damaged by metallic lugs of tracked vehicles. Two short cover plates,

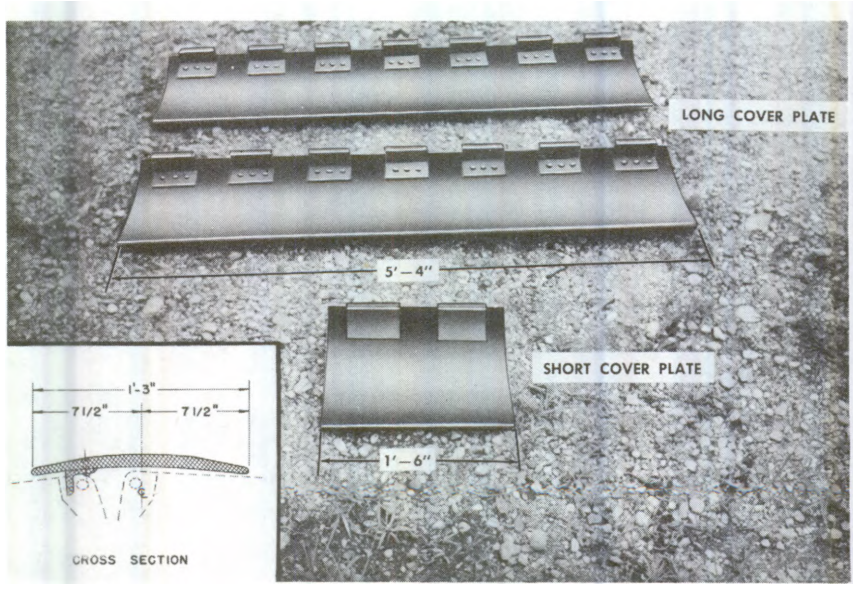

Figure 16. Cover plates (shown in inverted position).

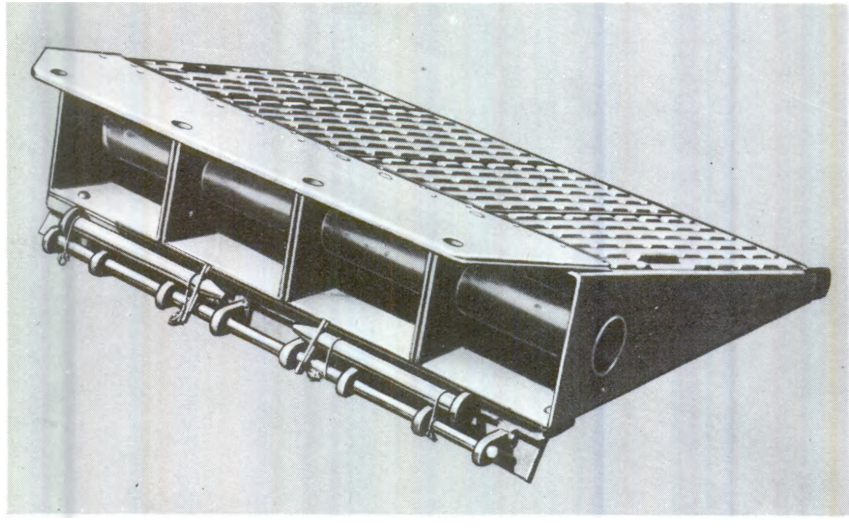

Figure 17. Ferry ramp.

1 foot 6 inches long, and two long cover plates, each 5 feet 4 inches long, are required to cover the normal width of the bridge deck. Wider roadways require additional plates. Short cover plates weigh 28 pounds; long cover plates, 97 pounds.

14. Ferry Ramp

Four aluminum-alloy ferry ramps (fig. 17) are used at each end of a ferry to provide a sloping approach. The ramps are placed in the center so that each outside balk is left without a ramp approach. This tends to assure that vehicles will load in a centerline position. Ferry ramps are 3 feet ¾ inches wide, have an effective length of about 3 feet and weigh 236 pounds (fig. 12). They are 9¼ inches high and taper to about 2 inches high.

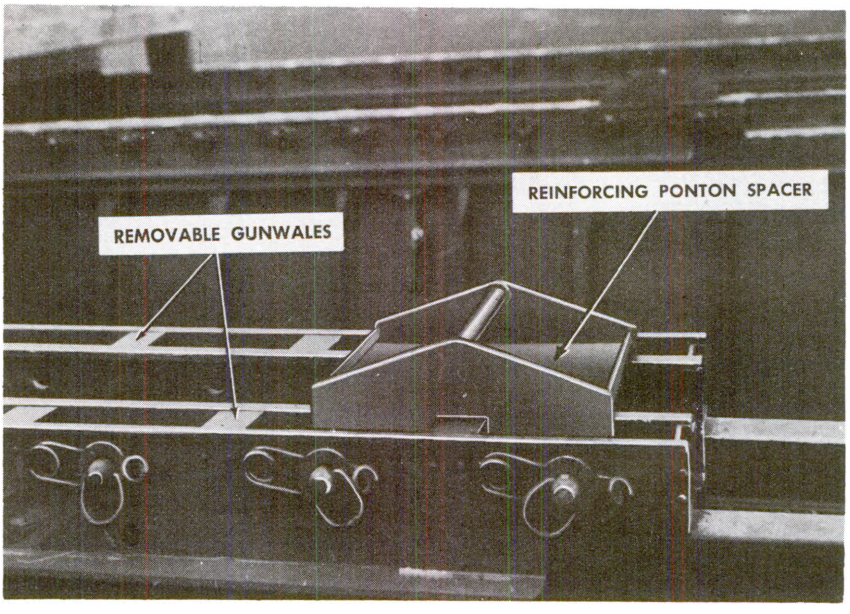

Figure 18. Reinforcing-ponton spacer.

15. Reinforcing-Ponton Spacer

Reinforcing-ponton spacers (fig. 18) are used to secure reinforcing M4 half-pontons to adjacent M4 half-pontons when assembling a reinforced ponton bridge or ferry. The spacers are pinned to the ends of removable ponton gunwales by the same type pins used in securing balk. Each spacer weighs 18 pounds.

16. Clamp, Balk (Pusher)

Pusher balk clamps (fig. 19) are used to secure a standard deck balk to the near gunwales of two adjacent half-pontons. During ferrying or rafting operations, the bow of a bridge erection boat pushes against the beam thus formed and propels the raft or ferry in this manner.

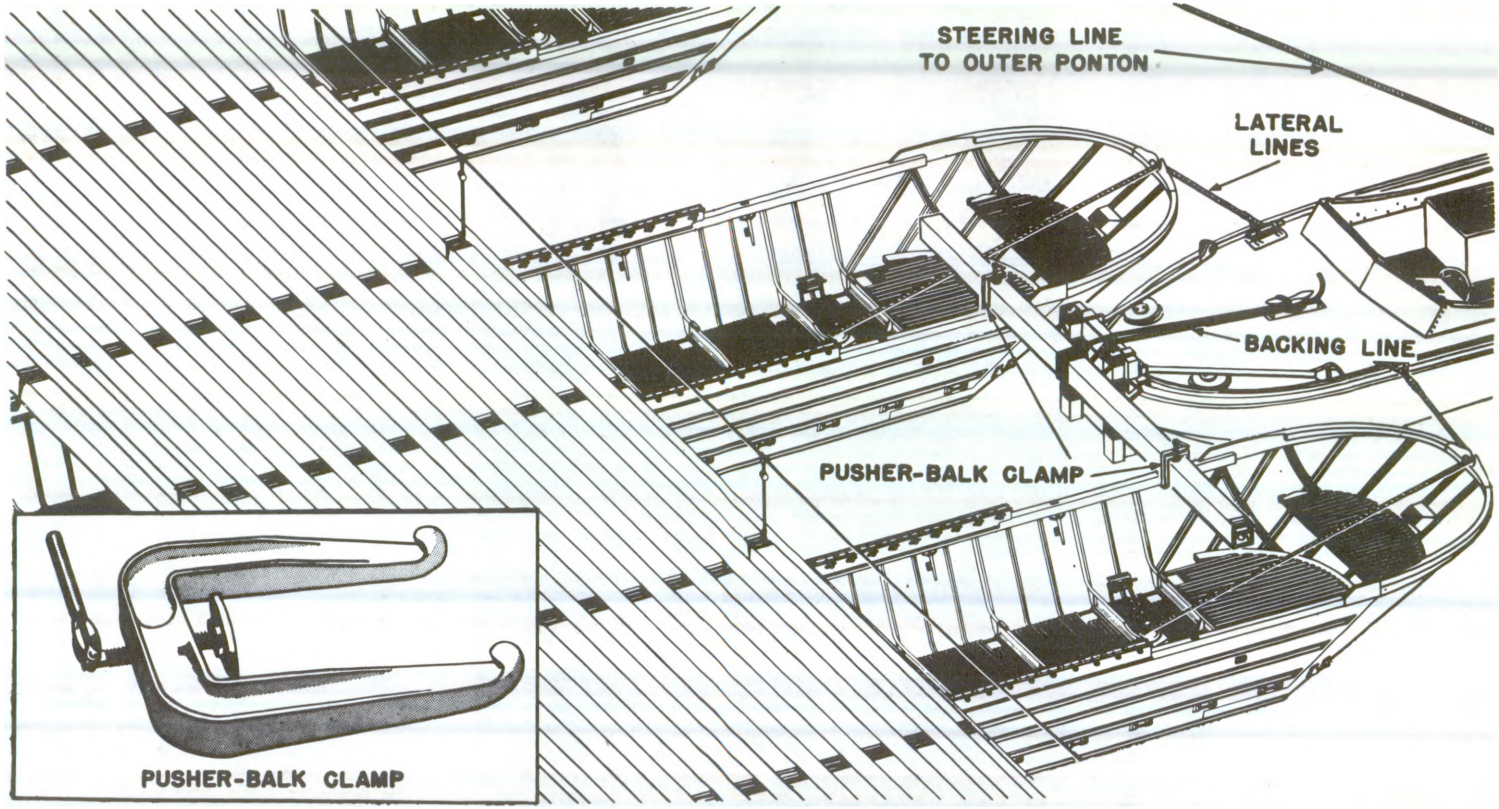

Figure 19. Clamp, balk (pusher).

17. Trestles and Trestle Bracing

Trestles (fig. 20), with bracing, provide intermediate supports for multiple-span fixed bridges or to accommodate changes in water level.

a. Trestle. The trestle proper consists of the following items:

Quantity	Item	Unit wt (lb)
1	Transom	1, 680
2	Column, full	330
2	Shoe	220
2	Bracket, chain-hoist	20

The top of the transom is fitted with recesses to accept 22 balk lugs and has 22 horizontal holes through which the adapter pins are inserted to hold the balk in place. The transom is pinned to each column by a pin 1¾ inches in diameter and 11⅜ inches long. Holes in the column are on 6-inch centers; two holes in the transom at 9-inch centers permit 3-inch adjustments in transom height. The transom is raised and lowered when the roadway over the transom is not loaded. Hoists are slacked off or removed after adjustment has been made.

b. Trestle Bracing. Trestle bracing gives lateral and longitudinal stability to trestles. The following trestle-bracing equipment (fig. 21) is issued with each trestle:

Quantity	Item	Unit wt (lb)
4	Strut, bracing	145
8	Clamp, bracing	50
4	Screw point, trestle bracing	17
2	Wrench, special	13

In addition to the above equipment, half-columns may be included as anchor posts. A special wrench is used to tighten column connectors, to remove the shoe coupling from the trestle shoe, and to force column sections apart.

18. Accessories

The following accessories are issued with the M4 bridge set:

a. Handrail Post. Handrail posts (fig. 22) are metal rods 3 feet 3 inches long used to mark the roadway of bridges. The lower end has a fitting which fits in the handles of the balk used as curbs. The upper end has a fitting for a handrail line. The post has detachable luminous markers on each side to guide drivers and foot traffic at

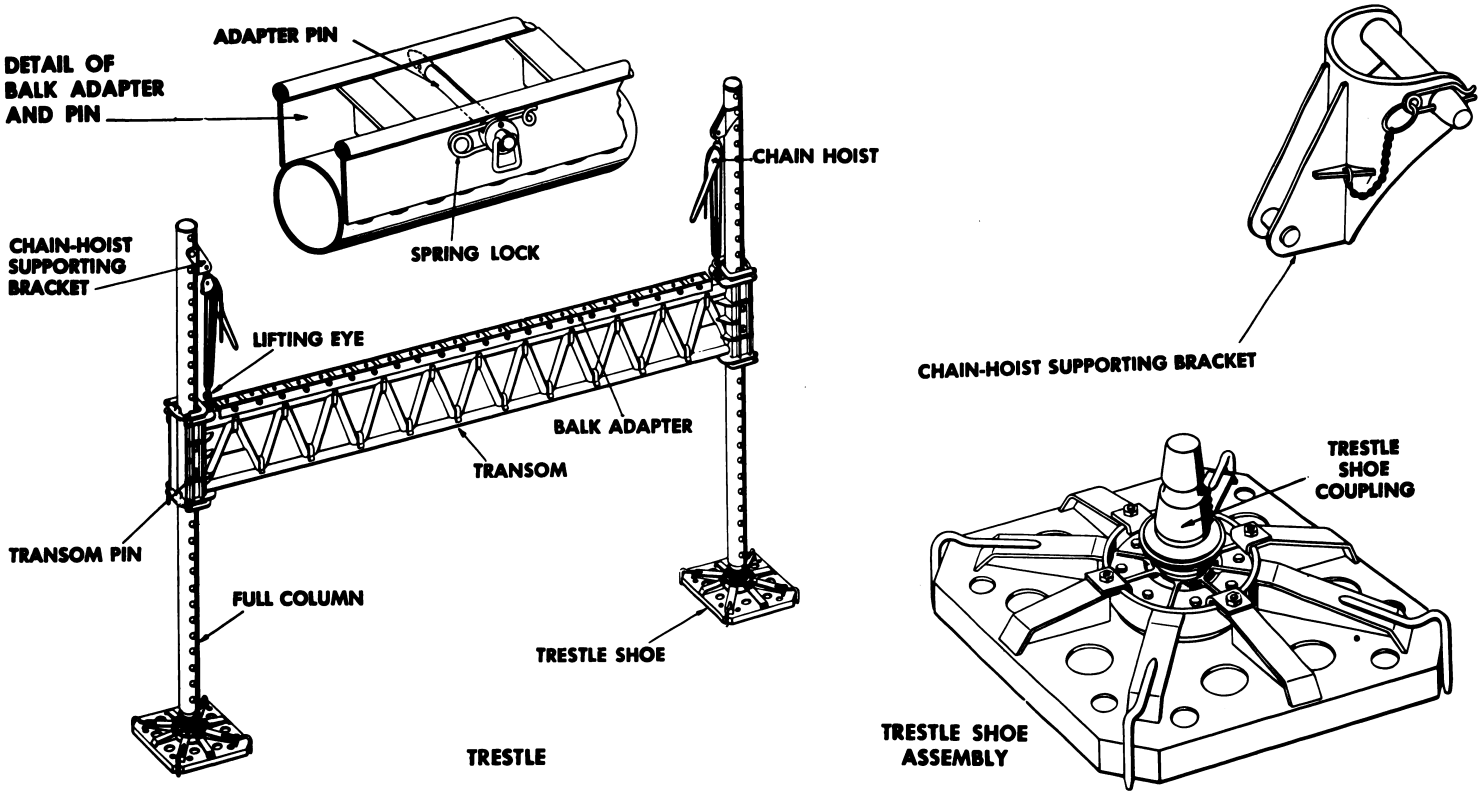

Figure 20. Trestle.

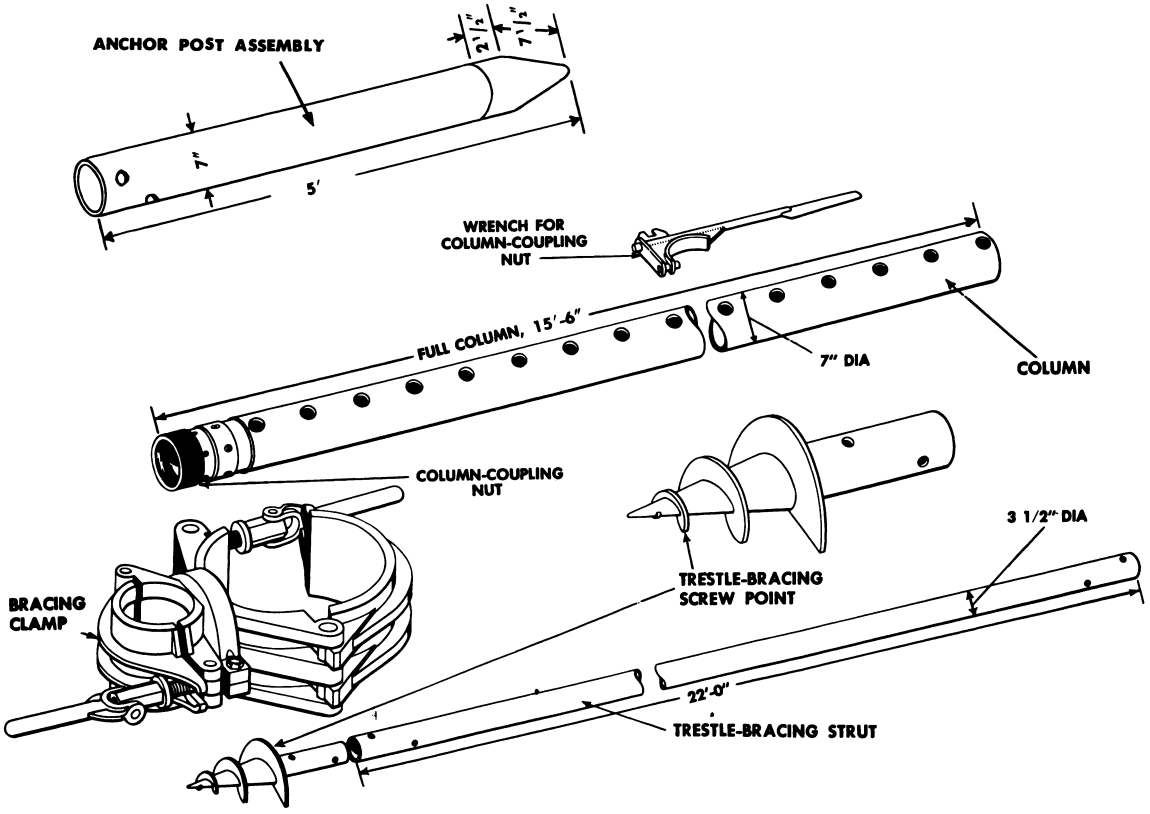

Figure 21. Trestle columns, trestle bracing, and accessories.

night. The markers are issued and normally carried separately in a lead-lined case. Handrail posts are used on each side of the roadway at each curb joint. One-half-inch rope threaded through the upper fittings serves as a handrail line.

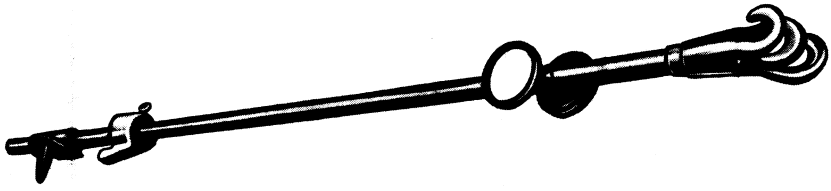

Figure 22. Handrail post with attached luminous marker.

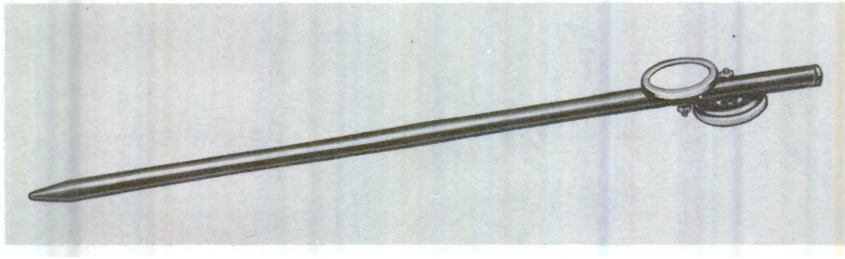

Figure 23. Approach post with attached luminous marker.

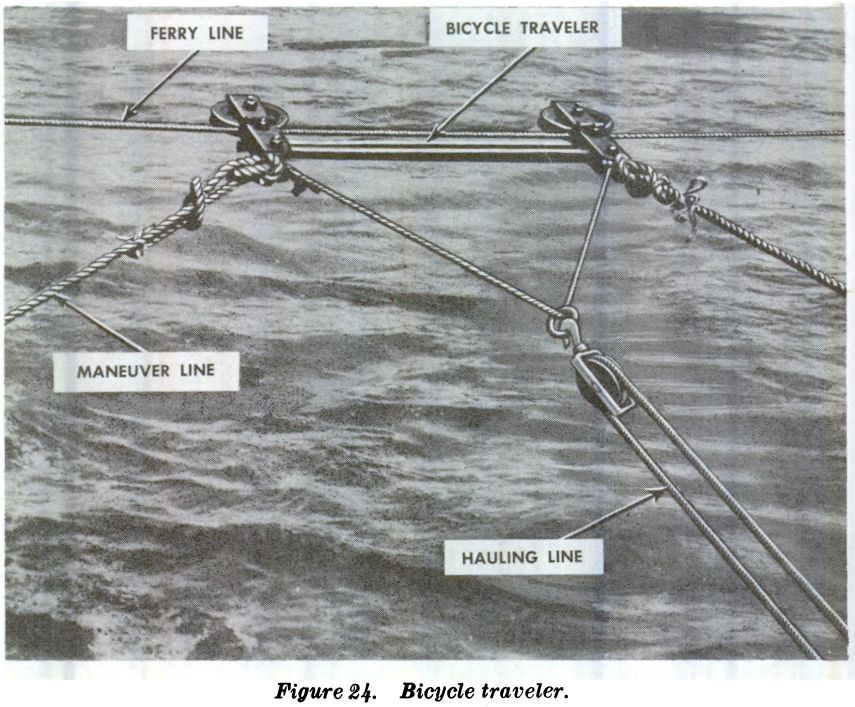

Figure 24. Bicycle traveler.

b. Approach Post. Approach posts (fig. 23) are similar to handrail posts. They are 2 feet 2 inches long and pointed at one end to facilitate driving into the ground. They are fitted with two detachable luminous markers to guide traffic at night. The markers are issued and carried separately.

c. Pumps. One ponton-bailing pump accompanies each whole ponton and is used to keep pontons dry while the bridge is in use.

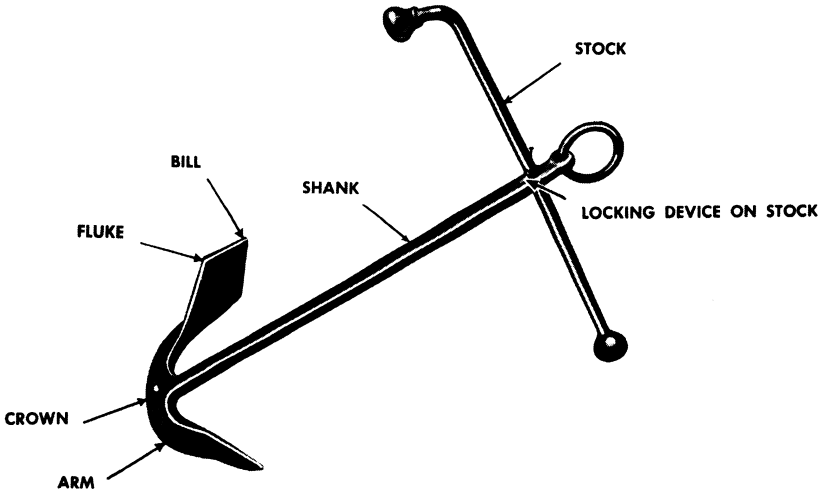

Figure 25. Standard kedge anchor.

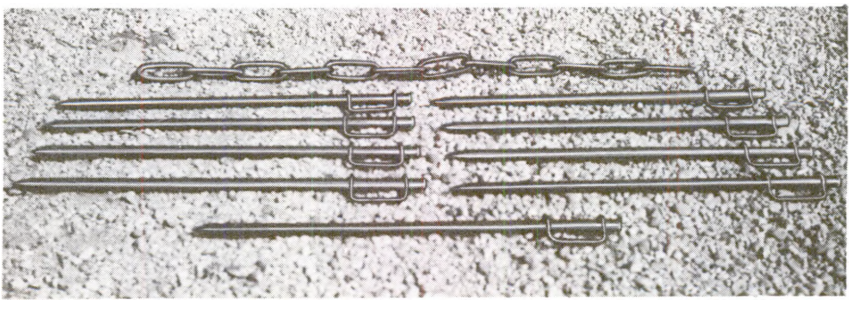

Figure 26. Component parts of holdfast.

d. Bicycle Traveler. The bicycle traveler (fig. 24) is used for attaching a raft or ferry to an overhead cable as a trail ferry when a power boat is not necessary or available.

e. Anchor. Standard kedge anchors (fig. 25) weighing 100 pounds are issued on the basis of one per two half-pontons. Anchors are used for anchoring bridges when stream conditions are suitable.

f. Holdfast. Prefabricated holdfasts for use as anchorages are issued with the bridge. Nine steel pickets and a length of chain compose each holdfast (fig. 26).

19. Erection Equipment

The following erection equipment is issued with the M4 bridge set:

a. Diving Outfit. A diving set No. 3 is used for miscellaneous diving operations, such as construction, repair of bridge in place, and salvaging of equipment. Instructions for use of the set are nailed on the inside cover of the chest.

b. Pioneer Equipment. The pioneer equipment sets No. 5 are issued with the bridge to provide pioneer tools for bridge assembly and approach preparation. The set is carried in a box which weighs about 1620 pounds when packed.

Figure 27. Rigging equipment set No. 1.

c. Repair Set No. 7, Pneumatic-Float, Large. A pneumatic-float repair set No. 7 is provided for maintenance of the 18-ton floats issued with the bridge. The set contains tools and supplies for repair of punctures, rips, or displaced rings. The set with chests weigh about 320 pounds coated.

d. Rigging Equipment Set. A rigging equipment set No. 1 (fig. 27) is provided for rigging and splicing of manila and wire rope.

e. Balk-Depressing Lever. When gunwale pins prove difficult to insert through balk lugs and removable gunwales because the holes are

not alined, the balk-depressing lever (fig. 28) is used to apply pressure to the top of the balk being pinned (par. 79*c*).

f. Aluminum-Equipment Repair Set. An aluminum-equipment repair set No. 10 is issued for the repair and maintenance of M4 aluminum floating bridges and ferries. This set consists of hand tools, parts and materials, and weighs about 315 pounds.

Figure 28. Balk-depressing lever.

20. Pneumatic Floats and Saddle Adapters

Eighteen-ton pneumatic floats and saddles are provided for use in shore connections of M4 bridges.

a. Pneumatic Floats. The 18-ton pneumatic float is a component part of the M4 bridge set and is used principally in making the shore connection of bridges, when rigid pontons or trestles are not as suitable. It is adaptable also as an intermediate support in fixed spans across shallow water and as a temporary support for end spans in ferry assembly. Detailed use of this float is given in subsequent chapters and in TM 5–266.

b. Saddle Adapters. By means of the saddle adapter (fig. 29) which is secured to the saddle beams of the float, the removable gunwale, pinned to the adapter, furnishes a means of securing the M4 deck balk at the same height as on the M4 rigid pontons. The M4 ponton and 18-ton pneumatic float may be used in combination, but because they have different capacities, such use is not usually practical or recommended. The saddle adapters are steel frames which connect removable gunwales to the saddles. Two adapters are used on each float. Removable gunwales are held to adapters by means of steel

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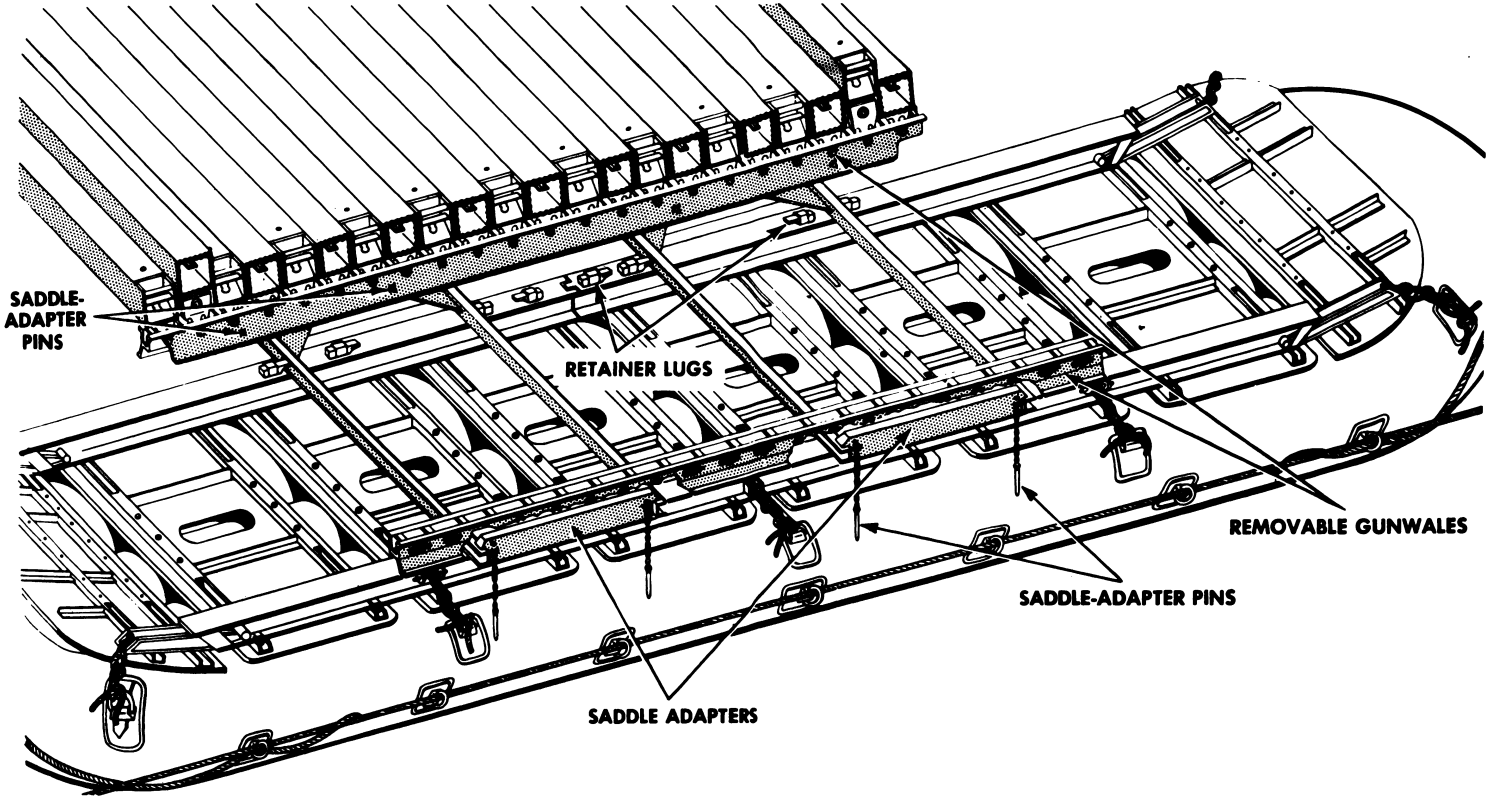


Figure 29. Saddle adapters on 18-ton pneumatic float.

pins which, in turn, are secured with safety pins. Each gunwale is fastened to adapters by four steel pins, two on each adapter. A saddle adapter weighs approximately 260 pounds.

Section II. T/O & E EQUIPMENT

21. General

A large variety of tools and equipment is provided for the assembly and maintenance of the bridge. The most important items are described below and the complete list of T/O & E equipment is given in T/O & E 5–139A.

22. Twenty-Seven-Foot Bridge Erection Boat

a. This twin-screw bridge erection boat has a two-section hull, fabricated in aluminum, and consists of a forward cargo-carrying section and a stern section which contains the engines and operator's cockpit

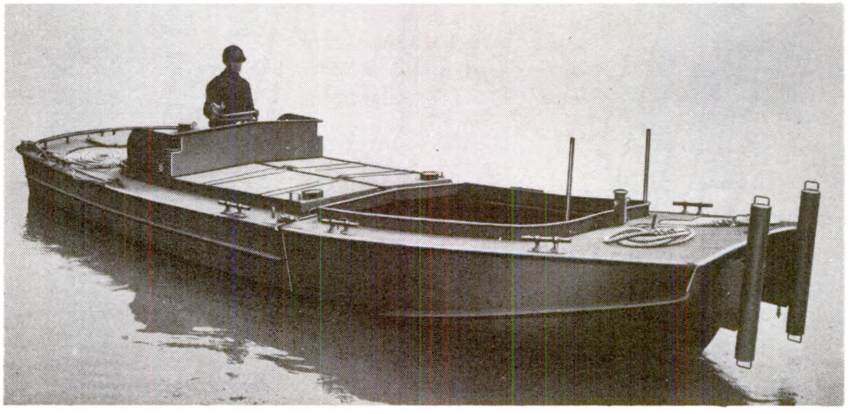


Figure 30. Twenty-seven-foot bridge erection boat.

with operating controls. The two sections are easily and quickly connected by means of special connecting hooks and clamps, and are readily disengaged for the separate handling of each section for transport. The overall length of the two-section boat is 27 feet ½ inch; the maximum width is 8 feet 2 inches, and the maximum draft of the boat is 40 inches. The dry weight of the boat, complete with accessories, is 5900 pounds, and its service weight (fully stowed with fuel) is 6325 pounds. Its net cubage is 1550 cubic feet. The shipping weight of both sections packed in one crate is 14,440 pounds and the shipping cubage is 1794 cubic feet.

b. The boat is powered by two separately controlled six-cylinder marine type gasoline engines mounted side by side in the stern section of the boat, each of which drives a single propeller. Each engine de-

velops approximately 92 shaft horsepower at 2400 rpm. The maximum forward thrust or pulling power of the boat is 3800 pounds, and the maximum reverse thrust is 2500 pounds. The maximum forward speed of the unloaded boat is 20 miles per hour.

23. Nineteen-Foot Bridge Erection Boat

a. This bridge erection boat has a single-section hull fabricated of aluminum. The boat is 19 feet 2½ inches long, has a maximum width of 8 feet ¼ inch and a maximum draft of 30 inches. The dry weight of the boat complete with accessories is 3100 pounds, and its service weight is 3450 pounds. Its net cubage is 1050 cubic feet. When crated for shipment the boat weighs 9000 pounds and has a cubage of 1200 cubic feet.

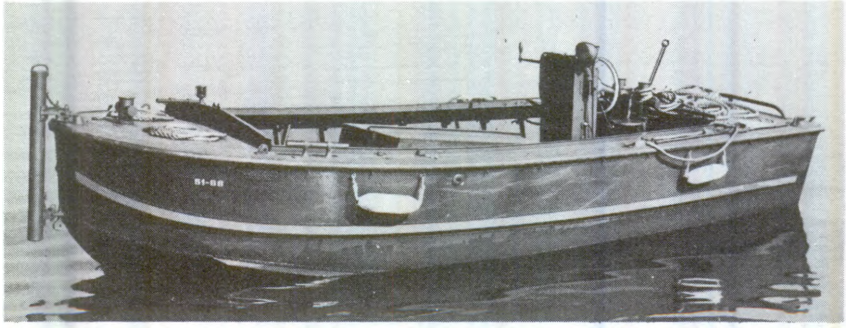


Figure 31. Nineteen-foot bridge erection boat.

b. The boat is powered by a single engine equal to and interchangeable with one of the two engines in the 27-foot bridge erection boat. The maximum forward thrust for full power is 2100 pounds, and the maximum reverse thrust is 1000 pounds. The maximum forward speed of the unloaded boat is 22 miles per hour.

24. Inflation-Deflation Manifold

The inflation-deflation manifold (fig. 32) consists of a valve and four sections of hose. It is used to inflate pneumatic floats and to remove the last traces of air when floats are being prepared for packing. The manifold should be carried on the motorized air compressor.

25. Ratchet Chain Hoist

Ratchet chain hoists (fig. 33) are used for raising trestle transoms, tightening guy lines and anchor cables, and other miscellaneous purposes. The hoist has a capacity of 1½ tons or 3 tons depending upon the manner in which it is rigged. Two hoists are packed in a chest. Weight of the chest and contents is about 135 pounds.

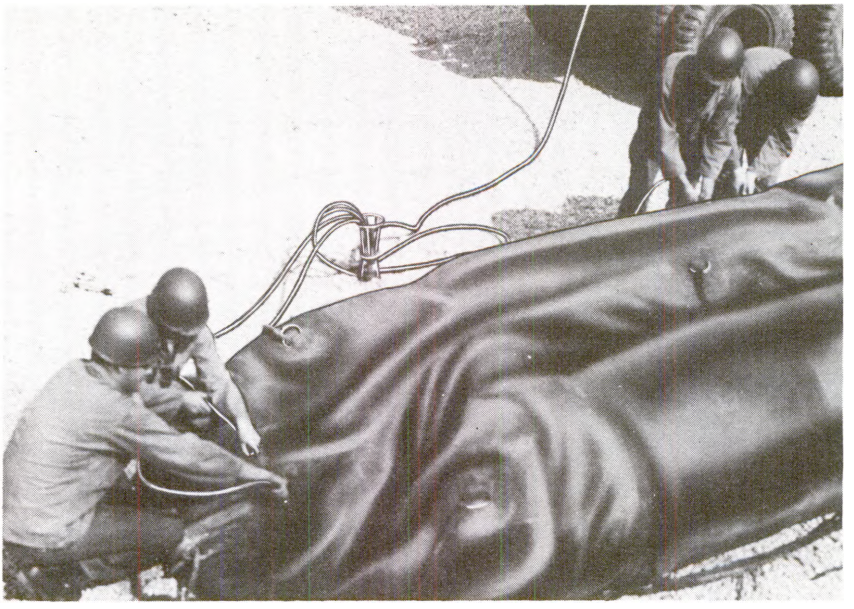


Figure 32. Inflation-deflation manifold.

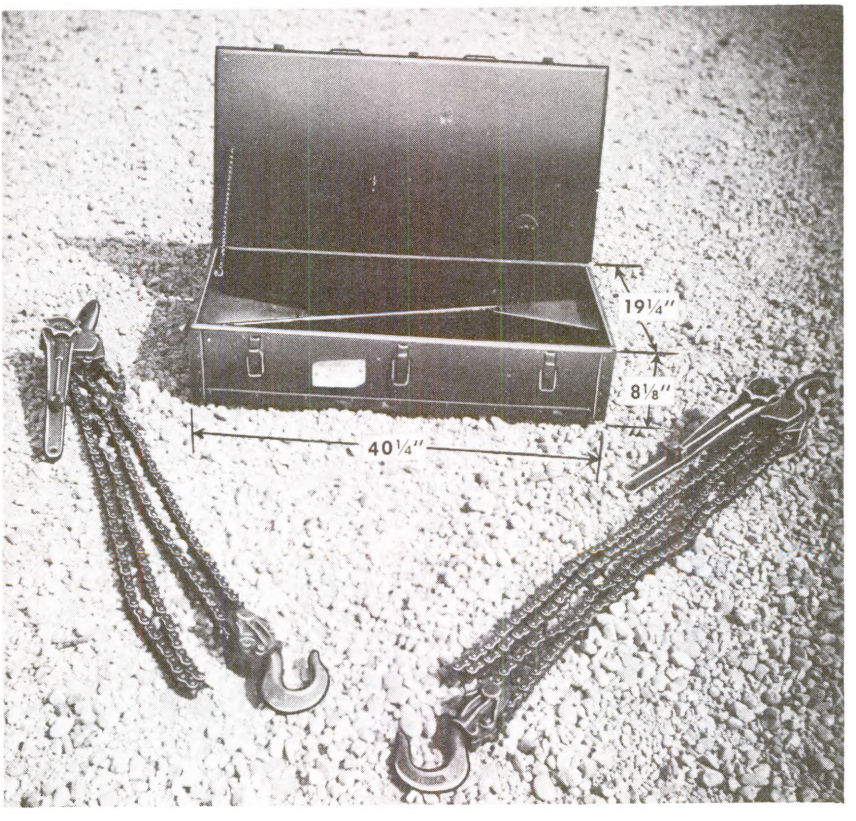
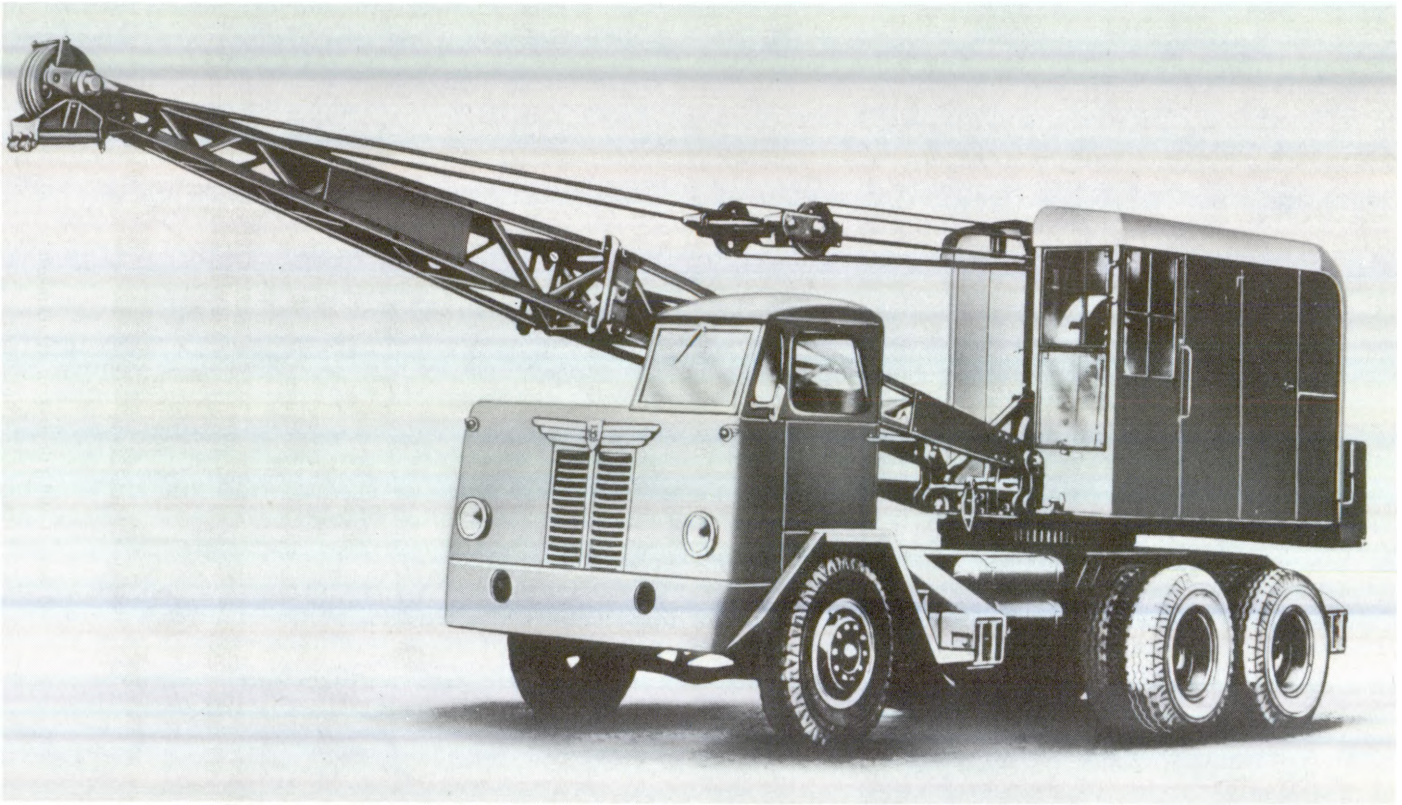


Figure 33. Ratchet chain hoists, 1½ to 3 tons.



① Truck-mounted crane

Figure 34. Truck-mounted crane with crane and shovel attachments.

26. Crane

a. Five truck cranes (fig. 34) are issued to the engineer ponton bridge company. They are gasoline-driven, revolving, two-engine drive, 20-ton, ¾-cubic-yard units. Three of the cranes are each accompanied by two flat-bed four-wheel trailers carrying the following equipment:

Bucket, dragline, ¾-cu-yd
Extension, boom, middle, 5-ft
Bucket, clamshell, ¾-cu-yd
Leads, pile driver
Shovel front
Adapter, leads, pile driver caps, drop hammer
Fair lead
Hammer, pile driver
Tagline

b. The cranes are used to perform miscellaneous lifting tasks, to load and unload equipment from trucks, and for light excavation. Approximate quantities are given below.

Lifting Capacities of 20-Ton ¾-Cubic-Yard Crane With 30-Foot Boom and Outriggers

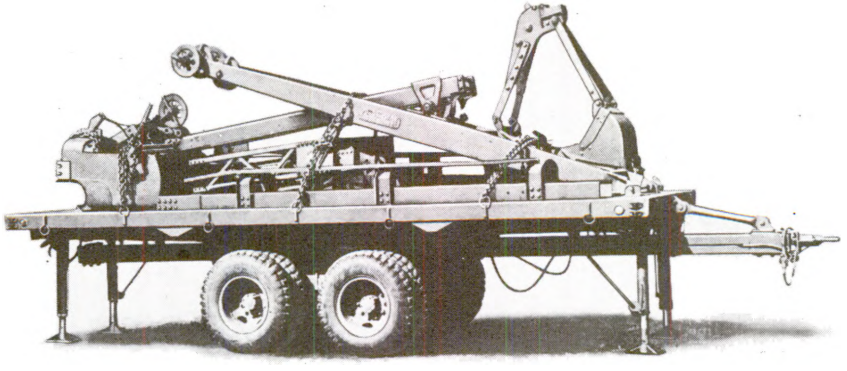
Radius, feet	10	15	20	25	30	35	40
Load, tons	20. 0	13. 0	9. 75	7. 5	6. 25	------	------

30-Foot Boom Without Outriggers (Side)

Radius, feet	10	15	20	25	30	35	40
Load, tons	12. 0	7. 0	5. 0	3. 75	3. 0	------	------

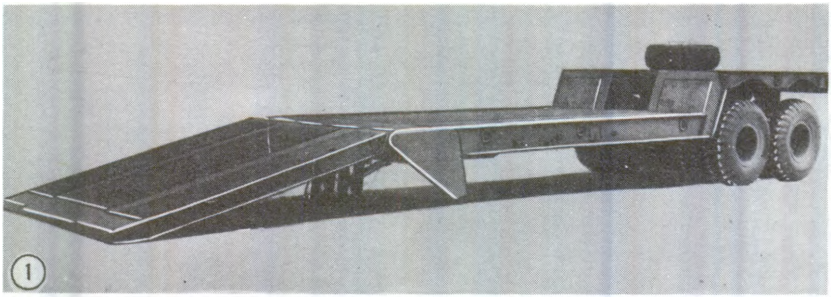
40-Foot Boom With Outriggers

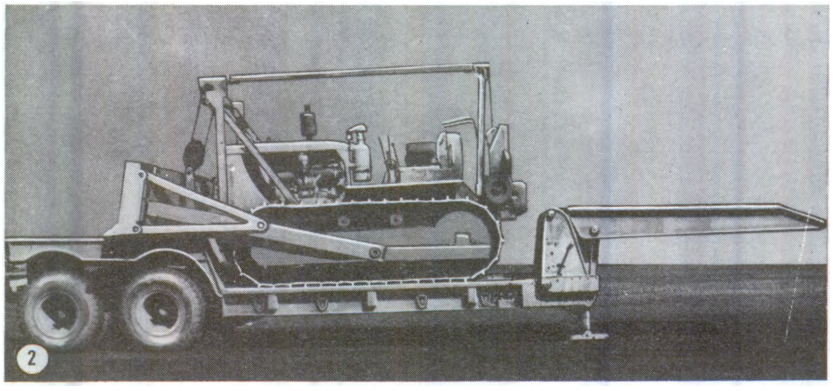
Radius, feet	10	15	20	25	30	35	40
Load, tons	20. 0	13. 0	9. 75	7. 5	6. 25	5. 25	4. 5



② Shovel and pile-driving attachments

Figure 34—Continued





① Ramp in loading position
② Ramp in raised position ready to couple to prime mover
③ Trailer loaded and coupled to 6-ton truck-tractor

Figure 35. Tractor, trailer, and prime mover.

27. Tractor

The tractor issued to bridge units is a crawler type tractor having a drawbar pull of 17,100 to 22,500 pounds, equipped with cable-operated tilting bulldozer blade. The tractor is carried on a 20-ton front-loading semitrailer towed by a 6-ton 6 x 6 truck tractor (fig. 35). The tractor is used for miscellaneous earth-moving and towing tasks at bridge sites.

28. Motorized Air Compressor

The 210-cfm motorized air compressor (fig. 36) is mounted on a 2½-ton 6 x 6 truck chassis. The compressor is used to inflate pneumatic floats and to perform utility work requiring use of pneumatic powered saws, drills, hammers, and other pneumatic tools.

Figure 36. Truck-mounted air compressor, 210-cfm (2½-ton 6 x 6 truck).

29. Tool Kit, Outboard Motor Repair

A tool kit set No. 5 is issued for the maintenance and repair of the 25-hp outboard motors. This set was developed for the 22-hp outboard motor but is applicable to the 25-hp motor when augmented by special tools provided with the 25-hp motor.

30. Drafting and Duplicating Set

The drafting and duplicating set No. 1 contains the drawing instruments, paper, tracing cloth, film, drawing board, and miscellaneous supplies essential to produce plans and duplications.

31. Signal Equipment

a. Communication Equipment. The equipment and material required to establish a communication system between the unit headquarters, supply points, transporting units, and bridge erection and maintenance crews is listed in the organizational T/O & E. This communication system is also used by the bridge guards and for traffic control.

b. Mine Detector Set. This set is a portable instrument designed specifically to detect buried metallic objects, such as antitank or anti-

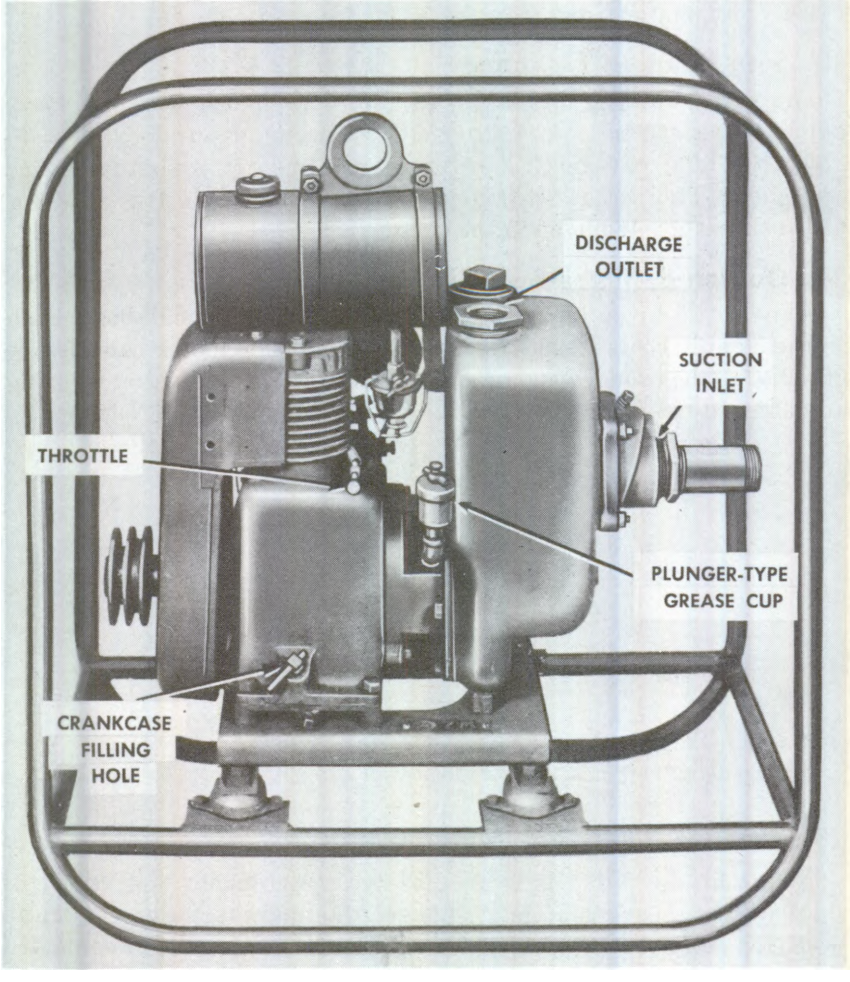


Figure 37. A 55-gallon-per-minute gasoline-driven centrifugal pump.

personnel mines. The equipment is designed to operate in all areas, including artic areas and under water to a depth of 10 feet without losing sensitivity. When in use, this set is attached to a harness-knapsack combination carried on the back of the operator. The set is composed of six main components. The complete set packed in a transit case weighs about 52 pounds. Instructions for operation, maintenance, and adjustments are included in the set.

32. Pumps

a. A 55-gpm gasoline-driven centrifugal pump (fig. 37) is used for general utility pumping where hand pumps do not provide sufficient discharge. The pump is particularly useful for removing the water from damaged pontons. Two 10-foot suction hoses and two 25-foot discharge hoses are provided with each pump.

b. A 2½-inch diameter pneumatic sump pump is used to remove water from pontons, and for general utility pumping.

33. Sign Painting Equipment

The sign painting equipment set No. 1 as issued contains tools, paints, paper, stencils, and other miscellaneous material required to make the kind of signs likely to be required by a ponton bridge company. This set is packed in two containers. Instructions for use of the set are included in the chest.

34. Outboard Motor and Bracket

Standard 25-hp outboard motors are used to propel small boats, such as the assault boats issued with the bridge. The motor can also be attached to the rounded end of a whole ponton or half-ponton by using an outboard motor bracket.

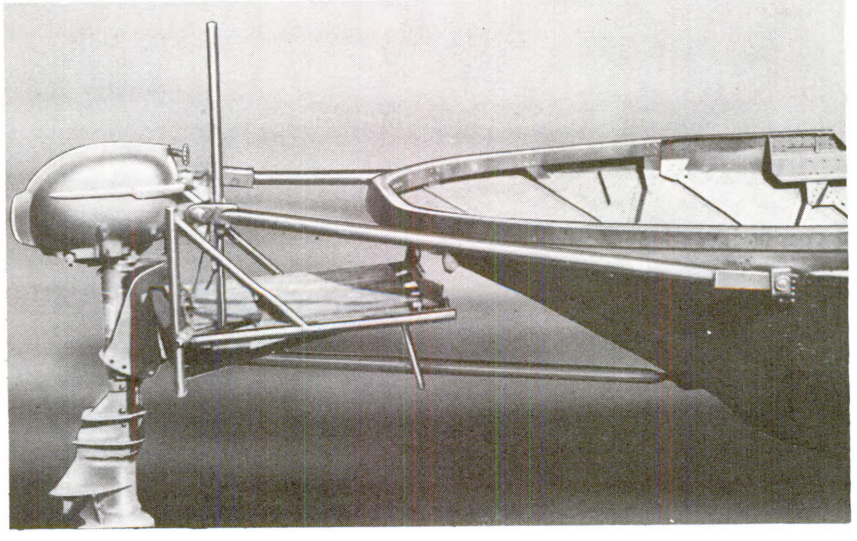


Figure 38. Outboard motor and bracket attachment.

CHAPTER 3

TRANSPORTATION AND LOADINGS

35. General

The principal vehicles issued for transporting M4 floating bridge equipage and accessories are shown in appendix III. Substitute items will be issued as changes occur in T/O & E's or as new equipage is developed. Improved items of transportation equipment have been developed to obtain greater efficiency in transporting and loading M4 bridge equipage. The principal features of the improved transportation equipment are described in the following paragraphs.

36. Equipment

a. Truck, Bolster Body, 2½-Ton. This unit is a 164-inch wheel base truck with a special bolster body to carry the load (fig. 39). At each end of the bolster there is a post with a chock on which the bottom half-ponton rests. At the base of one post there is a winch and at the other a hook to tighten and secure ponton binders. Tie-down chains are threaded through round bars on the base of the bolster.

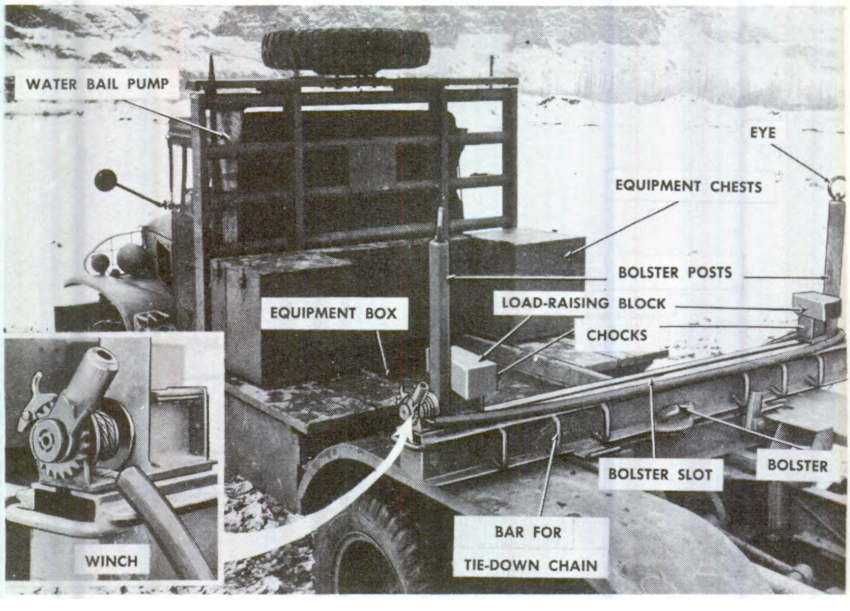


Figure 39. Chest and bolster on 2½-ton truck.

The post assembly, with chock and winch or hook, can be moved along the bolster slot or removed by unscrewing the eye at the top of the post.

b. Slip-Pole Type Trailer With Bolster. This unit is a 2½-ton, single-axle, slip-pole trailer with a special bolster (fig. 40). The bolster and attachments on the slip-pole trailer are the same as the bolster on the truck, described in *a* above. This slip arrangement permits easy adjustment of distance between the truck and trailer and provides for a greater variation in lengths of material that can be transported. When the trailer is unloaded, the slip-pole must be locked to the trailer reach assembly. This is done by blocking the

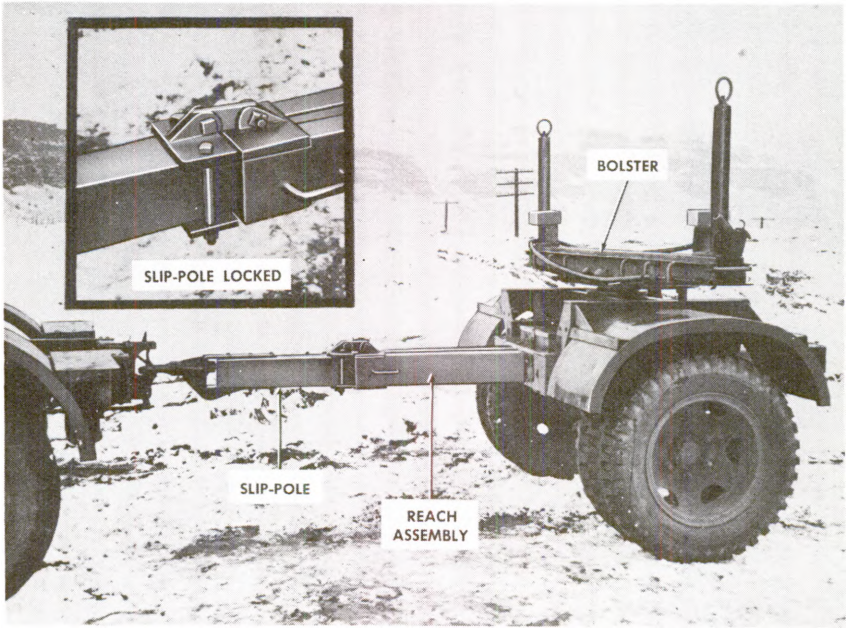


Figure 40. Slip-pole on bolster type trailer.

trailer wheels at the rear and backing the truck until the lock is secured. The empty trailer is pulled by or through the pole, and the loaded trailer is pulled through the load. When the trailer is loaded, the slip-pole is unlocked to permit variation in length of turns and over rough ground. Proper interval between truck and trailer is maintained by binding the load to the truck bolster and engaging the end lugs of the bottom layer of deck balk in the trailer-bolster slots.

c. Pintle-Hook Assembly. The bolster type trailer is connected to the truck by a shockless pintle hook bolted to the rear of the truck frame (fig. 41). This special hooking device prevents play in the connection between the trailer and the truck, and also provides additional security. The shockless pintle-hook assembly consists of a grip

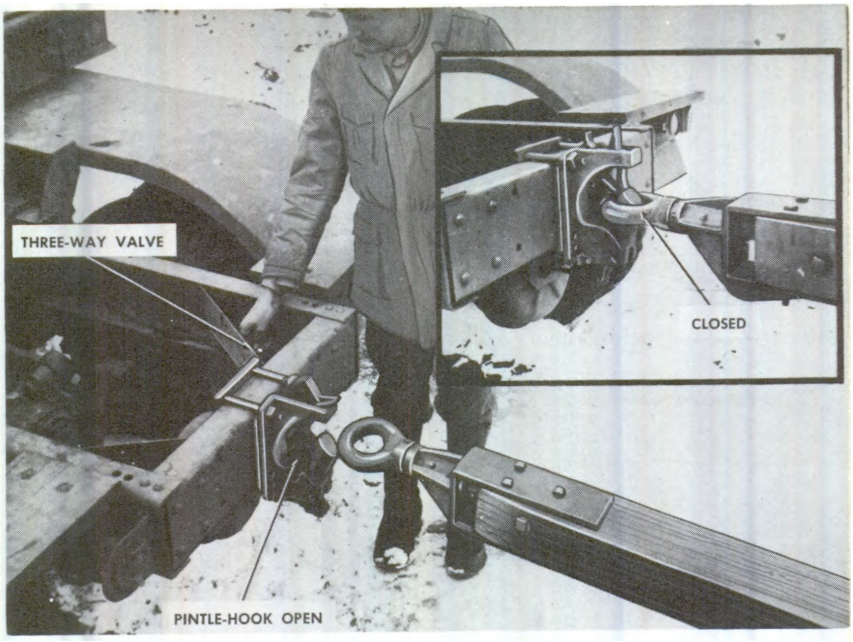


Figure 41. Pintle-hook assembly on rear of 2½-ton truck.

link, activated by means of a 14-inch long tension rod, connected to a diaphragm within a 14-inch diameter vacuum chamber. This chamber is connected by ⅜-inch tubing to a Hydrovac tank, which is standard equipment. A three-way valve in the vacuum line, between the Hydrovac tank and the vacuum chamber, controls the vacuum power applied to the grip hook of the pintle. By placing the control

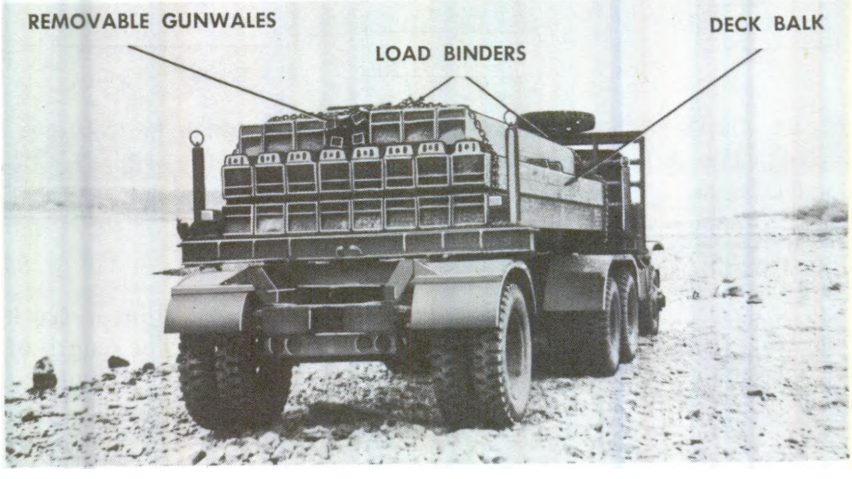


Figure 42. Balk load on bolster type truck and trailer.

valve in the various control positions the trailer can be attached to, securely retained, or released from the truck in the normal manner.

d. Binding of Loads. Generally, balk loads are bound to each bolster with a covered wire-rope binder and tie-down chains (fig. 42). Pontons, loaded over a balk load, are held down by two covered wire-rope binders tightened by the chock winches (fig. 43). Trestle loads are lashed down with covered wire-rope binders and tie-down chains (fig. 44). The covered wire-rope binders are a component part of the truck and trailer bolster. Tie-down chains are issued separately.

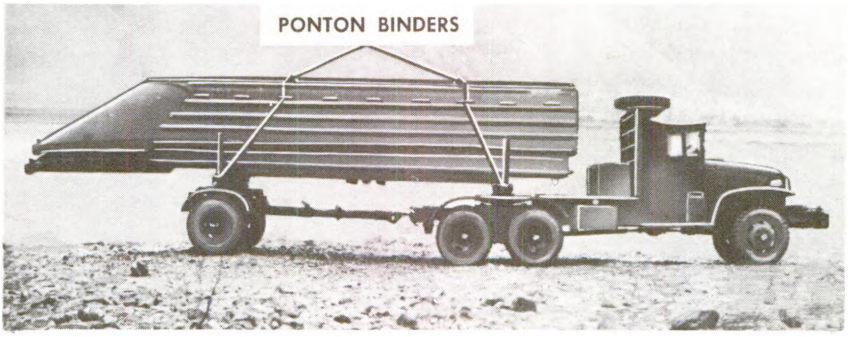


Figure 43. Ponton load on bolster type truck and trailer.

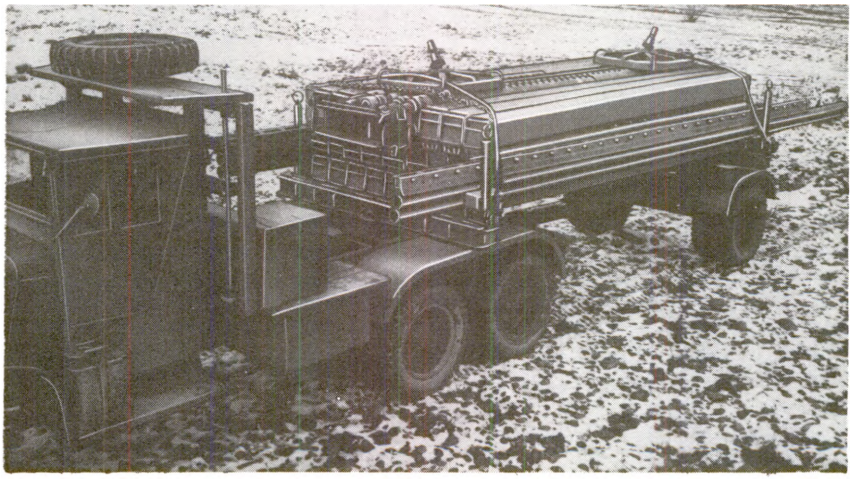


Figure 44. Trestle load on bolster type truck and trailer.

37. Loadings, General

It is not practical to present a definite procedure to follow in truck loadings, as conditions may vary greatly in the field. The length of bridge required and whether it will be fixed or floating, or a combination of both, will not be known until a field reconnaissance has been made. After the bridge site survey is completed, it is the responsibility of the officer in charge of bridge assembly to determine how much

and what type of bridging and other equipment is required to accomplish the mission. This information in detail is then transmitted to the supply point, indicating the quantity and type of bridging and construction equipment required, and the priority in which the material and equipment shall be forwarded to the bridge site. The actual requirements and priority in the movement of material and equipment to the bridge site are the controlling factors in loading procedure. A suggested procedure for ponton, trestle, and boat loading is as follows:

a. Ponton Loading. Unpin trailer-pole, block trailer wheels and move truck forward. Have one normal deck balk ready on bolster to drop into the bolster slot when proper span is reached. Load remaining balk over end of trailer or from either side of the trailer. To facilitate side loading, remove bolster chocks. Load as follows:

(1) Lay eight balk in first layer, four balk each side of the center, and engage end lugs in bolster slot.

(2) Lay eight balk, lugs up, directly over first layer.

(3) Lay six balk with lugs down and forward of balk lugs on second layer. Leave space two balk wide in center of layer.

(4) Place four removable gunwales in center space, with heads of gunwale pins toward center of load.

(5) Lash load at front and rear bolsters with wire-rope binders and chains.

(6) Load half-pontons by crane after removing and loading gunwales, bow duckboards, and all loose parts. Place crane sling hooks on carrying handles near ponton bow and stern. Rig sling legs so that stern of half-ponton is carried higher than the bow. Lower first half-ponton onto end-post chocks, with stern approximately 36 inches forward of truck bolster. Place 4- by 4-inch wooden blocks to permit pontons to nest properly. Nest second half-ponton over first, and lash securely (fig. 43).

b. Trestle Loading. Load bolster as follows:

(1) Place two layers of eight balk each.

(2) Place transom on its side in center of load.

(3) Add six deck balk, three on each side of the transom, with lugs down and forward of lugs on second layer of balk.

(4) Place two full trestle columns and four half-columns on trestle transom. Add two long cover plates on each end of the load.

(5) Place four bracing struts on bolster end-post chocks, two struts on each side. Add two removable gunwales, one on each side of load, with gunwale pin heads toward balk load.

(6) Lash load with bolster load binders and tie-down chains.

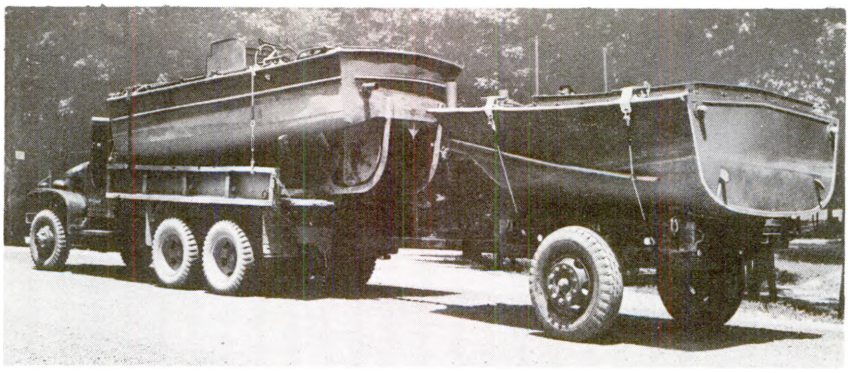


Figure 45. Twenty-seven-foot bridge erection boat loaded for transportation.

(7) Place two trestle-column shoes on top of load, one near each bolster. Thread ponton binders through eyes on each shoe and tighten (fig. 44).

c. Twenty-Seven-Foot Bridge Erection Boat, Transportation. The boat is transported in two sections (fig. 45), the forward section on a standard 2½-ton utility pole type trailer and the stern section in the body of a standard 2½-ton cargo truck. However, either section is supported on a specially designed hull-fitting cradle furnished with the boat. At a suitable site, both sections can be launched from a 2½-ton pole type trailer without the use of a crane.

d. Nineteen-Foot Bridge Erection Boat, Transportation. The boat is transported on a standard 2½-ton pole type trailer towed by a standard 2½-ton cargo truck (fig. 46). A specially designed hull-fitting cradle is provided with each boat to prevent damage to the

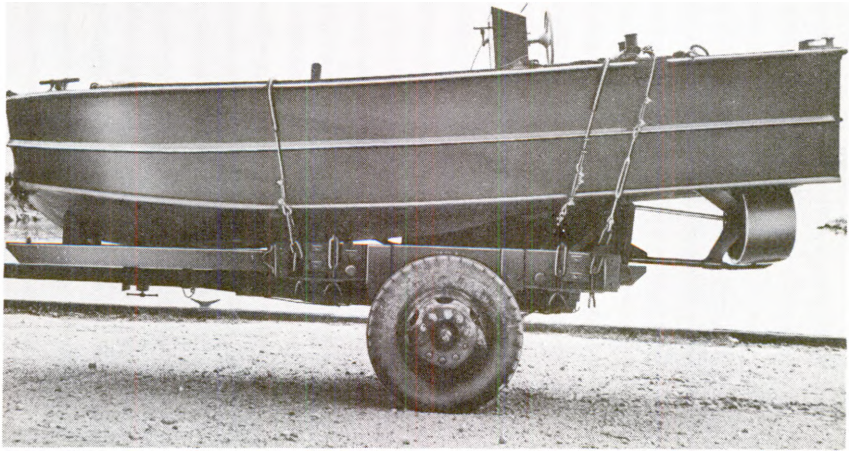


Figure 46. Nineteen-foot bridge erection boat loaded for transportation.

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hull during transportation and storage. The boat can also be carried on a 2½-ton cargo truck. In this loading, the stern of the boat should be toward the front of the truck.

38. Loading Plan, Engineer Ponton Bridge Company

The truck and trailer loadings shown in appendix III are based on the movement of the organizational, bridge, transportation, and erection equipment authorized for a ponton bridge company, as indicated in T/O & E 5–139A. If the movement is made by platoons, each platoon would acquire the relative proportion of the equipment indicated in the T/O & E. Careful consideration is given to truck or trailer capacities, distribution of the equipage to prevent overloading some vehicles and underloading others, and to provide for quick division of transporting vehicles without losing full utility of the equipage should movement by platoons be necessary.

CHAPTER 4

NORMAL ASSEMBLY

Section I. BRIDGES LESS THAN 300 FEET LONG

39. Site Selection and Planning

a. General. The selection of a bridge site is governed by both tactical and technical considerations. Tactical requirements fix the general area in which the bridge will be built. Technical requirements fix the exact location within this general area, and in some cases are important enough to eliminate the sites considered best from a tactical standpoint. Details pertaining to reconnaissance, desirable site characteristics, and the planning and construction of bridge sites are given in TM 5–260.

b. Site Layout. The layout of a bridge site requires selection and designation of assembly areas, and roads. Figure 47 shows a suggested site layout for assembly by successive pontons and figure 48 shows a suggested site layout for assembly by rafts.

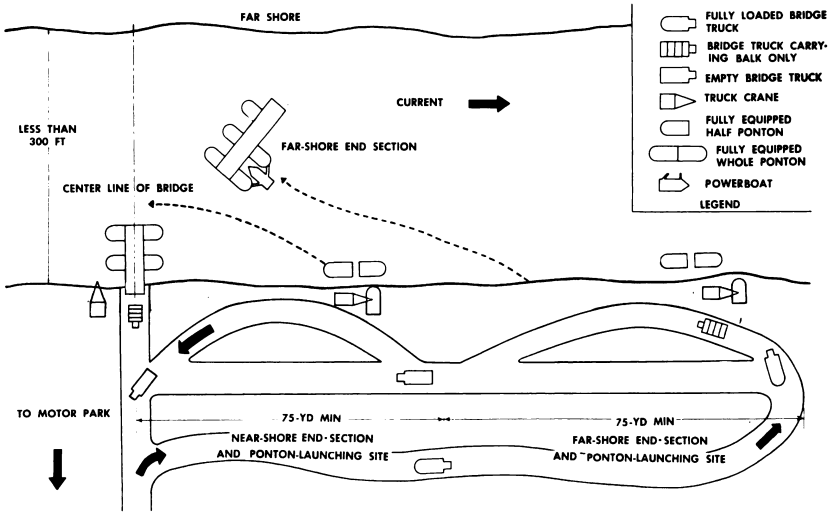


Figure 47. Suggested site layout for assembly by successive pontons.

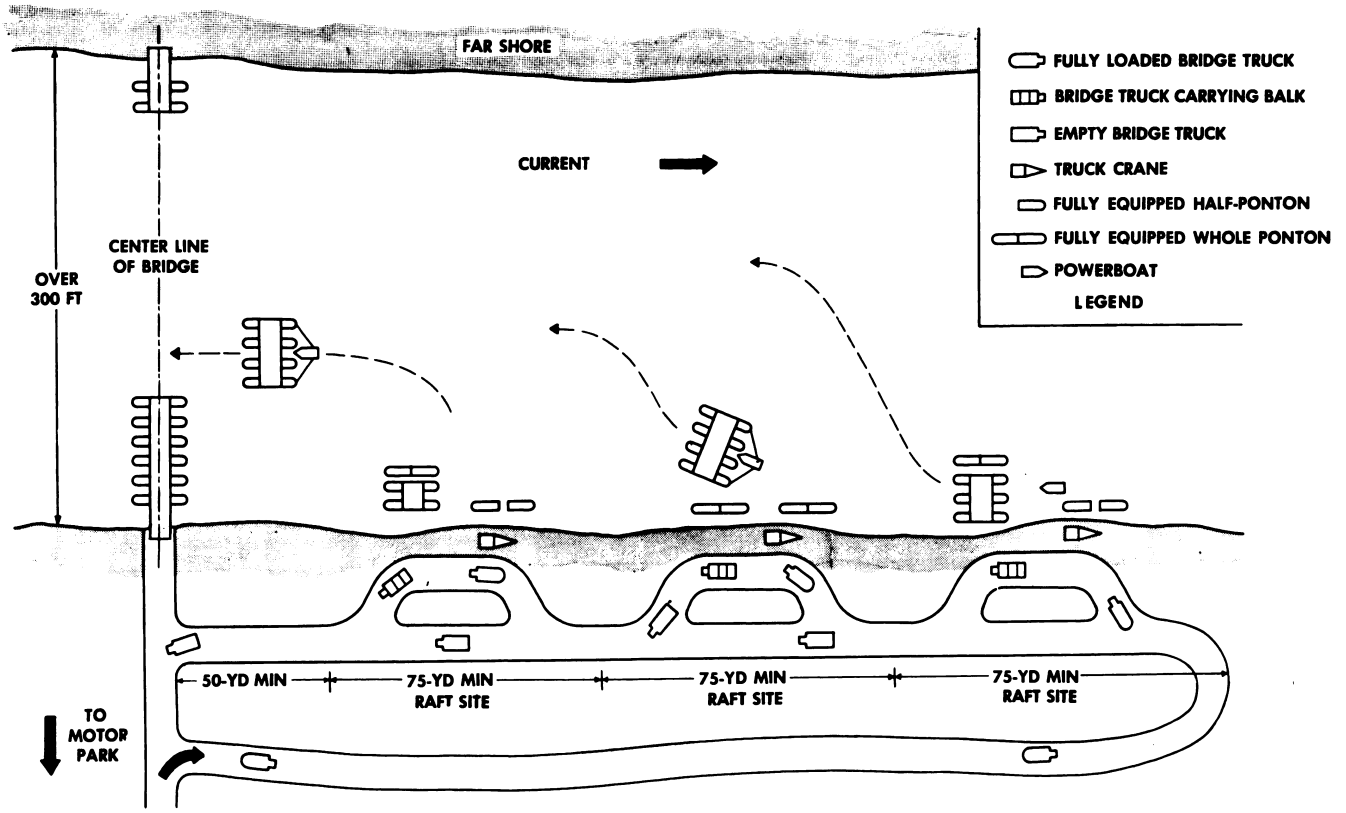


Figure 48. Suggested site layout for assembly by rafts.

c. Assembly by Successive Pontons. When the bridge is assembled by the successive ponton method, the following activities take place at assembly sites:

(1) *Ponton-launching sites.* Half-pontons, removable gunwales, curb adapters, anchors, anchor lines, bail pumps, and boat hooks are unloaded. Half-pontons are fully equipped for use after unloading the equipment, and then launched and connected together.

(2) *End-section sites.* The first pontons are delivered to the near- and far-shore end-section sites, where assembly of the end sections is accomplished. After delivery of the end sections, each site may be used as a ponton-assembly and launching site.

d. Assembly by Rafts. When the bridge is assembled by rafts, activities at the assembly sites are as follows:

(1) *Raft site.* Each raft site is divided into a launching area and an assembly area. Half-pontons are unloaded and fully equipped in the launching area. Balk and other equipment are unloaded and rafts assembled in the assembly area. Near- and far-shore end sections are also assembled at raft sites. The number of raft sites required depends on site conditions, length of bridge required, and the personnel and equipment available.

(2) *Bridge site.* After end sections are installed, subsequent rafts are connected to the bridge one at a time. Assembly may be from either shore, or both shores simultaneously. Assembly sites are required only on the near shore.

40. Abutments

a. General. The abutments of a floating bridge are the earthworks and structural parts which support the ends of the bridge deck. Details pertaining to the preparation and construction of abutments are given in TM 5–260.

b. Typical Abutment Sills.

(1) For good soil and thorough compaction, 10 pieces of 3 x 12-inch by 3-foot planking can be used under the transverse stiffener parallel to the bridge centerline (figs. 49 and 50 ①).

(2) For slightly less stable soil or when the soil is not uniformly compacted, use three standard abutment sills issued with the bridge set, 8 x 10-inch by 15 feet 6 inches, perpendicular to the bridge centerline as a footing and on this footing use 10 pieces of 3 x 12-inch by 3-foot planking parallel to the bridge centerline (fig. 50 ②).

(3) For reinforced bridges or for poor soils, use 12 pieces of 3 x 12-inch by 6-foot planking parallel to the bridge center-

line as a footing. Place three standard abutment sills, 8 x 10-inch by 15-foot 6-inch, centered on the footing perpendicular to the bridge centerline and then lay 10 pieces of 3 x 12-inch by 3-foot planking on the timber parallel to the bridge centerline (fig. 50 ③).

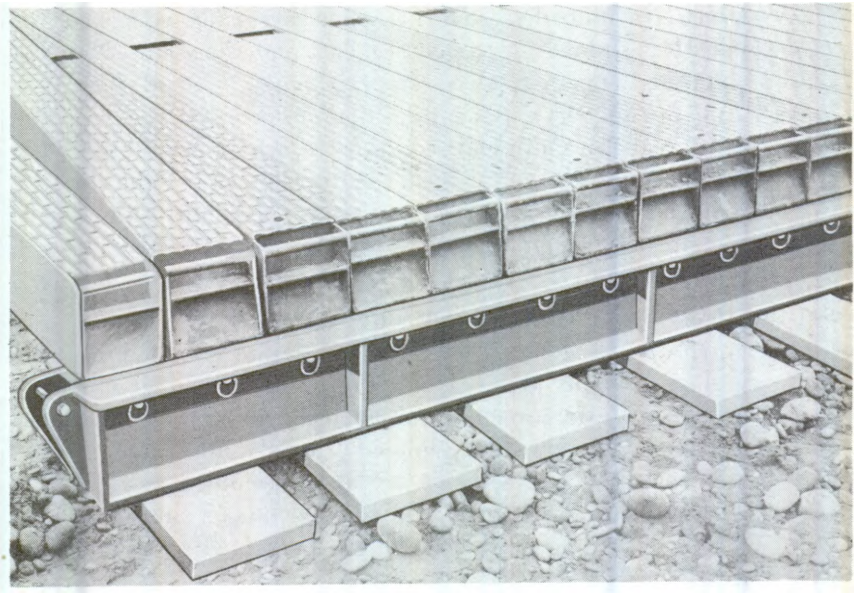


Figure 49. Simple plank abutment sill.

41. Assembly

Bridges less than 300 feet long are usually assembled by successive pontons when assembly areas are restricted. A disadvantage is the balk carry to the end of the bridge. This section discusses assembly of a bridge about 275 feet long in a current of 7 feet per second.

42. Working Party

a. Organization. See table V for suggested organization of working party and summary of tasks. Many of the separate tasks are performed at the same time to lessen the time lag between completion of each phase of assembly.

b. Duties of Details.

(1) *Near-shore abutment.* One NCO and eight men prepare near-shore abutments, using a bulldozer for heavy earthmoving. This detail later places approach and handrail posts and attaches handrail lines.

(2) *Ponton outfitting.* At each of the two sites, one NCO, 3 men, and one crane operator unload and launch half-pontons. Four men connect the half-pontons together. One NCO and 10 men outfit each whole ponton with four removable gun-

Table V. Organization of Working Party for Assembly by Successive Pontons

Details	NCO	EM	Equipment	Summary of tasks [a]
Near-shore abutment	1	8	Pioneer tools, bulldozer, abutment sill or footings, sandbags.	Build near-shore abutment; install sill; install handrail and approach posts and handrail lines.
Ponton outfitting:				
Crew 1	2	18	Crane	Unload and outfit half-pontons; join half-pontons.
Crew 2	2	18		
Ponton delivery:				
Crew 1	1	5	2 bridge erection boats	Deliver pontons for end sections; deliver end sections to near-shore and far-shore abutments; deliver pontons to bridge; tie bridle lines to anchor cable.
Crew 2	1	5	(27′), 4½″ lines 20′ long	
Anchorage [b]	2	12	1 bridge erection boat (27′), 4 crescent wrenches, rigging set, pioneer tools, bulldozer (if needed).	Install upstream anchor cable; attach and tighten shore guys; install downstream anchor cable.
Balk carrying	2	88	None	Help assemble end sections; unload and carry balk for bridge.
Balk laying	1	8	1 hammer each	Assemble and install near-shore end section; lay and pin balk on each span of bridge.
Far-shore abutment	1	16	4 hammers, pioneer tools, bulldozer (if needed), abutment sill or footings, sandbags.	Assemble far-shore end section; prepare far-shore abutment; install abutment sill.
Pin checking	1	3	1 hammer, 1 balk-depressing lever	Inspect every ponton after installation in bridge; install all pins which balk layers cannot insert.
Total	14	181		

[a] See paragraph 42 for detailed description of tasks.
[b] Will vary according to site characteristics.

Note. An officer is in charge of each of the following: near-shore abutment, far-shore abutment, anchorages, each ponton-launching site and bridge.

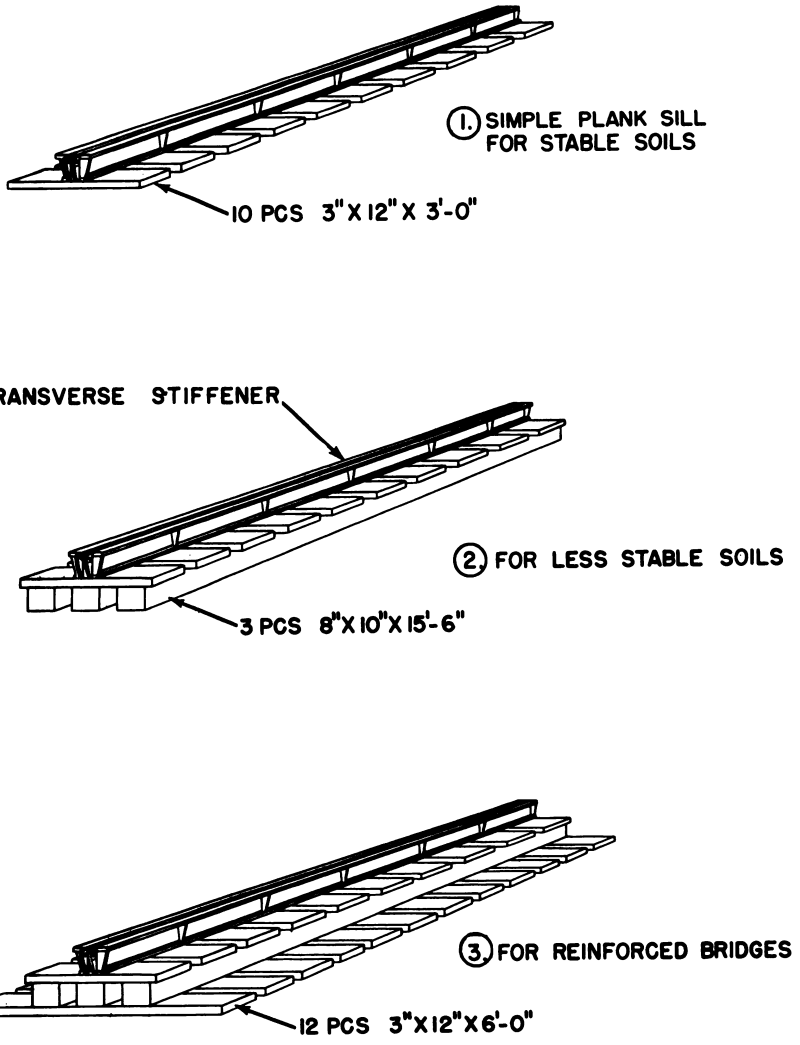


Figure 50. Typical abutment sills and footings.

wales, four curb adapters, two bridle lines, one bail pump, and one boat hook. (If no crane is available, one NCO and 25 men unload and launch the half-pontons.)

(3) *Ponton delivery.* At each of two sites, three men tie bridle lines to anchor cable and hold ponton at end of bridge until balk are laid. Two men form the crew of each 27-foot bridge erection boat.

(4) *Anchorage.* One NCO and six men cross to the far shore and prepare upstream anchor-cable deadmen. One NCO and six men prepare near-shore anchor-cable deadmen and transport one end of cable to far shore. After anchor cable is

installed, one detail attaches near-shore longitudinal shore guys and downstream shore guys; the other detail attaches far-shore longitudinal shore guys and upstream shore guys. Downstream anchor cable and bridle lines are installed after the bridge is otherwise completed. When there is tidal action the downstream anchorage is installed during the assembly of the bridge.

(5) *Balk carrying.* At each of two sites, one NCO and 44 men unload and carry balk for each end section. When end sections are completed, these details unload and carry balk for the remainder of the bridge. One NCO supervises balk unloading and another on the bridge supervises balk carrying.

(6) *Balk laying.* Use half the balk carriers to assemble the near-shore end section. After installing end section at abutment, one NCO and eight men lay and pin balk. Four of the men pin balk in the last whole ponton in bridge and four men lay and pin balk in the ponton being added to bridge.

(7) *Far-shore abutment.* One NCO and 16 men assemble far-shore end section with the assistance of half the balk carriers. The NCO and 16 men use the end section as a ferry to move to the far shore. All necessary tools and a bulldozer, if required, are carried on the ferry. On arrival at the far shore, the detail prepares the abutment and anchors the end section preparatory to closing the bridge.

(8) *Pin checking.* One NCO and three men use balk-depressing lever to install pins which balk layers could not insert. Horizontal pin connectors of half-pontons should be inspected.

43. Anchorage

a. General. A floating bridge must be anchored to secure the bridge between the abutments and to assure continued alinement. The most satisfactory method of anchoring the floating bridge is the overhead cable system supplemented by shore guys. The location and spacing of various types of anchorage are given in table VI.

b. Overhead Cable System. An overhead cable anchorage system consists of one or more tower-supported cables spanning the river parallel to and upstream of the bridge. Bridle lines secure the bridge to the cable. It is usually necessary to support the cable with towers to keep the cable above the maximum high water and to allow for enough sag to avoid overstressing the cable. Cable systems can be rigged as single cable anchorage or as multiple cable anchorage.

c. Single Cable Anchorage. This is a single cable supported by towers and spanning the stream upstream of the bridge (fig. 51). Single cable systems can be built readily for bridges less than 650 feet

Table VI. Location and Spacing of Anchorage

Current velocity	Type of anchorage	Where attached to bridge	Spacing of anchorage	
			Upstream	Downstream
3 fps or less	Guy line	Additional balk fastened adjacent to deck.	Every 6th ponton	Every 6th ponton.
3 fps or less	Anchors	Cleats in pontons	Every ponton	Every 4th ponton.
5 fps or less	Anchors *and* guy line	Cleats in pontons	Every ponton	Every 2d ponton.
		Additional balk fastened adjacent to deck.	Every 6th ponton	Every 12th ponton.
7 fps or less	Anchor cable w/bridle lines *and* guy line.	Cleats in pontons	Every ponton	Every 2d ponton.
		Additional balk fastened adjacent to deck.	Every 6th ponton	12th and 18th pontons from each shore.

long. Cable spans greater than 650 feet are more difficult to erect. In rivers with current reversals, as tidal estuaries, or severe winds from downstream, a single cable system is installed downstream in addition to the upstream cable.

d. Dual Cable Anchorage System. If the size of cable required for a single cable system cannot be obtained or if the cable required is too

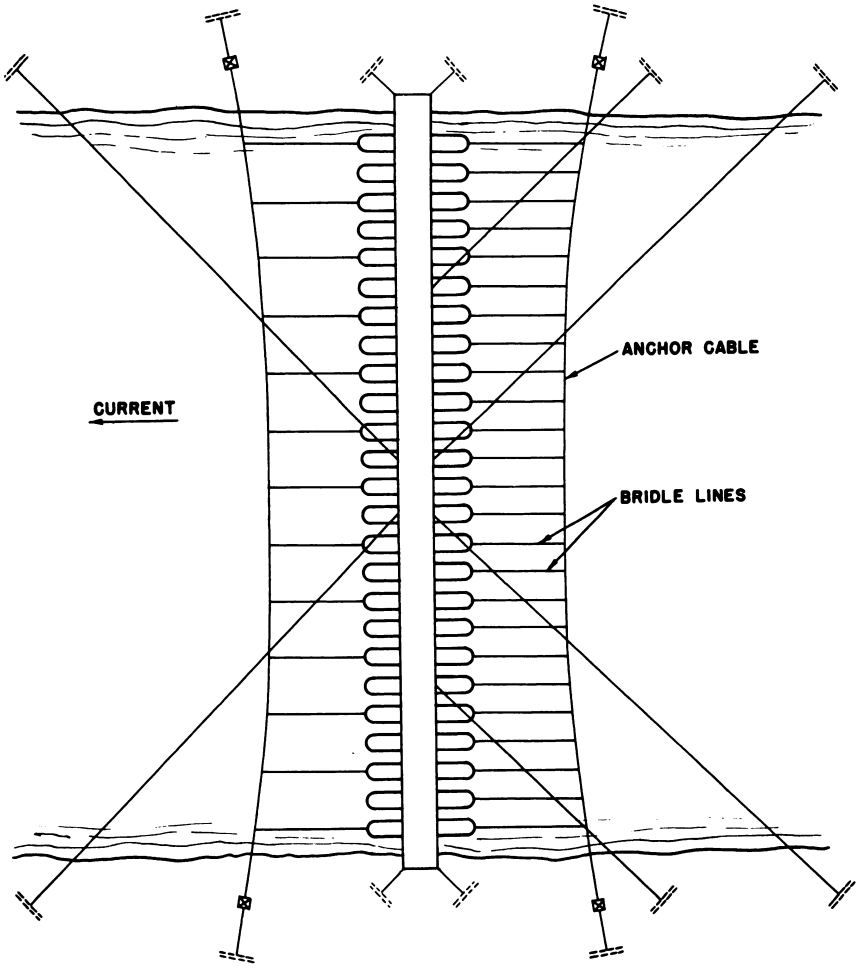


Figure 51. Single cable anchorage system.

large for the bridle line and tower fittings, two or more smaller cables may have to be installed from two or more supports (fig. 52). The load is then divided equally between the cables.

e. Cable Sizes. The size of cable required for an anchorage system depends on the width of the river and the velocity of the current. The size of cable required for single and dual cable systems anchoring the M4 bridge can be determined from tables VII and VIII.

Table VII. Cable Requirements for Single Cable Anchorage, M4 Floating Bridge

Span in feet	Cable size in inches for various current velocities in feet per second			
	5	7	9	11
400	½	½	⅝	¾
600	⅝	⅝	¾	⅞
800	⅝	¾	⅞	1
1,000	¾	⅞	1	1⅛
1,200	⅞	⅞	1⅛	*Unsafe

*Intermediate anchor cable supports must be provided to shorten clear span.

Table VIII. Cable Requirements for Dual Cable Anchorage, M4 Floating Bridge

Span in feet	Cable size in inches for various current velocities in feet per second			
	5	7	9	11
400	⅜	½	½	⅝
600	½	½	⅝	¾
800	½	⅝	¾	⅞
1,000	⅝	⅝	¾	1
1,200	⅝	¾	⅞	1

f. Cable Sag. The stress in an anchor cable decreases as the sag increases. The minimum allowable sag is 2 percent and the maximum sag is 5 percent of the cable span between shore holdfasts or towers. Greater sag than 5 percent is allowable but increases the working strength very little.

g. Line Pull. The live load line pull for individual M4 whole pontons with a maximum safe load on the bridge at various velocities is given in table X. To obtain the line load for which each deadman must be designed, multiply the number of pontons in the bridge by the pounds pull for each ponton.

h. Holdfasts.

(1) The anchorage system is fastened to the shore by holdfasts or deadmen. The best and quickest method is to use natural holdfasts such as trees or stumps. When natural means are not available, holdfasts or deadmen must be constructed.

(2) A single wood or steel picket, driven into the ground as a stake, can be used as a hasty means of anchoring lines, but does not have much holding power.

(3) A stronger holdfast can be made by using two or more pickets at least 3 inches in diameter and 5 feet long. The pickets are

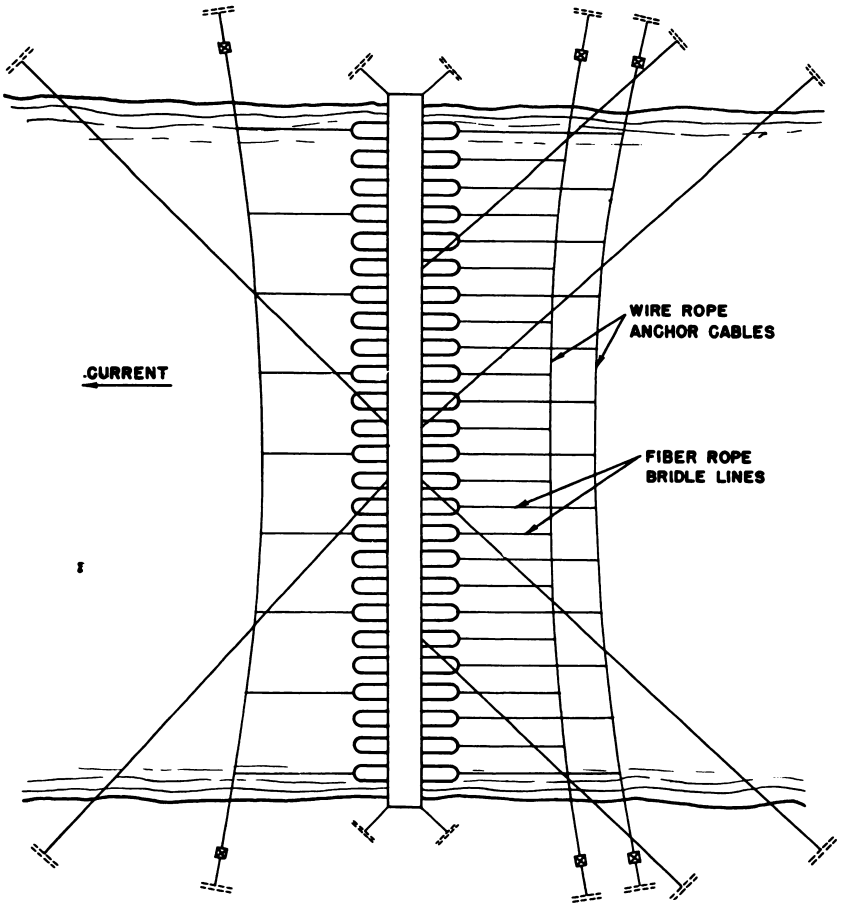


Figure 52. Dual cable anchorage system.

driven 3 feet into the ground, 3 to 6 feet apart, in line with the anchorage line.

(4) For heavier loads, or in soft or wet earth, the guy or anchor line can be fastened to a large timber, which is supported against four or six picket holdfasts. The timber acts as a beam and must bear evenly on each picket.

i. Deadmen.

(1) For heavy loads or on permanent installations, the best form of anchorage is a deadman. The deadman consists of a timber or steel beam buried in the ground with a guy or anchor line connected to it. Since guy and anchor lines often require adjustment, a turnbuckle is placed in the line within reach of the ground and near the deadman.

(2) The strength of the deadman depends partly on the strength of the log or beam buried, but mainly on the holding power

of the earth. For a given cable pull, the number of square feet of deadman bearing surface required is determined by dividing the total pull by the value given in table IX for the depth and cable inclination selected.

Table IX. Holding Power of Deadmen in Loamy Soil

Mean depth of anchorage (ft)	Inclination of pull (vertical to horizontal) and safe resistance in pounds per sq ft				
	Vertical	1/1	1/2	1/3	1/4
3	600	950	1, 300	1, 450	1, 500
4	1, 050	1, 750	2, 200	2, 600	2, 700
5	1, 700	2, 800	3, 600	4, 000	4, 100
6	2, 400	3, 800	5, 100	5, 800	6, 000
7	3, 200	5, 100	7, 000	8, 000	8, 400

(3) The principle of installing a deadman is to utilize as much surface of the undisturbed earth as possible so as to prevent the tendency for the beam to rotate out of position.

(4) The best position for a deadman is where the angle of pull is as near horizontal as possible. Advantage should be taken of sharp banks or crests to decrease the inclination of guy or anchor lines.

(5) The hole is dug large enough for the deadman and as deep as necessary for good bearing. The bank in the direction of the pull is cut straight and slanted at an angle of about 15° to the vertical, away from the line. To strengthen the anchorage, stakes can be driven into the bank and over the deadman at each end. A narrow trench for the guy or anchor line to lie in is dug on an incline, leading to the center of the deadman.

(6) The guy or anchor line is tied to the center of the deadman so that the main or standing end of the line leads from the bottom of the deadman. The deadman is tamped in in such a way as to make sure that the greatest bearing area faces the direction of pull.

Table X. Line Pull in Pounds for Individual M4 Whole Pontons with a Maximum Scfe Load on the Bridge

Velocity, fps	3	5	7	9	11	13	15
Line pull, lb	60	180	370	600	820	Unsafe	

44. Shore Guys

a. Description. Shore guys attached to the bridge and to deadmen or natural holdfasts on the shore are used to hold the bridge during assembly and can be incorporated into the final anchorage system of the bridge. They are constructed of ½-inch wire rope which is run at an angle of 45° from the bridge to the shore. Shore guy lines should not be used for more than 300 feet from either shore. They are permanently installed on the upstream side, and slacked off after installation, to provide a supplementary anchorage system and to help maintain bridge alinement. For spans under 600 feet, shore guys can be used as the downstream anchorage unless there are severe eddies or tidal conditions producing current reversals. All guy lines must be pulled clear of the water; if banks are low, they should be raised on A-frames or other supports. Deadmen or holdfasts should be above maximum anticipated water level and strong enough to withstand emergency conditions. Shore guy lines require constant adjustment.

b. Installation.

(1) *Upstream shore guys.* The upstream guy lines are unreeled from shore and passed out along the bridge. One man at every other ponton or float holds the cable out of the water as it is passed from shore. The cable is run under each bridle line except the two shoreward of the point the cable is attached to the bridge. The running end is attached to the bridge at the place and spacing shown in table VI. The shore end of the cable is attached to deadmen or holdfasts and the slack is taken out with a ratchet hoist or winch.

(2) *Downstream shore guys.* Downstream guy lines can be installed rapidly and safely with a bridge erection boat if there are no dangerous obstacles below the bridge. Downstream guys to the far shore are not installed until after the bridge is completed, since they will interfere with ponton delivery.

45. Launching and Outfitting Pontons

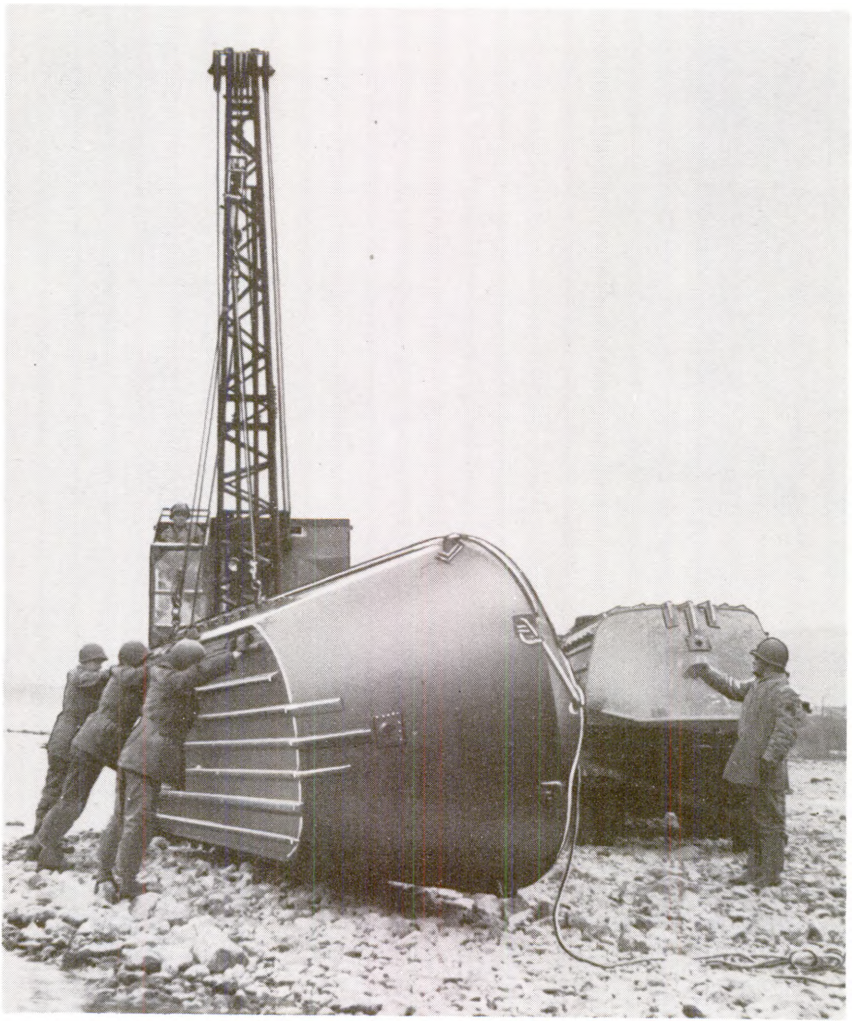
a. Unloading (fig. 53, steps 1 to 4).

(1) *Step 1.* Remove ponton load binders and attach crane slings to four points on top of ponton. Improvised spreader bars can be used to reduce the length of slings and to minimize the possibility of crushing the sides of pontons when handled in an upright position.

Step 1. Crane attached to half-ponton

Figure 53. Unloading pontons.

(2) *Step 2.* Lower half-ponton gently to ground, remove crane slings from riverward side, and tumble half-ponton to right-side-up position.



Step 2. Half-ponton being turned over

Figure 53—Continued.

(3) *Step 3.* Lift second half-ponton and move truck clear. Lower half-ponton and turn over as in step 1.

Step 3. Unloading second half-ponton

Figure 53—Continued.

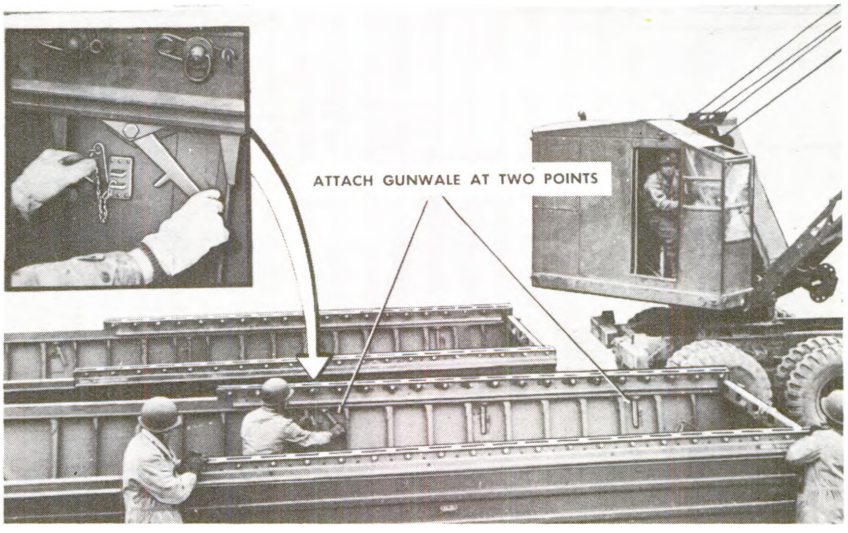
(4) *Step 4.* Unload removable gunwales and accessories.

Step 4. Unloading accessories

Figure 53—Continued.

b. Outfitting and Launching (fig. 54, steps 1 to 6).

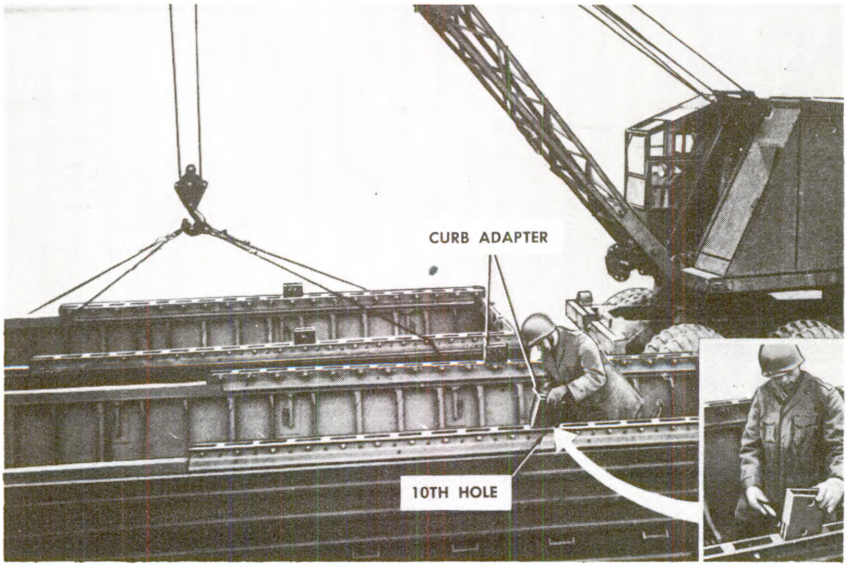
(1) *Step 1.* Place removable gunwales on half-pontons and attach at two points by means of locking levers, and install bow duckboards.



Step 1. Attaching removable gunwales

Figure 54. Outfitting and launching pontons.

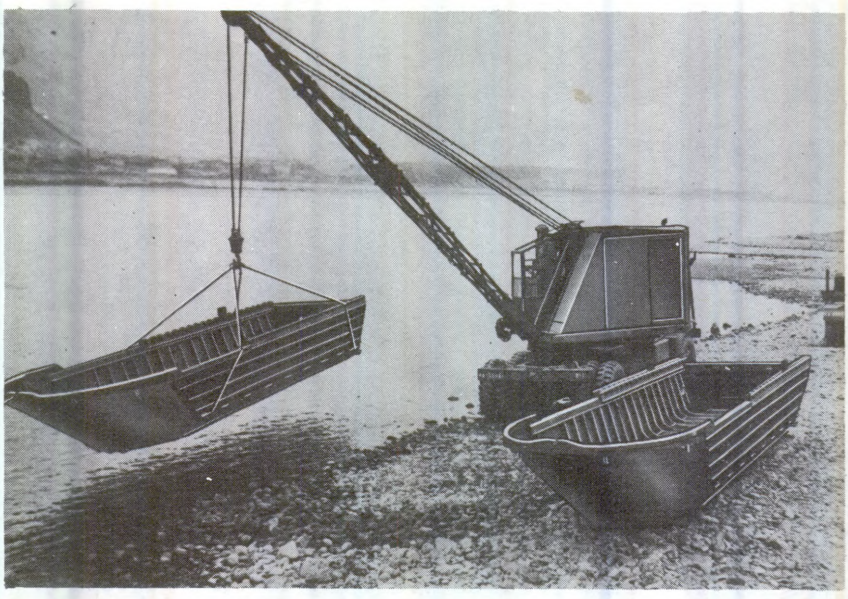
(2) *Step 2.* Pin curb adapters on both gunwales at the tenth hole from the stern of the half-ponton.



Step 2. Pinning curb adapters

Figure 54—Continued.

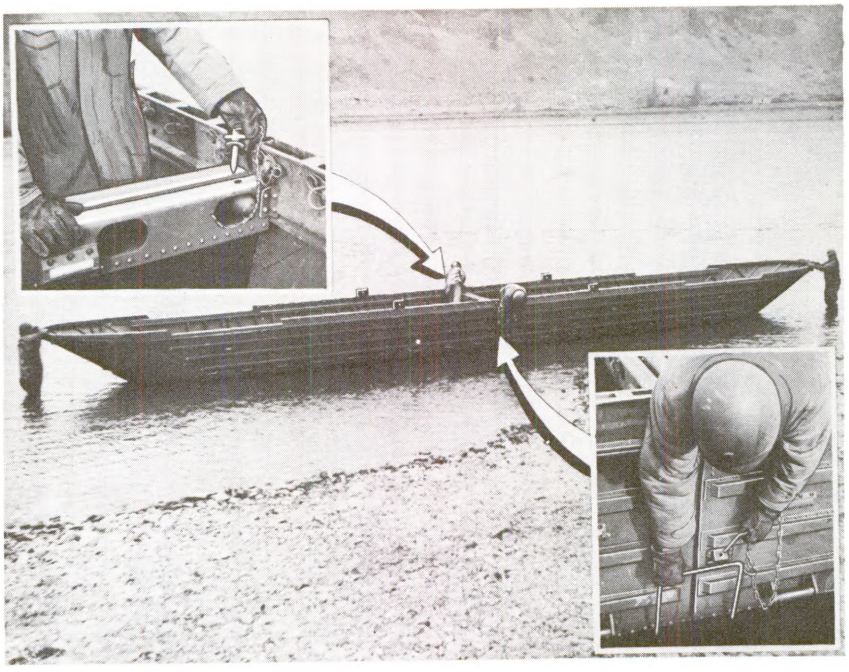
(3) *Step 3.* **Lower half-ponton into water.**



Step 3. Lowering half-ponton into water

***Figure 54*—Continued.**

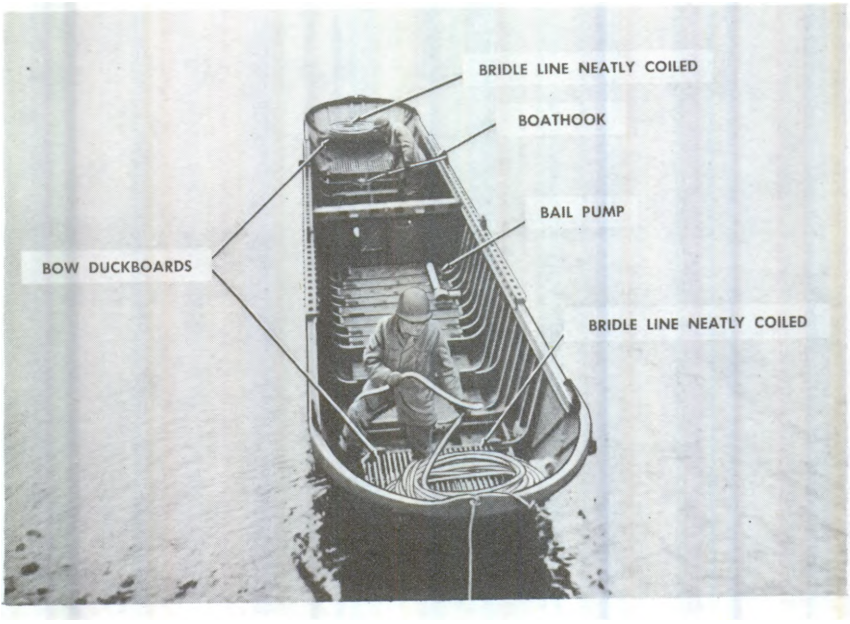
(4) *Step 4.* Connect half-pontons together stern-to-stern by horizontal connectors on either side and vertical pins at transoms.



Step 4. Connecting half-pontons stern-to-stern

Figure 54—Continued.

(5) *Step 5.* Install bridle lines, boathooks, and bail pump. Coil bridle lines ready for use. The bridle lines can be attached to the anchor cable from the shore or from the ponton, whichever is more advantageous.



Step 5. Installing accessories in ponton

Figure 54—Continued.

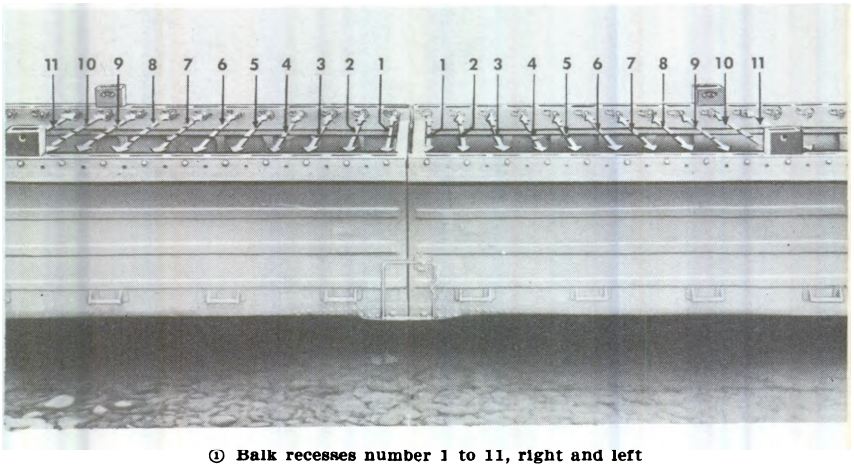
(6) *Step 6.* Attach bridge erection boat to downstream half-ponton by two lines. Move completed ponton to bridge or assembly site.

Step 6. Bridge erection boat moored to downstream half-ponton

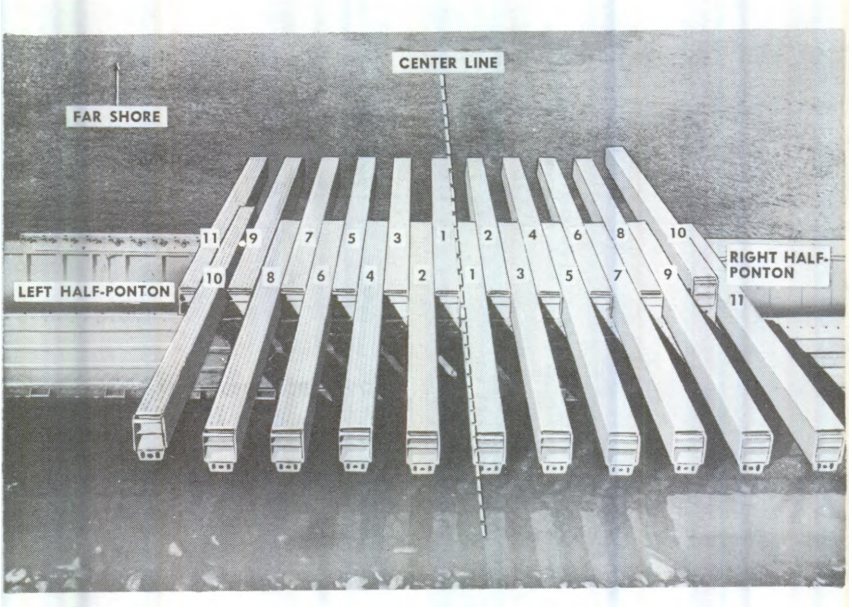
Figure 54—Continued.

46. Method of Laying Balk on Pontons

Balk recesses in gunwales are numbered 1 to 11 to right and left from the joint between half-pontons. Numbers in figure 55 correspond with numbers of the recesses in the gunwales. When viewed from the near shore, odd-numbered balk on the right half-ponton and even-numbered balk on the left half-ponton always extend toward the near shore and are called near-shore balk. The even-numbered balk on the right and the odd-numbered balk on left, extending toward the far shore, are called far-shore balk.



① Balk recesses number 1 to 11, right and left



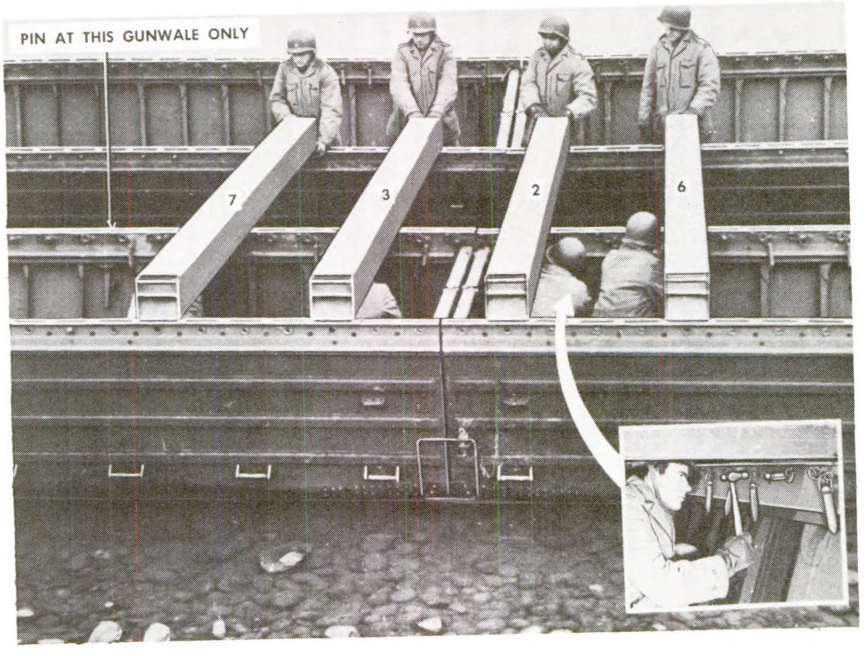
② Near- and far-shore balk

Figure 55. Method of laying balk on pontons.

47. Assembly of End Sections

a. Near-Shore End Section (fig. 56, steps 1 to 16).

(1) *Step 1.* Moor two pontons side-by-side parallel to shore. Remove first 11 pins from each gunwale and hang them on spring fasteners beside each pin hole. Lay four far-shore balk (7 and 3 on the left; 2 and 6 on the right) over the first ponton with one end extending riverward and pin only at interior lugs.



Step 1. Laying four far-shore balk on first ponton

Figure 56. Assembly of end sections.

(2) *Step 2.* Lay four near-shore balk (6 and 2 on the left; 1 and 5 on the right) extending from the riverward gunwale of the first ponton across the second ponton and pin only interior lugs.

Step 2. Four near-shore balk have been laid on second ponton

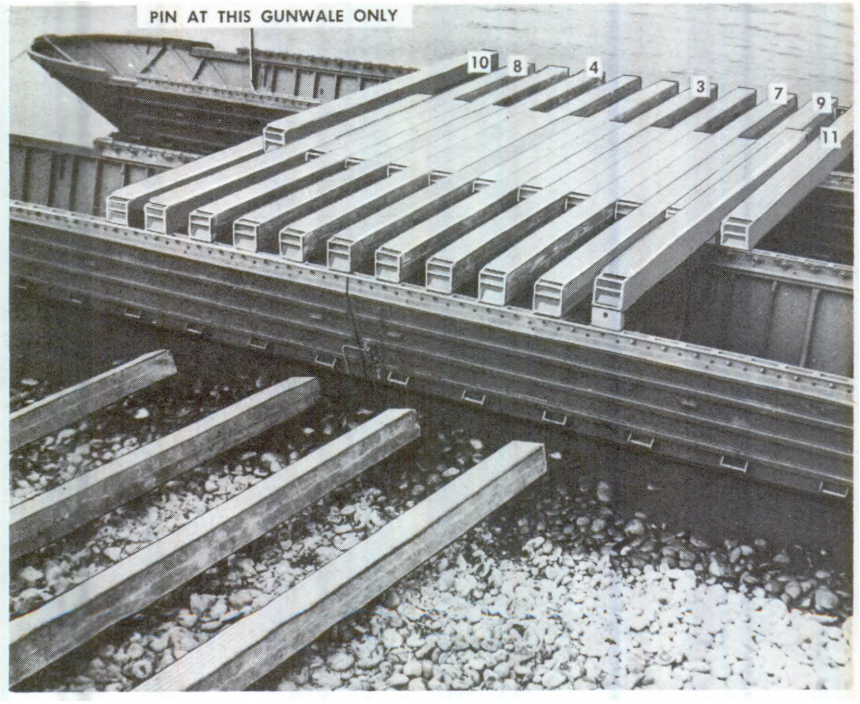
***Figure 56*—Continued.**

(3) *Step 3.* Lay seven far-shore balk (11, 9, 5, and 1 on the left; 4, 8, and 10 on the right) over the first ponton and pin only interior lugs. Balk number 10 is the curb and is pinned to the curb adapters.

Step 3. Laying remainder of far-shore balk on first ponton

Figure 56—Continued.

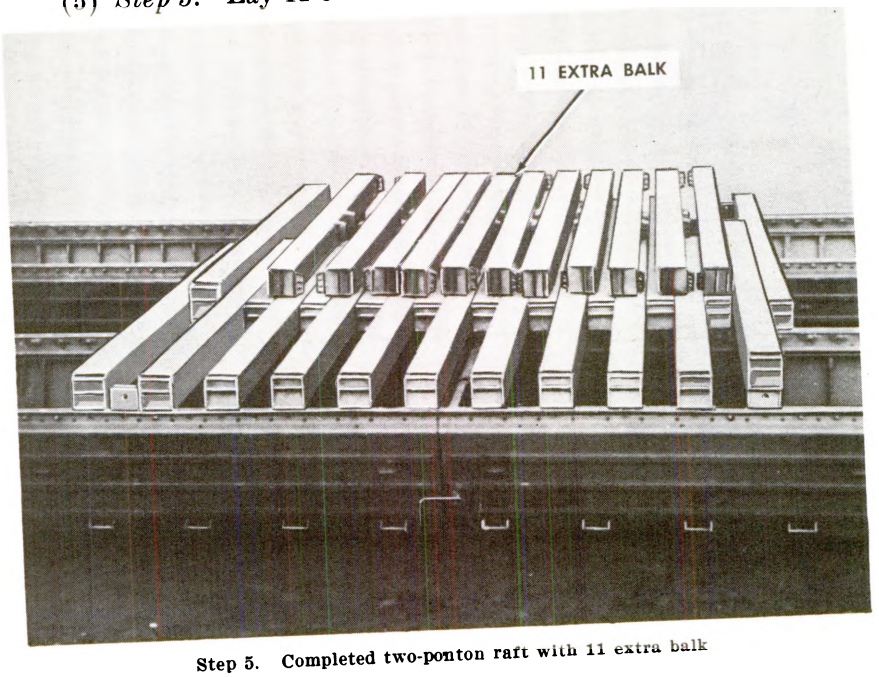
(4) *Step 4.* Lay seven near-shore balk (10, 8, and 4 on the left; 3, 7, 9, and 11 on the right) over the second ponton and pin only interior lugs. Balk number 10 is the curb and is pinned to the curb adapters.



Step 4. Laying remainder of near-shore balk on second ponton

Figure 56—Continued.

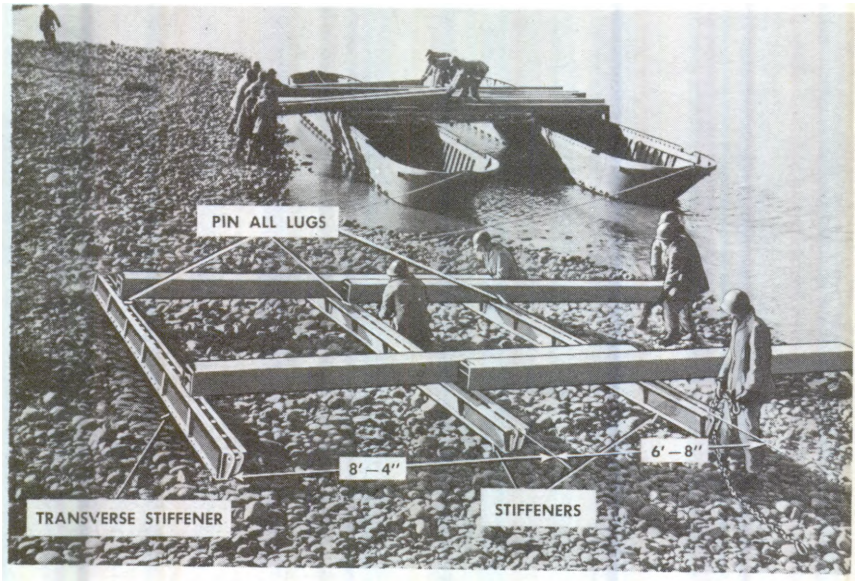
(5) *Step 5.* Lay 11 extra balk on the two-ponton raft.



Step 5. Completed two-ponton raft with 11 extra balk

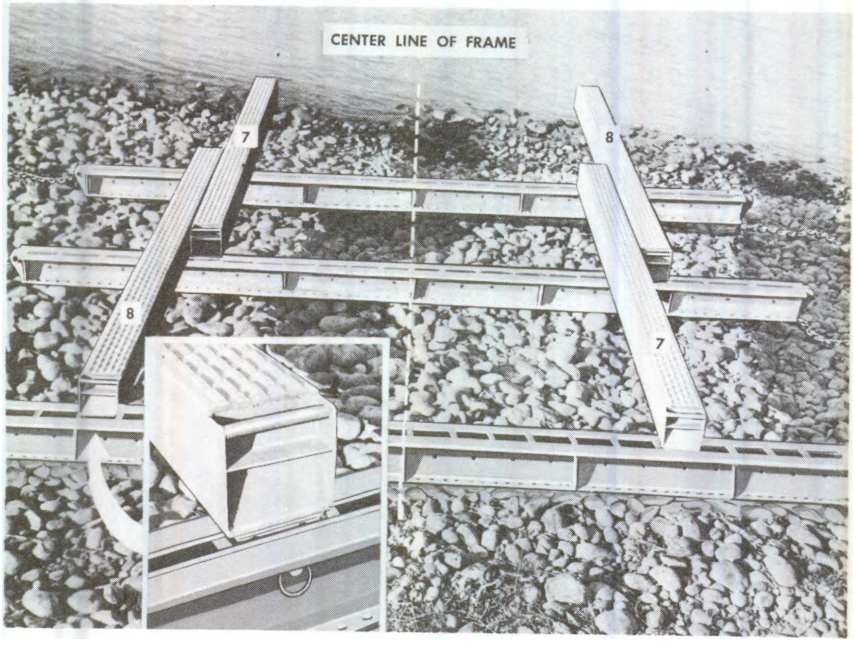
Figure 56—Continued.

(6) *Steps 6 and 7.* Simultaneously with steps 1 through 5, assemble end-section frame of three transverse stiffeners, and four balk. Pin at stiffeners. End transverse stiffener is



Step 6. Assembling frame for end section

Figure 56—Continued.

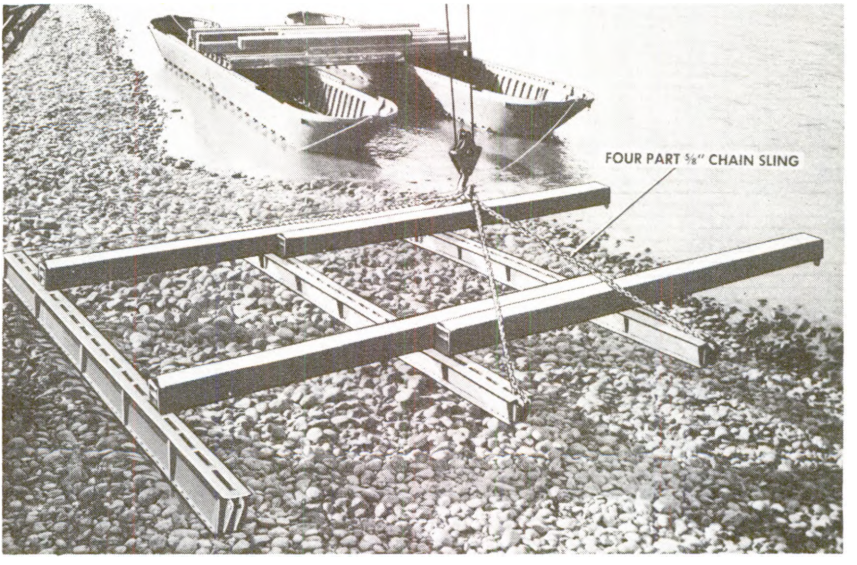


Step 7. Completed frame for end section

Figure 56—Continued.

spaced by balk lugs 8 feet 4 inches from second transverse stiffener. The second and third transverse stiffeners are 6 feet 8 inches apart, spaced by balk lugs.

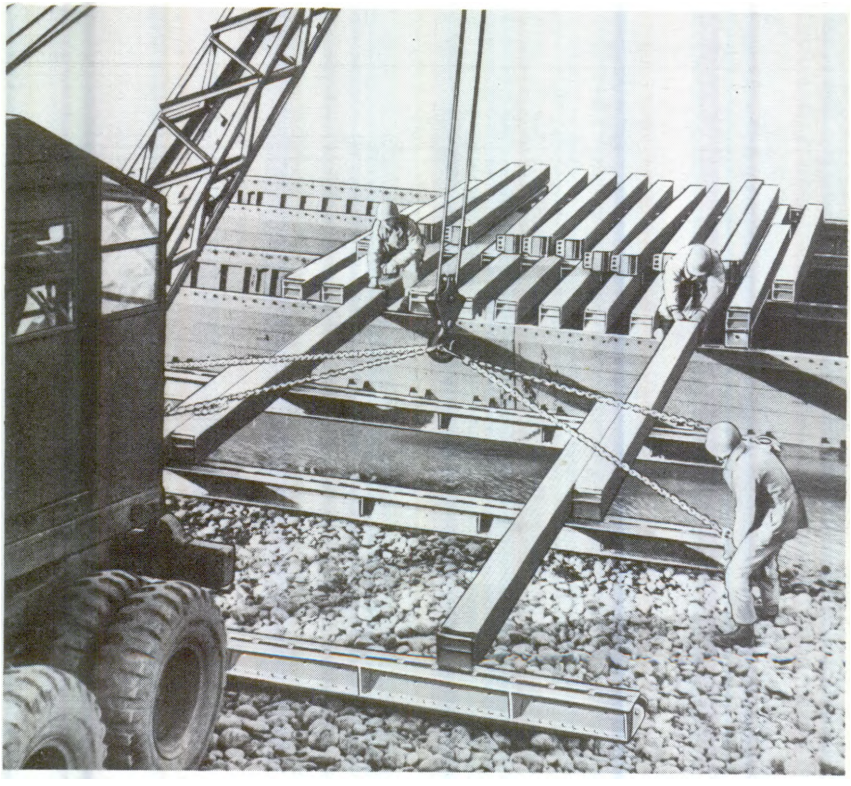
(7) *Step 8.* Attach crane sling to the ends of the stiffeners. Lift frame and move to completed two-ponton raft.



Step 8. Crane sling attached to frame for end section

Figure 56—Continued.

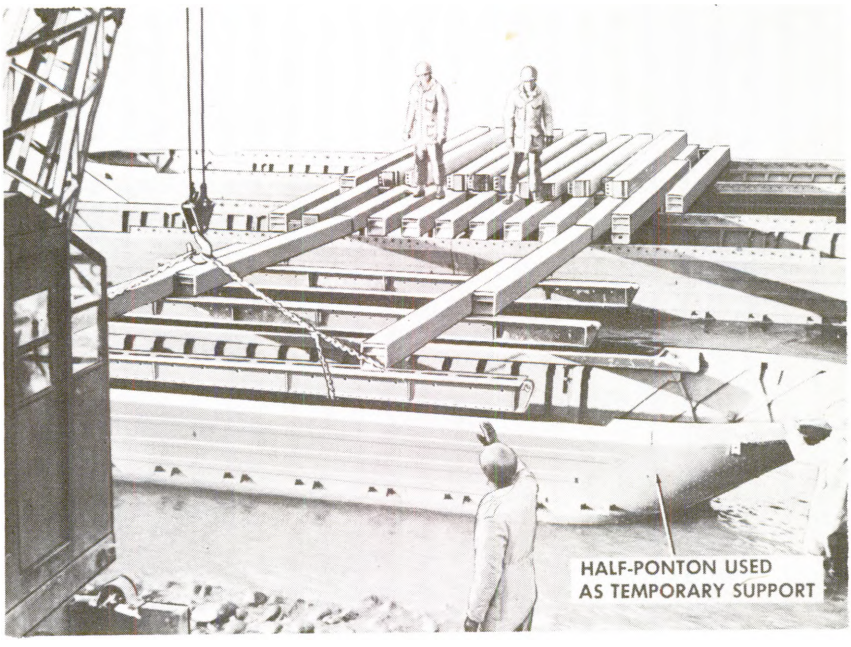
(8) *Step 9.* Rest riverward ends of frame balk on inshore gunwales at slot number 7 on left and slot number 8 on right of raft and pin lugs.



Step 9. Placing frame on gunwales of inshore ponton

Figure 56—Continued.

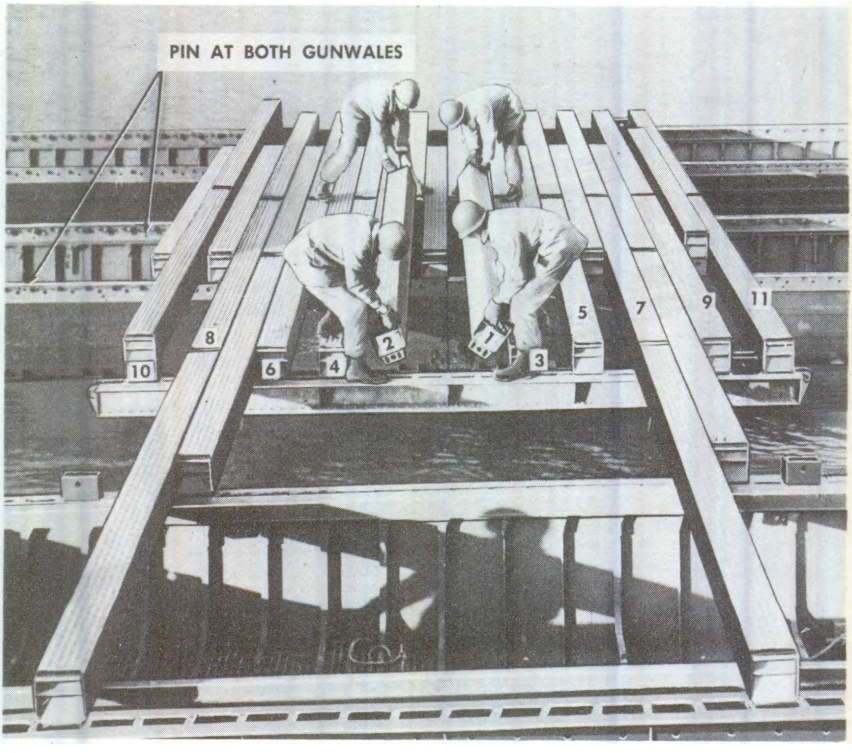
(9) *Step 10.* Move sling to end transverse stiffener, raise frame, and slide a half-ponton (with gunwales) underneath the frame, beneath the end and second stiffener.



Step 10. Placing temporary support under end section

Figure 56—Continued.

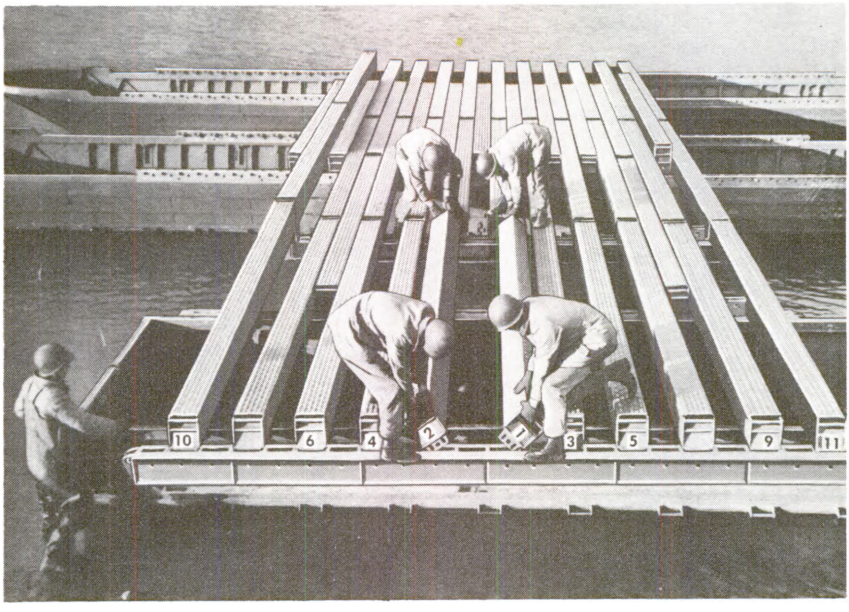
(10) *Step 11.* Remove crane slings and lay extra balk from raft across inshore ponton as near-shore balk. Pin at both gunwales of inshore ponton.



Step 11. Laying extra balk from pontons to stiffener

Figure 56—Continued.

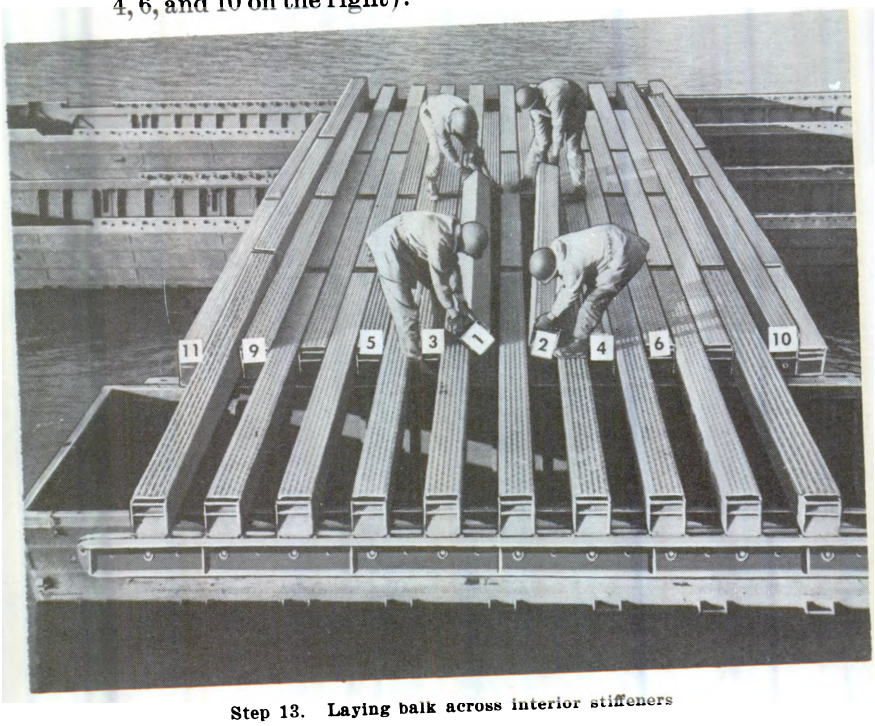
(11) *Step 12.* Carry nine balk from shore and lay across stiffeners as near-shore balk (10, 6, 4, and 2 on the left; 1, 3, 5, 9, and 11 on the right).



Step 12. Laying balk from end transverse stiffener

Figure 56—Continued.

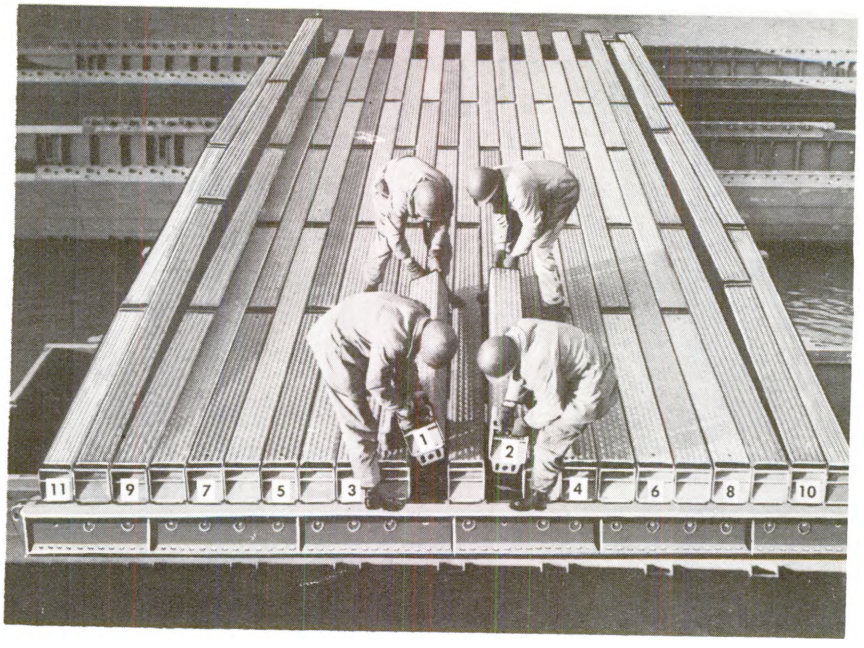
(12) *Step 13.* Carry nine balk from shore and lay across interior stiffeners as far-shore balk (11, 9, 5, 3, and 1 on the left; 2, 4, 6, and 10 on the right).



Step 13. Laying balk across interior stiffeners

Figure 56—Continued.

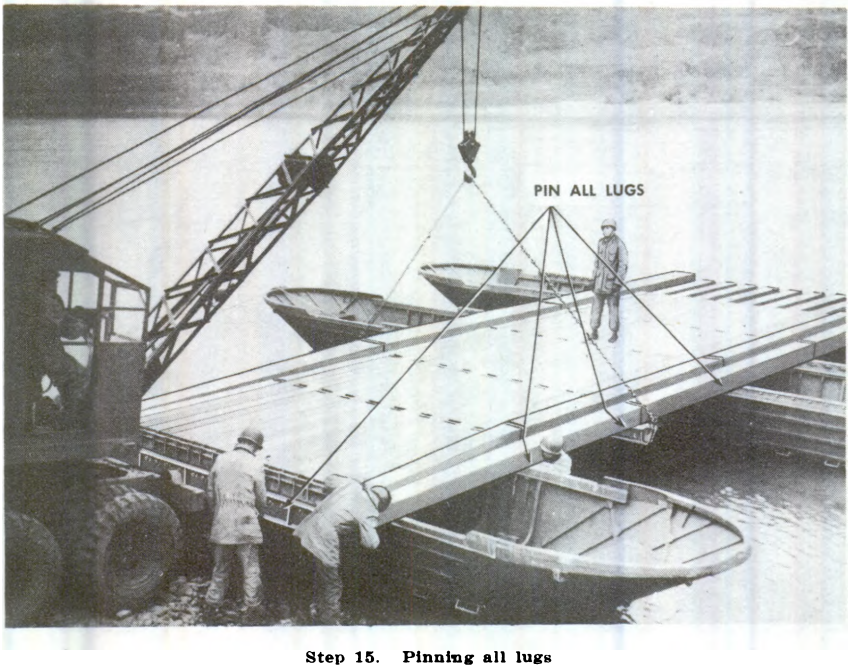
(13) *Step 14.* Carry 11 short deck balk from shore and lay in gaps between normal balk from end stiffener to second stiffener.



Step 14. Laying short balk in gaps

Figure 56—Continued.

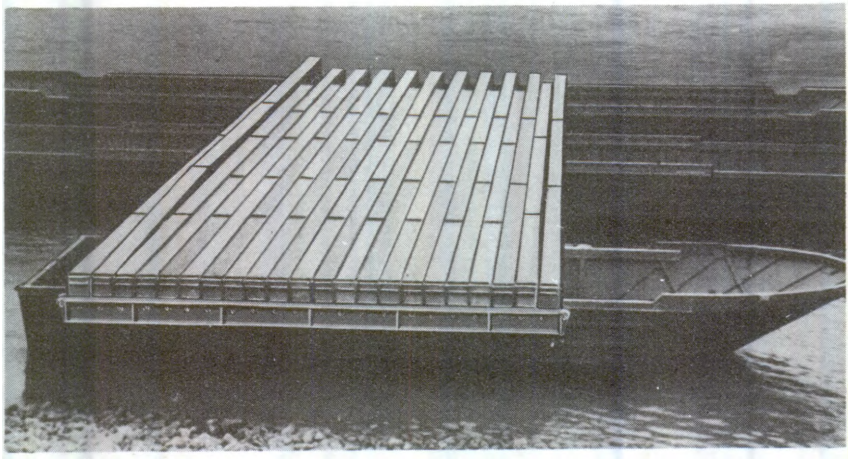
(14) *Step 15.* Attach crane slings to ends of riverward stiffener, raise slightly, and pin all lugs at inshore ponton, and stiffeners.



Step 15. Pinning all lugs

Figure 56—Continued.

(15) *Step 16.* Move completed two-ponton end section to bridge site. All lugs are pinned except at riverward end of offshore ponton. Reinforcing ponton is added to end section after installation or after completion of the bridge.



Step 16. Near-shore end section ready to be moved to bridge site

Figure 56—Continued.

b. Far-Shore End Section (fig. 57, steps 2 to 11). The far-shore end section is assembled using an 18-ton pneumatic float as a temporary support. The near-shore end section also can be assembled using the pneumatic float in place of the half-ponton temporary support. Both near- and far-shore end sections can be assembled with or without the use of a crane. A method of assembling the far-shore end section without a crane is—

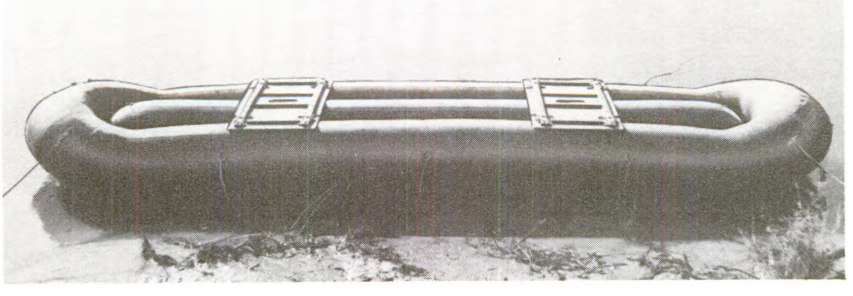
(1) *Step 1.* Inflate and launch the float. Each float has 16 compartments which can be inflated in about 8 minutes by use of two 4-hose manifolds. The float is inflated to a pressure of 2 pounds per square inch. At this pressure the compartments are firm, but will yield to hand pressure. Launch the float by *carrying* to the water; do not drag float.

(2) *Step 2.* Position inflated center tube so valves are up and center bulkhead is in line with center bulkhead of one outer tube.

Step 2. Center tube positioned in float

Figure 57. Far-shore end section.

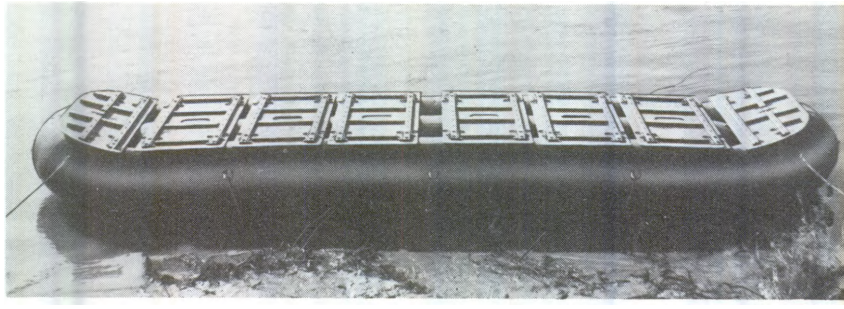
(3) *Step 3.* Place first two interior bearing plates over inflation valves of center tube. Bearing plates are listed as "saddle panels" in the supply catalogs.



Step 3. First two interior bearing plates in position

Figure 57—Continued.

(4) *Step 4.* Place remaining four interior bearing plates with 3-inch spacing each side of the first two. Place end bearing plates well up on the upturned ends of the float.



Step 4. Float with all bearing plates in position

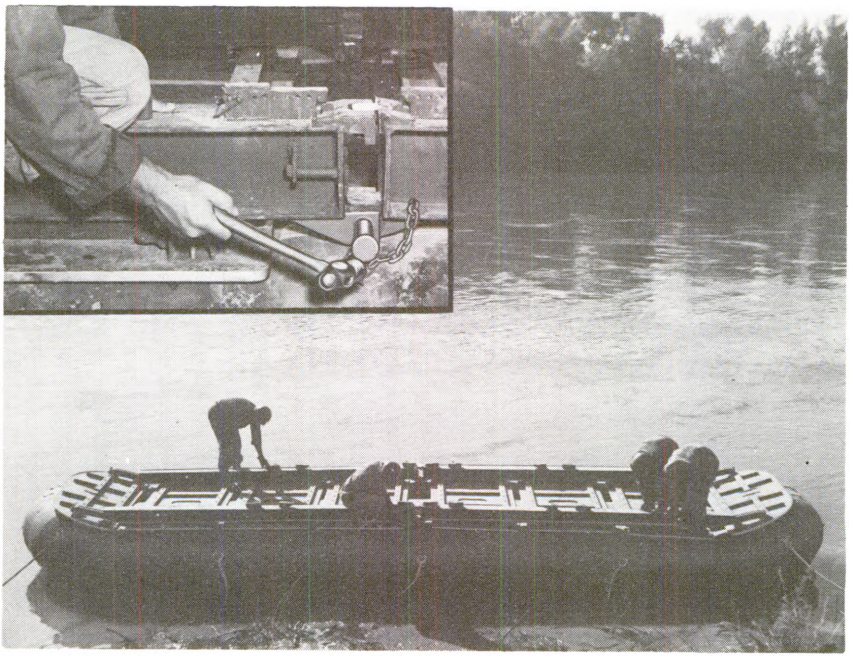
Figure 57—Continued.

(5) *Step 5.* Place female sections of the saddle beams, with outriggers extended and pinned in position, on the upstream end of the float. Aline by sighting through pin hole at center connection. Fasten saddle beams with spring-actuated catches on bearing plates.

Step 5. Female sections of saddle beams in position

Figure 57—Continued.

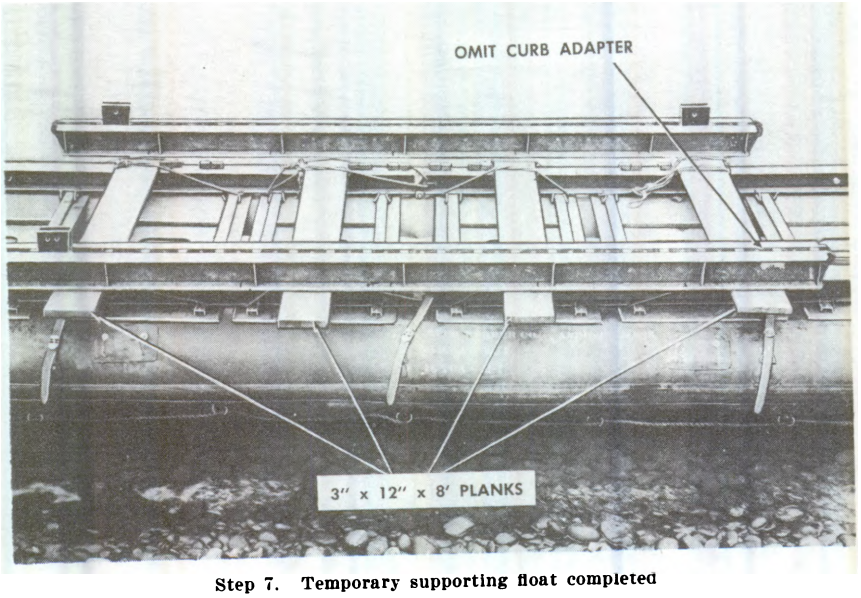
(6) *Step 6.* Position male sections of saddle beams (with steel shims welded in place) and pin to female section of saddle beam. Fasten to bearing plates with spring-actuated catches.



Step 6. Completed saddle beams in position

Figure 57—Continued.

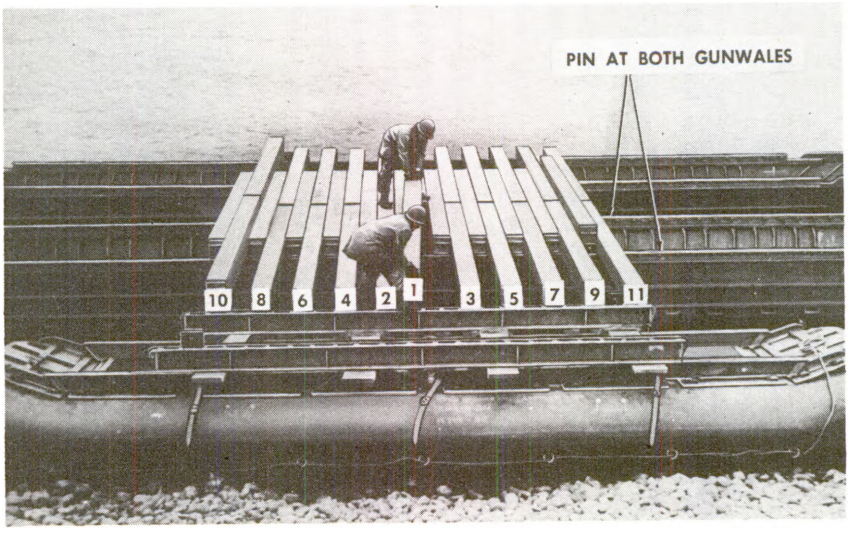
(7) *Step 7.* Lay four 3- by 12-inch by 8-foot planks across saddle beams and place two stiffeners 6 feet 8 inches apart center-to-center. Place curb adapters in three of the number 10 recesses (fig. 57, step 7). Pin retainers face out. Lash stiffeners and planks to saddle beams.



Step 7. Temporary supporting float completed

Figure 57—Continued.

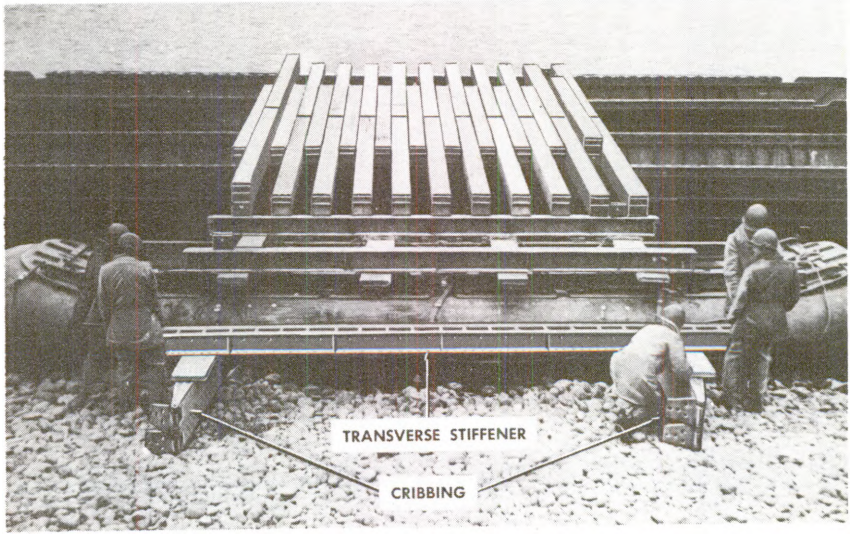
(8) *Step 8.* Bring a two-ponton raft alongside pneumatic float and lay 11 extra balk from raft across inshore ponton as near-shore balk and pin at both gunwales of ponton.



Step 8. Two-ponton raft connected to float

Figure 57—Continued.

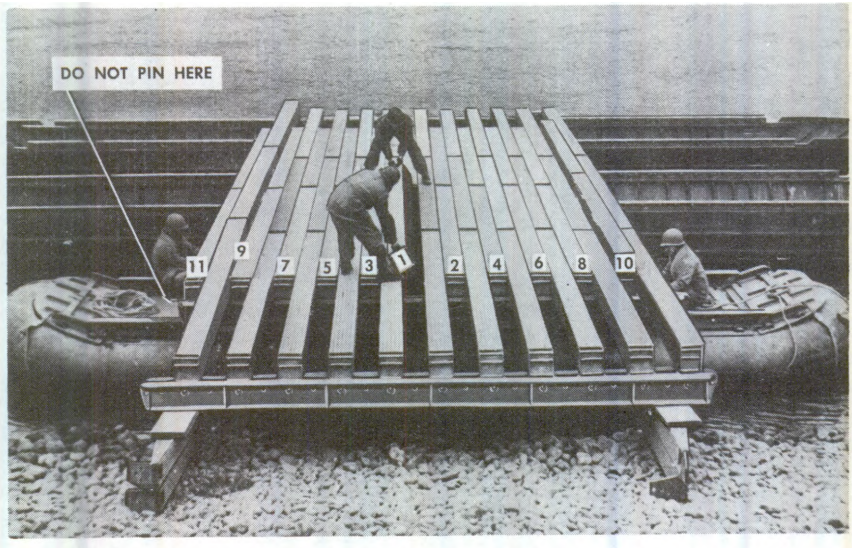
(9) *Step 9.* Place transverse stiffener on cribbing 8 feet 4 inches from inshore stiffener. Crib up until top of stiffener is level with tops of other stiffeners.



Step 9. Placing transverse stiffener

Figure 57—Continued.

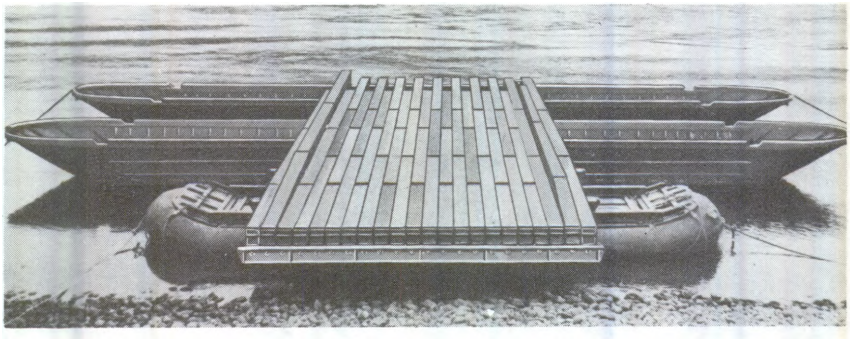
(10) *Step 10.* Lay 11 balk across stiffeners on float as near-shore balk and pin at both stiffeners on float and at end stiffener. Then lay 11 balk across stiffeners on float as far-shore balk and pin at riverward and interior lugs only.



Step 10. Laying remaining balk across stiffeners. Near-shore balk in place

Figure 57—Continued.

(11) *Step 11.* Lay 11 short balk between end stiffener and in-shore stiffener on the float and pin at both ends.



Step 11. Far-shore end section ready to be moved to bridge site

Figure 57—Continued.

48. Installing End Sections

Whenever the situation permits, the near-shore abutment is constructed at the same time as, or before, the end section. Normally, the far-shore abutment cannot be completed until the far-shore end section arrives with necessary heavy equipment.

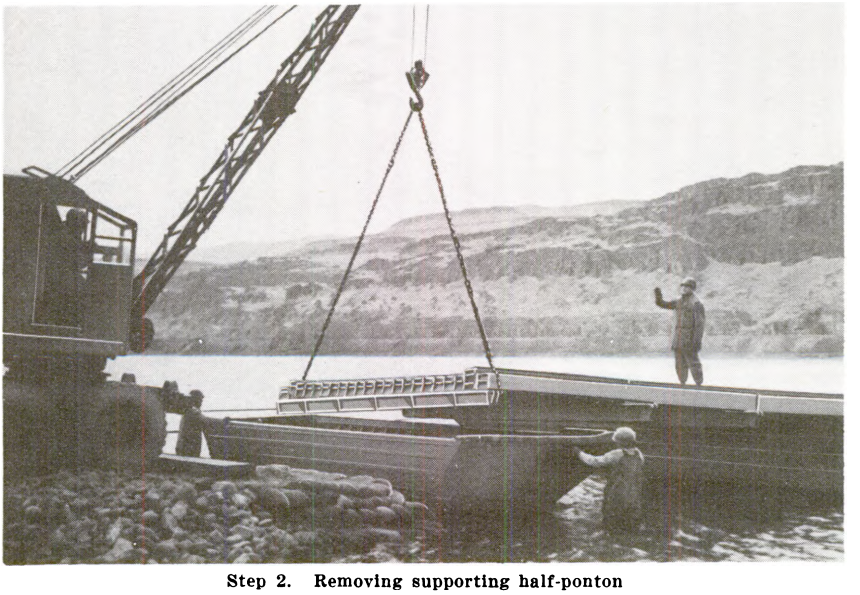
a. Near-Shore End Section (fig. 58, steps 1 to 9). The following is one method of installing a near-shore end section.

(1) *Step 1.* As soon as the near-shore abutment is ready, move the end section and a crane to the abutment. Moor the end section temporarily to holdfasts until the anchorage is installed.

Step 1. End section in position

Figure 58. Installing near-shore end section.

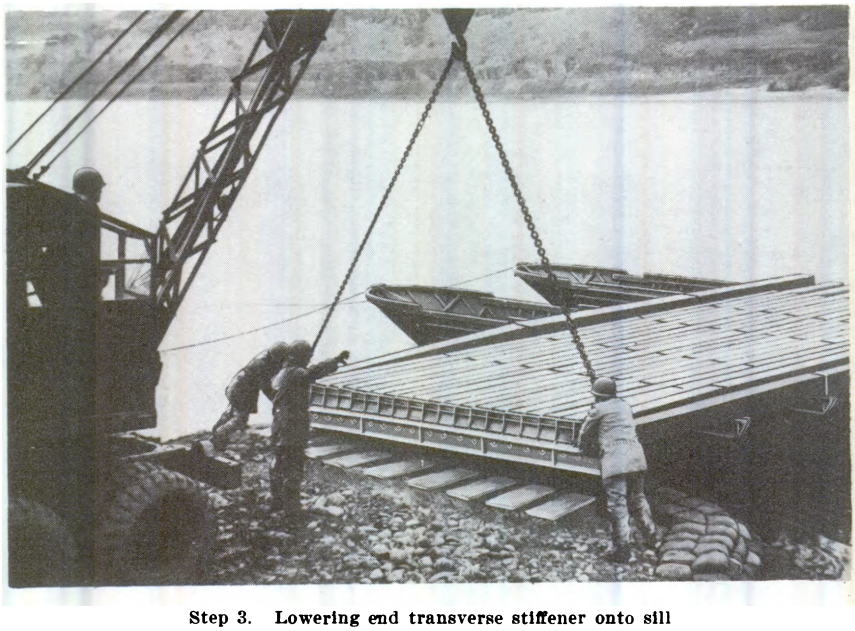
(2) *Step 2.* Attach crane slings to end transverse stiffener. Lift transverse stiffener with crane and remove supporting half-ponton.



Step 2. Removing supporting half-ponton

Figure 58—Continued.

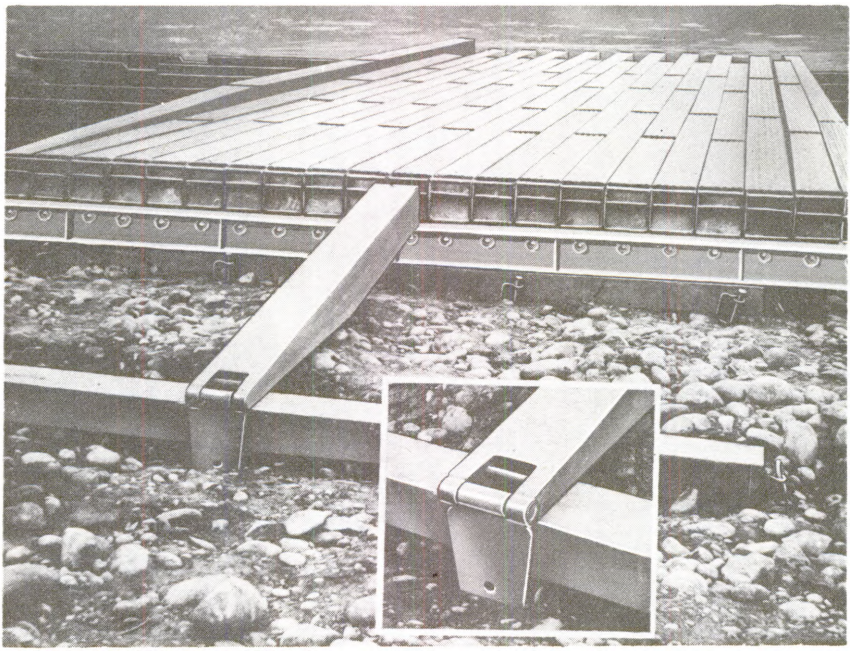
(3) *Step 3.* Lower transverse stiffener to abutment sill, making certain end section is correctly alined with reference to bridge centerline.



Step 3. Lowering end transverse stiffener onto sill

Figure 58—Continued.

(4) *Step 4.* As soon as the end section is installed on the abutment sill, place an 8- by 10-inch by 15-foot 6-inch timber sill to support a tapered-balk ramp. Lay two tapered balk from the transverse stiffener and place the timber sill under the shoreward end so that the hinge flap of the balk lies down over the face of the timber. The tapered balk are laid from the centerline outward to permit pinning. The timber sill is centered on the bridge centerline and must be accurately alined with the transverse stiffener. Entrench the sill at least half its depth, stake in place, and compact earth around it thoroughly.



Step 4. Placing sill to support tapered balk

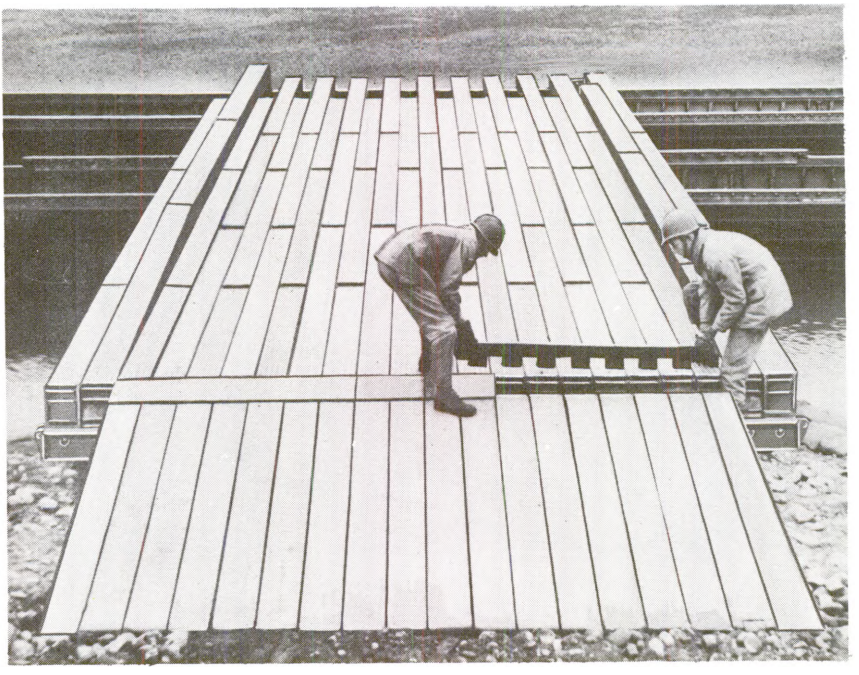
Figure 58—Continued.

(5) *Step 5.* Lay 18 tapered balk from transverse stiffener to timber sill and pin at transverse stiffener.

Step 5. Pinning tapered balk to transverse stiffener

Figure 58—Continued.

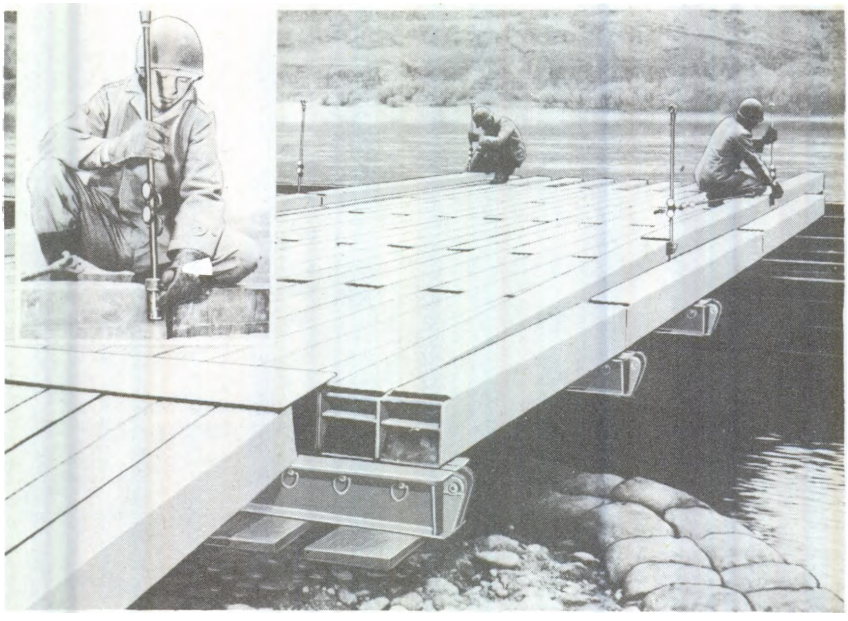
(6) *Step 6.* Cover the gap over the transverse stiffener with two long and two short cover plates. Place short cover plates in center.



Step 6. Placing cover plates

Figure 58—Continued.

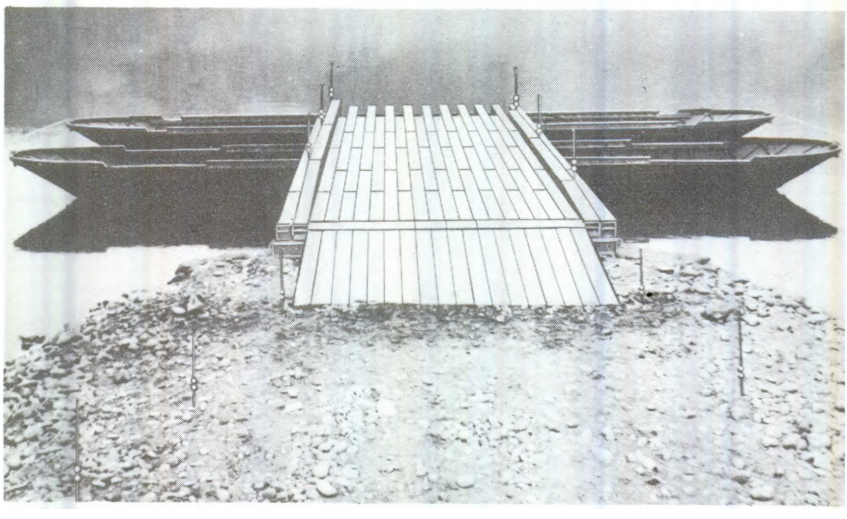
(7) *Step 7.* Place handrail posts at each break in curb by clamping them at balk handles. Place approach posts.



Step 7. Placing handrail posts

Figure 58—Continued.

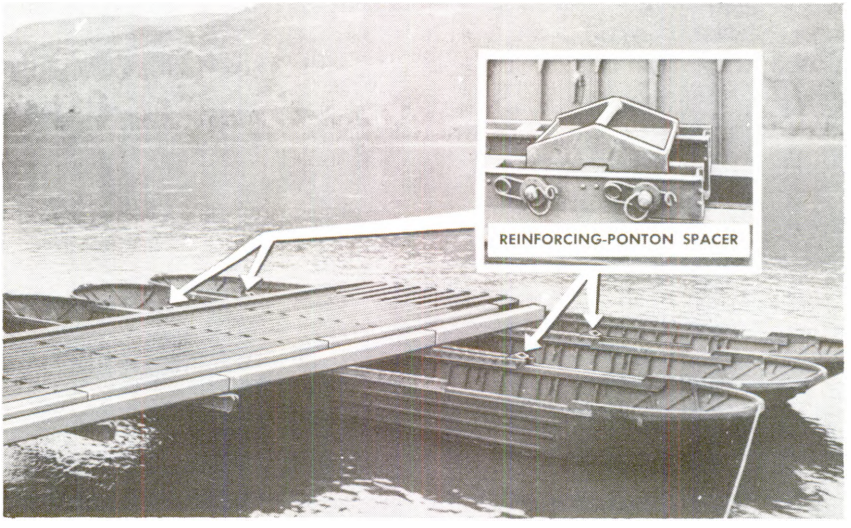
(8) *Step 8.* End section is now ready for addition of reinforcing ponton. This two-ponton end section can be used, but class of vehicles which may cross, as given in table I, must be reduced.



Step 8. Two-ponton end section

Figure 58—Continued.

(9) *Step 9.* Move a completed ponton (fig. 54, step 6) to the end section. Load it with enough men so that it can slide under the bridge deck. Insert between the two pontons of the two-ponton end section and secure in place with four reinforcing-ponton spacers. The end section is now complete and ready for addition of successive pontons or rafts. The reinforcing ponton can be added to the end section during end-section installation or after the bridge has been completed.



Step 9. Completed end section

Figure 58—Continued.

b. Far-Shore End Section (fig. 59, steps 1 to 4). The far-shore end section is installed similarly to the near-shore end section, but when the bridge is assembled from near- to far-shore the far-shore installation cannot be completed until the bridge is closed. Preparation for closing the bridge follows. The far-shore end section must be accurately alined on the bridge centerline and temporarily anchored in place.

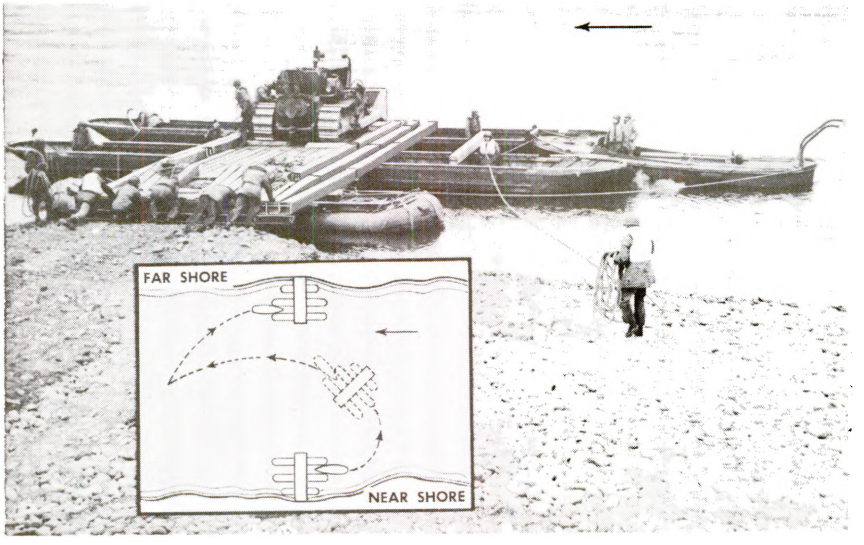
(1) *Step 1.* Load personnel, tools and equipment needed to prepare the far-shore abutment on the end section. The end section with a temporary 18-ton pneumatic float support (fig. 57) can carry vehicles safely up to the size of a D7 bulldozer in current velocities up to 7 feet per second. It may be necessary to partially deflate the pneumatic float before a vehicle can be loaded.

Caution: Do not let the aluminum pontons ground during loading.

Step 1. Loading D7 bulldozer. Note temporary ramp of tapered balk

Figure 59. Installing far-shore end section.

(2) *Step 2.* Move the loaded raft to the far shore. If possible, carry all personnel and equipment required on this load. The temporary tapered-balk ramp, to be used for unloading, is also loaded on the raft.



Step 2. Moving end section to far shore

Figure 59—Continued.

(3) *Step 3.* Prepare a temporary landing stage at or near the location of the bridge abutment.

Step 3. Preparing temporary landing stage

Figure 59—Continued.

(4) *Step 4.* Moor the end section securely to shore, unload personnel and equipment, and construct far-shore abutment. As soon as the bridge has been closed and the final position of the end transverse stiffener determined, complete the far-shore end section in the same manner as for the near-shore end section.

Step 4. Unloading bulldozer from moored end section

Figure 59—Continued.

49. Adding Successive Pontons

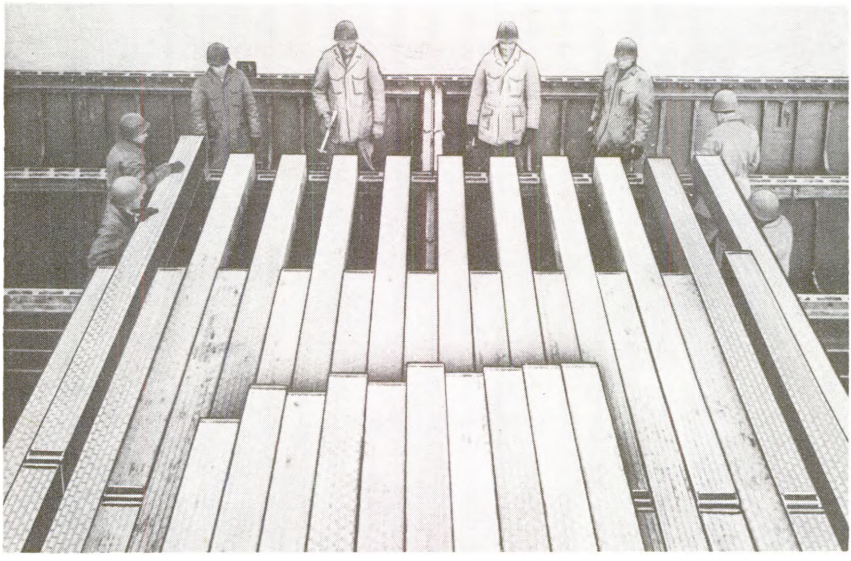
a. Near Shore (fig. 60, steps 1 to 7). The procedure for adding successive pontons is as follows:

(1) *Step 1.* Move each ponton directly from launching site to anchor cable and attach bridle line, or to anchor position and launch anchor.

Step 1. Ponton being moved into position

Figure 60. Adding successive pontons, near shore.

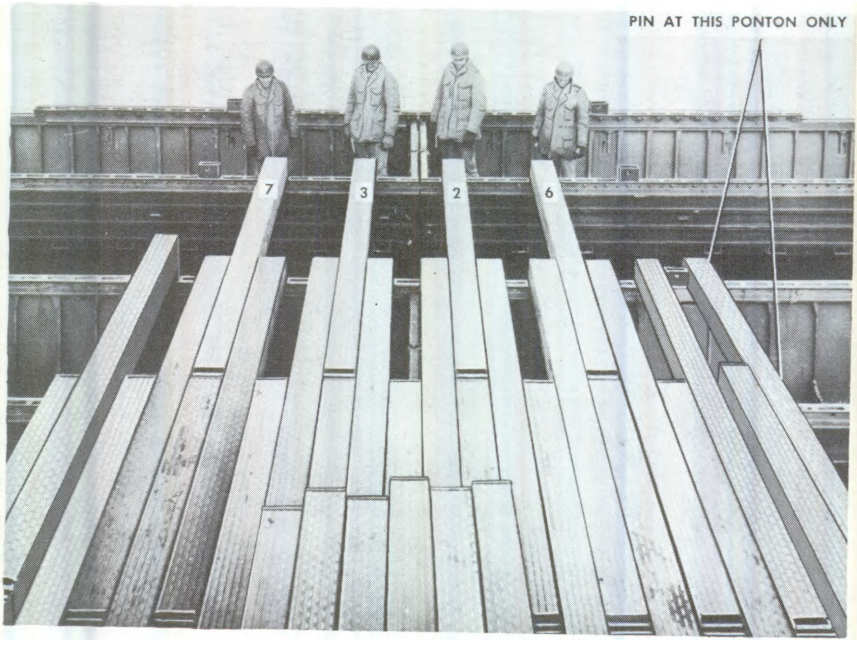
(2) *Step 2.* Allow ponton to drift down to bridge and alongside end ponton of bridge.



Step 2. Ponton alongside bridge

Figure 60—Continued.

(3) *Step 3.* Push the ponton out to proper position with four far-shore balk (7 and 3 on the left; 2 and 6 on the right) of the last ponton in the bridge.



Step 3. Spacing ponton with four balk

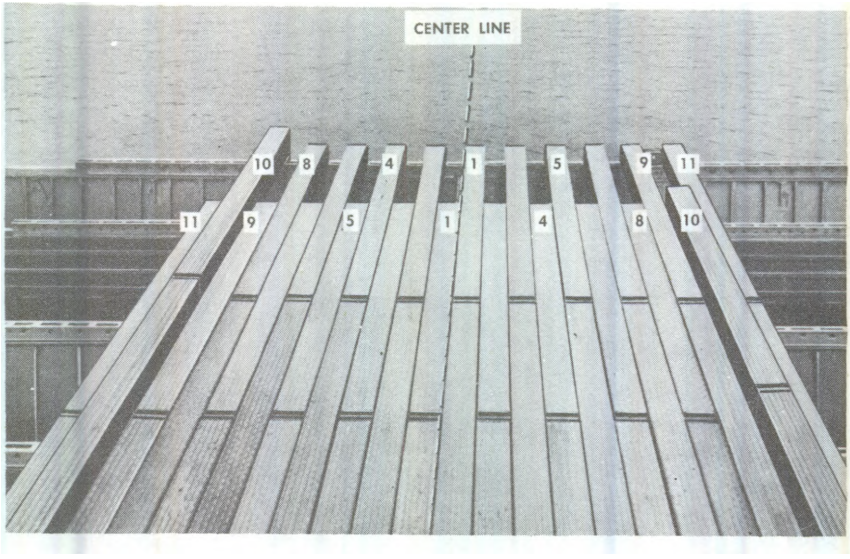
Figure 60—Continued.

(4) *Step 4.* Lay four near-shore balk (6 and 2 on the left; 3 and 7 on the right) across the newly added ponton and pin at interior and shoreward lugs.

Step 4. Adding balk to new ponton

Figure 60—Continued.

(5) *Step 5.* Lay remaining balk, pinning only at interior and near-shore lugs.



Step 5. Remaining balk added and pinned

Figure 60—Continued.

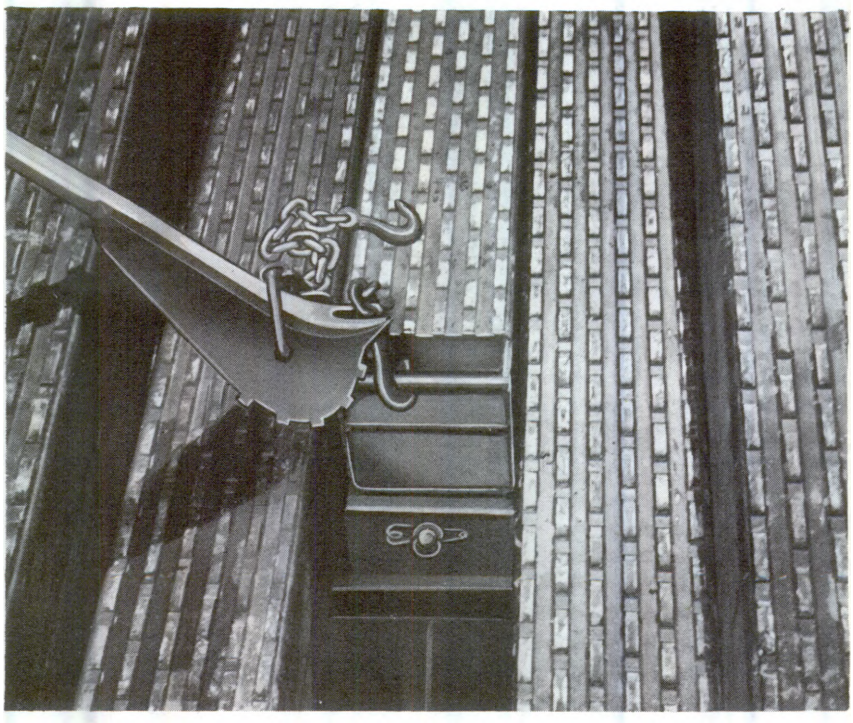
(6) *Step 6.* Aline ponton by adjusting bridle line.

Step 6. Alining ponton by adjusting bridle line

***Figure 60*—Continued.**

(7) *Step 7.* Pin-checking detail with balk-depressing lever follows two or three bays behind balk layers and completes pinning.

Caution: All pins must be fastened.



Step 7. Using balk-depressing lever. Balk removed to show operation

Figure 60—Continued.

b. Far Shore. In order to speed assembly of the bridge, successive pontons can be added to the far-shore end section in the same manner as for the near-shore end section. Extra balk will have to be transported with each ponton when it is delivered to the far shore and more men will be required for assembly.

50. Closing the Bridge

The last span of balk closes the gap between the far-shore end section and the last ponton added to the bridge. In order that this space be the exact length of one normal balk, 15 feet, it is usually necessary to move the far-shore end section longitudinally. To prevent moving the far-shore end section too great a distance, the near-shore end section can be temporarily located. Both ends of the bridge can then be moved for final adjustment.

a. Preparation for Closing. As soon as the gap between near-shore and far-shore pontons of the bridge is narrow enough to be measured accurately, the final position of the far-shore abutment sill is determined as follows:

(1) Measure accurately the distance between the far-shore gunwale of the last ponton added to the bridge and the far-shore gunwale of the riverward ponton in the far-shore end section.

(2) To close the bridge this gap must be a multiple of 15 feet. Subtract the measured distance from the closest multiple of 15 to get the distance that the transverse stiffener must be moved, considering the fact that there must be 40 inches of water under the near-shore ponton and that the abutment sill should be 30 inches above water level.

(3) Measure this distance back from the transverse stiffener and drive pickets on either side of the centerline to mark the final position of the transverse stiffener.

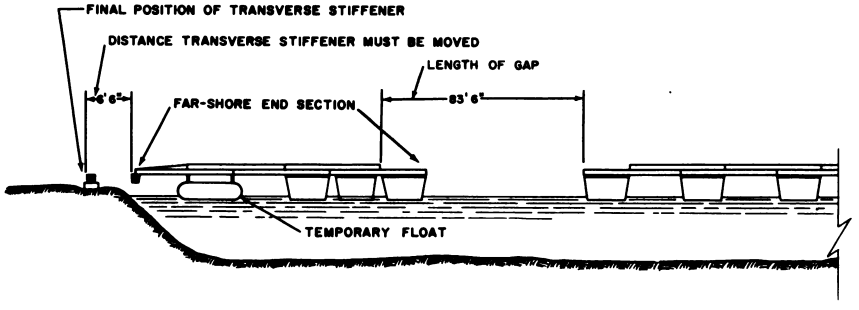
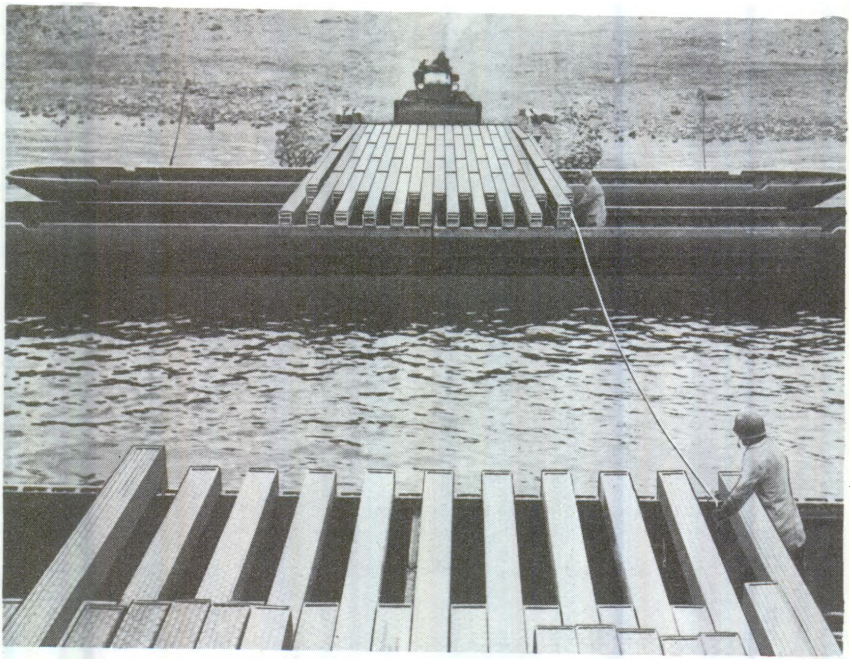


Figure 61. Determining final position of transverse stiffener.

Example: Refer to figure 61. The distance measured between far-shore gunwales of pontons on either side of gap is 83 feet 6 inches. The next highest multiple of 15 feet is 90 feet. Subtracting 83 feet 6 inches from 90 feet gives 6 feet 6 inches, the distance the transverse stiffener must be moved. Measure 6 feet 6 inches back from the transverse stiffener and drive pickets to mark position of the abutment sill.

b. Closing (fig. 62, steps 1 to 7).

(1) *Step 1.* Measure the distance between far-shore gunwales on either side of gap.



Step 1. Measuring the gap

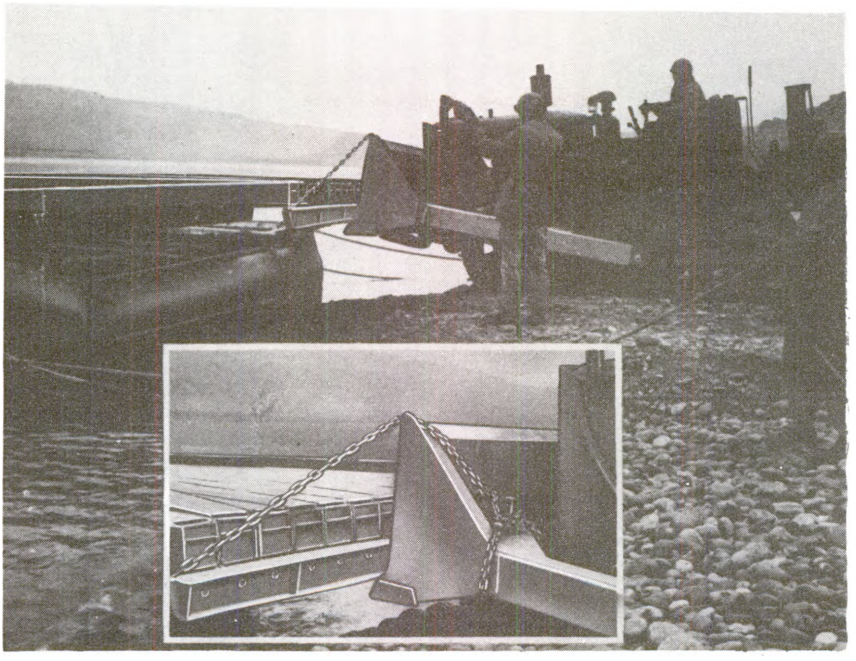
Figure 62. Closing the bridge.

(2) *Step 2.* Establish final position of transverse stiffener.

Step 2. Establishing final position of transverse stiffener

Figure 62—Continued.

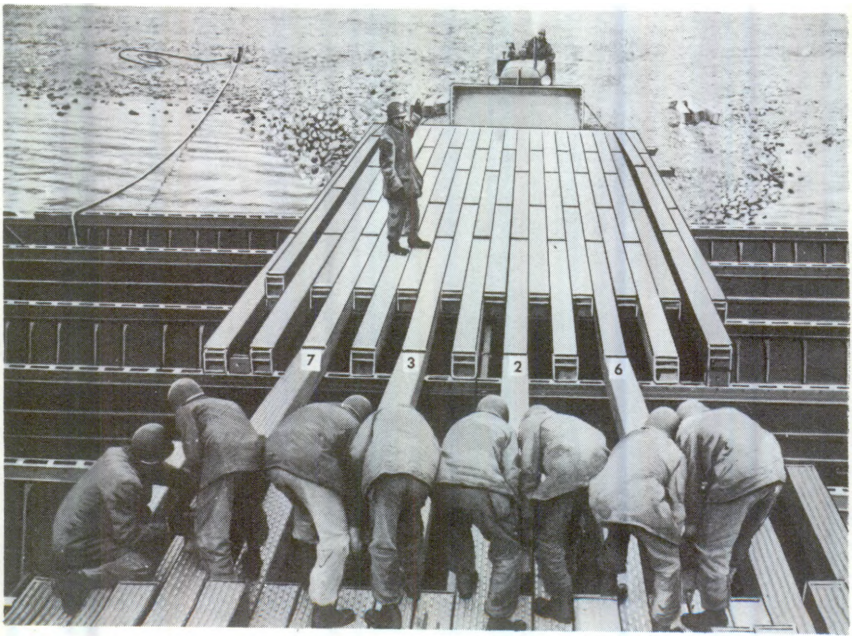
(3) *Step 3.* Raise stiffener with dozer blade and remove float.



Step 3. Stiffener raised with dozer blade to remove float

Figure 62—Continued

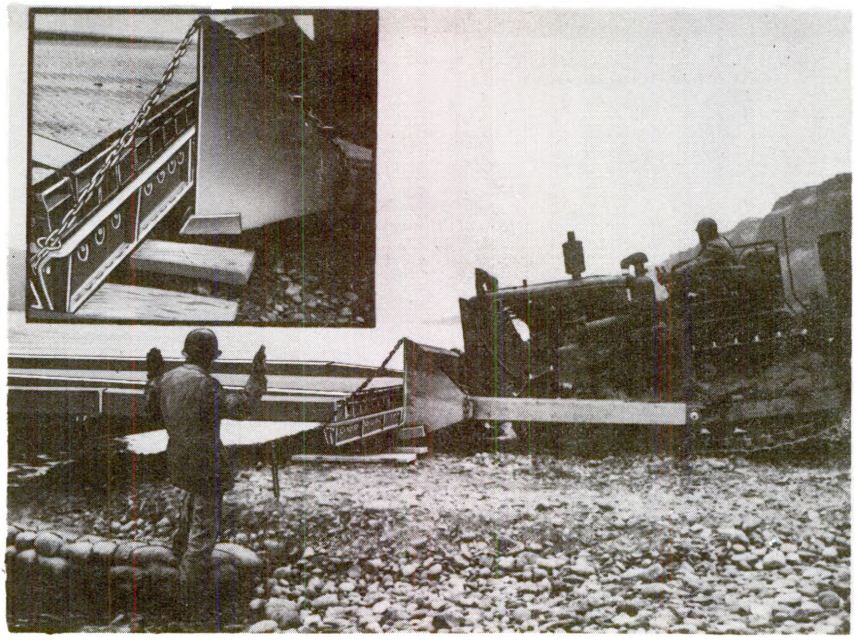
(4) *Step 4.* While final preparations are being made at the abutment, continue to add pontons to the bridge. As the end section is moved toward shore, close the gap with four balk (7 and 3 on the left; 2 and 6 on the right).



Step 4. Closing the gap with balk

Figure 62—Continued.

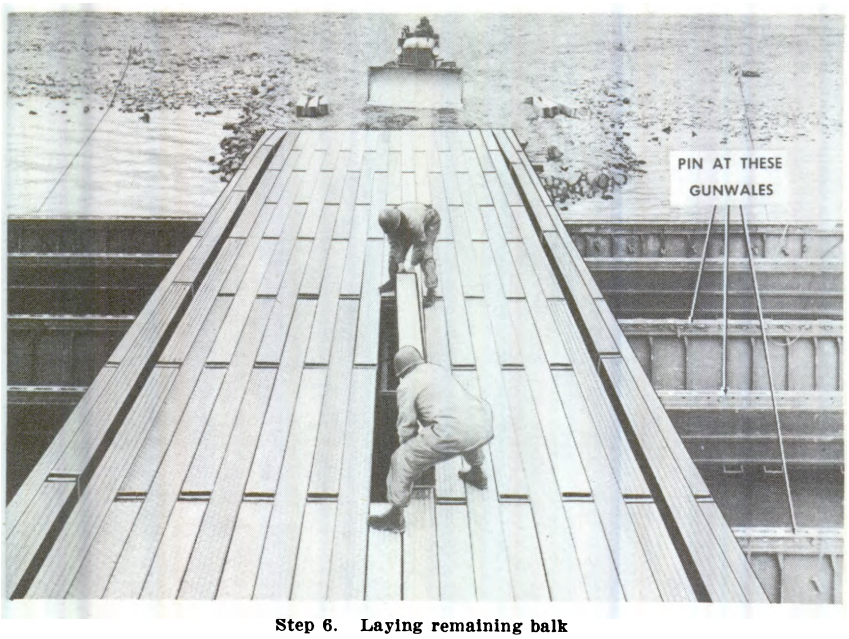
(5) *Step 5.* Pull end section inshore until transverse stiffener is over its final position. Lower stiffener onto sill.



Step 5. Lowering stiffener onto simple plank sill

Figure 62—Continued

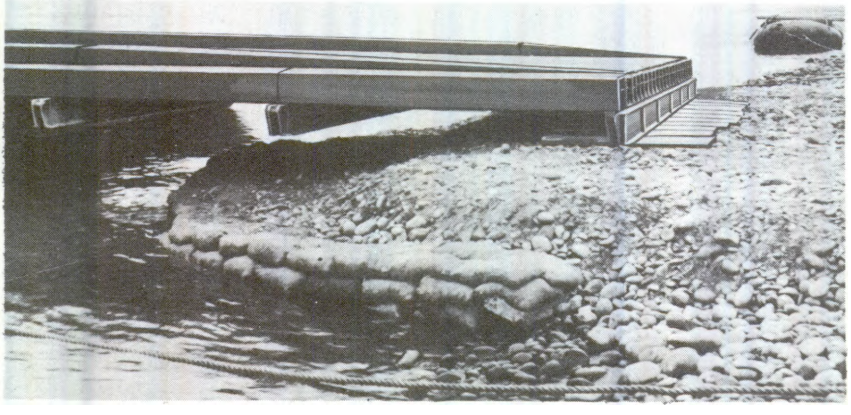
(6) *Step 6.* Continue laying balk across closing span until all are in place. Pin all balk at interior and end lugs.



Step 6. Laying remaining balk

Figure 62—Continued

(7) *Step 7.* Make minor adjustments in position of end section and complete abutment and abutment sill.



Step 7. Stiffener in final position

Figure 62—Continued

(8) *Step 8.* Lay tapered-balk ramp from stiffener to a sill (fig. 58, steps 4 to 6) or construct a floating-sill end span (fig. 64).

51. Variations in Assembly

Many variations are possible in the assembly of an M4 floating bridge. A few of the variations which have been tested and proved are discussed in this paragraph.

a. End Section.

(1) When the abutment is level with or lower than the floating section of the bridge, the continuous-deck end span tends to rise off the abutment (fig. 63). This condition can be

Figure 63. End span raised off abutment.

alleviated by the use of a 15-foot simple span extending beyond a "floating" sill to a fixed abutment sill (fig. 64).

(2) If a crane is used, the near-shore end section can be assembled most easily at the abutment. A temporary half-ponton or float is then unnecessary.

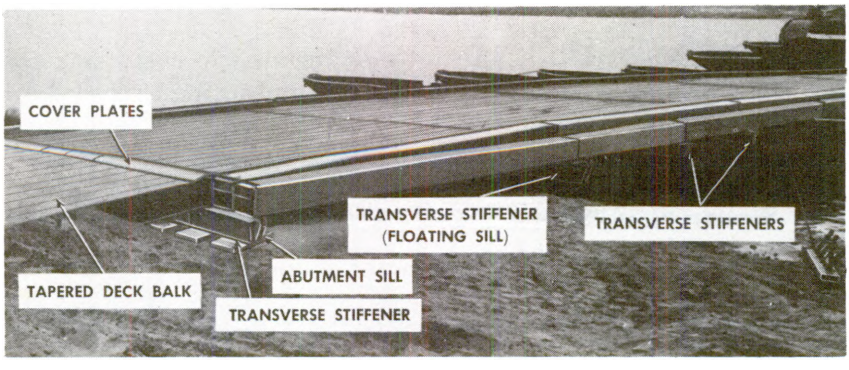


Figure 64. End section with "floating" sill.

(3) Methods of assembly by manpower other than the one described in paragraph 48*b* can be used to assemble either end section.

(*a*) Assemble a two-ponton raft as in paragraph 47*a*, steps 1 to 5, and move it to the centerline of the bridge. Add overhanging balk, using cribbing as a temporary support under the transverse stiffeners to keep them level with ponton gunwales. After the end transverse stiffener has been hung and all balk laid, remove the cribbing and lower the stiffener onto the sill.

(*b*) When the end section is assembled with a pneumatic float under the transverse stiffeners, deflate the float to allow the end transverse stiffener to drop to its final position. With this method, no heavy equipment is needed to install the end section.

(*c*) Use a half-ponton temporary support for the end span. Lay two 3- by 12-inch by 8-foot planks across the gunwales about 12 feet apart. Lay transverse stiffeners across the planks and over the gunwales. To install the end section, pump water into the half-ponton, or load men in it, until it is submerged enough to float free. The half-ponton must be submerged about 2 feet before it can be removed. When using this method for the far-shore end section, lash stiffeners and planks to the supporting half-ponton before moving the end section across the river.

b. Closing the Bridge. If a bulldozer is not available, use a truck winch to move the end section into final position. Attach winch cable so that it pulls directly along centerline of bridge. Run winch cable through a block-and-tackle, if necessary. Lay planks, 12 feet long, parallel to the bridge centerline, lower end-section transverse stiffener onto planks and slide stiffener along planks to its final position. Remove temporary planks and lower stiffener to the abutment sill. Truck, with winch, can be ferried to far shore or can cross closing gap on a simple fixed span.

c. Balk Laying. The number of men required to carry balk for successive ponton assembly can be reduced by backing a truck load of balk onto the incomplete bridge. This shortens the balk carry and speeds assembly.

Section II. BRIDGES MORE THAN 300 FEET LONG

52. Assembly by Raft Sections

M4 floating bridges over 300 feet long are usually assembled by the raft method. Instead of adding successive pontons to the bridge, four-ponton rafts are assembled and added to the bridge as a unit.

This section gives suggested working parties and procedures for assembly of a bridge approximately 1000 feet long in currents up to 7 fps.

53. Working Party

a. Organization. Table XI gives a suggested breakdown of the working party and a summary of the tasks of the details.

b. Duties of Details.

(1) *Near-shore abutment.* One NCO and eight men build the near-shore abutment, install the sill, approach posts and handrail lines, and maintain the bridge alinement with shore guys while the anchor cable system is being completed. In swift streams temporary shore guys are attached to the bridge during assembly.

(2) *Far-shore abutment.* One NCO and 16 men cross to far shore in bridge erection boats and prepare a landing for the far-shore end section. The detail receives the far-shore end section from the raft delivery detail, and prepares the abutment. If available, the bulldozer is used to prepare a deadman for the anchor cable before preparation of the abutment. If conditions warrant it, two bulldozers may be used.

(3) *Raft assembly (each of three crews).* The raft-assembly details are divided into three crews each as follows:

(*a*) *Ponton launching and outfitting.* One NCO, six men, and a crane operator unload and assemble pontons, gunwales, and curb adapters. They connect pontons and equip them with anchors, anchor lines, bridle lines, bail pump, boat-hooks, and bow duckboards.

(*b*) *Ponton delivery.* Three two-man teams hold half-pontons together until they are connected, deliver them to raft assembly detail, and hold guy lines as raft is assembled.

(*c*) *Raft assembly.* One NCO and 8 men lay and pin balk. One NCO and 24 men carry balk from trucks to raft.

(4) *Raft delivery (each of three crews).* Delivery crews consisting of 1 NCO and 12 men in a bridge erection boat carry far-shore abutment detail to far shore, and deliver end sections and rafts to the bridge site. In delivering rafts, 2 men form the bridge erection boat crew, 2 men handle the upstream bridle line in each ponton, and 2 men handle the mooring lines in the shoreward ponton of the raft.

(5) *Raft connecting.* Eight men lay the balk from the raft to the end of the bridge. Two men pin balk at the last ponton on the bridge and two men pin the balk at the raft end.

Table XI. Organization of Working Party for Assembly by Rafts

Details	NCO	EM	Equipment	Summary of tasks*
Near-shore abutment	1	8	Pioneer tools, bulldozer, abutment sill, sandbags.	Construct near-shore abutment; install sill, approach posts and handrail lines; maintain bridge alinement.
Far-shore abutment	1	16	Pioneer tools, bulldozer, abutment sill, sandbags, footings (3′′ x 10′′ x 3′).	Travel to far shore in bridge erection boats; construct far-shore abutment; install far-shore end section.
Raft assembly:			3 cranes, 24 hammers, 3 balk-depressing levers, 18 half-inch lines 20 feet long.	2 details assemble end sections, then assemble four-ponton rafts; third detail assembles four-ponton rafts. Each detail unloads, outfits, connects half-pontons; unloads balk; assembles rafts.
Crew 1	4	45		
Crew 2	4	45		
Crew 3	4	45		
Raft delivery:			3 bridge erection boats, 27′; six ¾-inch lines 20 feet long.	Bridge erection boats ferry far-shore abutment detail, deliver end sections to near- and far-shore abutment, then deliver rafts to bridge; move each raft to anchor cable, attach bridle lines and aline raft on centerline of bridge.
Crew 1	1	12		
Crew 2	1	12		
Crew 3	1	12		
Raft connecting	1	12	8 hammers	Connect raft to bridge; install pins in connecting balk; check all pins on rafts; make connections to far-shore end section.
Anchorage	4	24	1 bridge erection boat, 27′; 8 wrenches, 2 rigging chests, pioneer tools, bulldozer, 6 assault boats, prepared towers.	Install upstream anchor cables, install and tighter shore guys.
Rescue and utility:			1 bridge erection boat, 19′; 1 bridge erection boat, 27′.	Rescue boat; general utility boat.
Crew 1	------	2		
Crew 2	------	2		
Total	22	235		

*See paragraph 53 for detailed description of tasks.

(6) *Anchorage.*

(*a*) Two NCO's and 12 men cross to far shore with tools and equipment and prepare far-shore deadman. If a tower is used, it is ferried across. Two NCO's and 12 men unload cable reels and other equipment needed on near shore, prepare the anchor cables for installation, and install the anchor cable.

(*b*) After anchor cables are installed, four crews of one NCO and six men each prepare and install guy lines. One bridge erection boat ferries guy lines from shore to bridge.

(7) *Rescue and utility.* One 19-foot bridge erection boat with two-man crew acts as a rescue boat. One 27-foot bridge erection boat with two-man crew acts as a general utility boat.

54. Abutments

For a discussion of the construction of the abutments for the M4 floating bridge, see paragraph 40.

55. Anchorage

The anchorage must be carefully planned to meet local conditions and to insure safety of the bridge. For a discussion of anchorage systems for the M4 floating bridge, see paragraph 43. Bridle lines are attached to all pontons of a raft section at one time, instead of to each ponton individually.

56. Launching and Outfitting Pontons

The pontons are launched, outfitted and delivered to raft assembly sites in the same manner as for assembly by successive pontons (par. 45).

57. Assembly and Installation of End Sections

The assembly and installation of the end sections are the same whether the bridge is assembled by successive pontons or by raft sections. For assembly and installation information, see paragraphs 47 and 48.

58. Raft Assembly

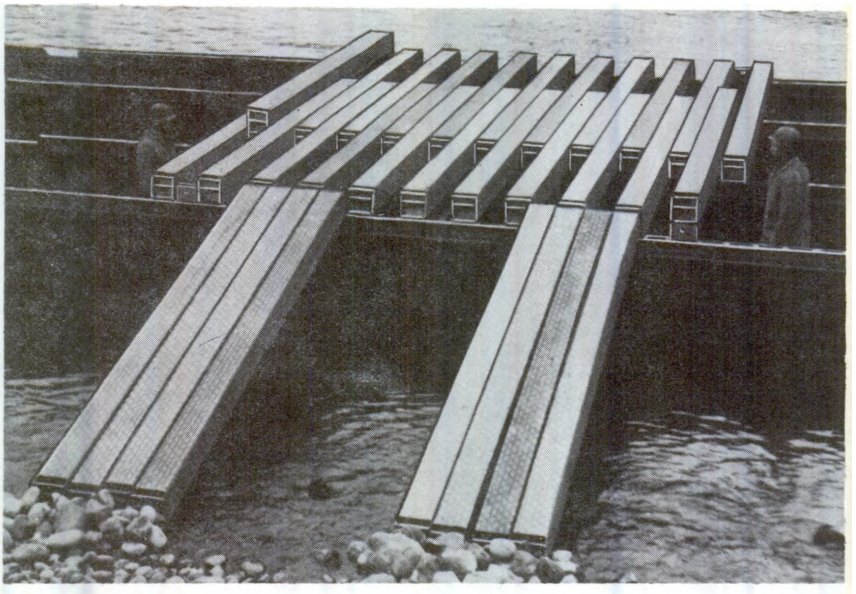
a. Method of Laying Balk.

Caution: Unless balk are placed properly on each raft, the raft cannot be attached to the bridge.

The method of laying balk is the same as for successive pontons (par. 46). All odd-numbered balk on the right half-ponton and all even-numbered balk on the left half-ponton must be *near-shore balk.*

b. Raft Assembly (fig. 65, steps 1 to 4).

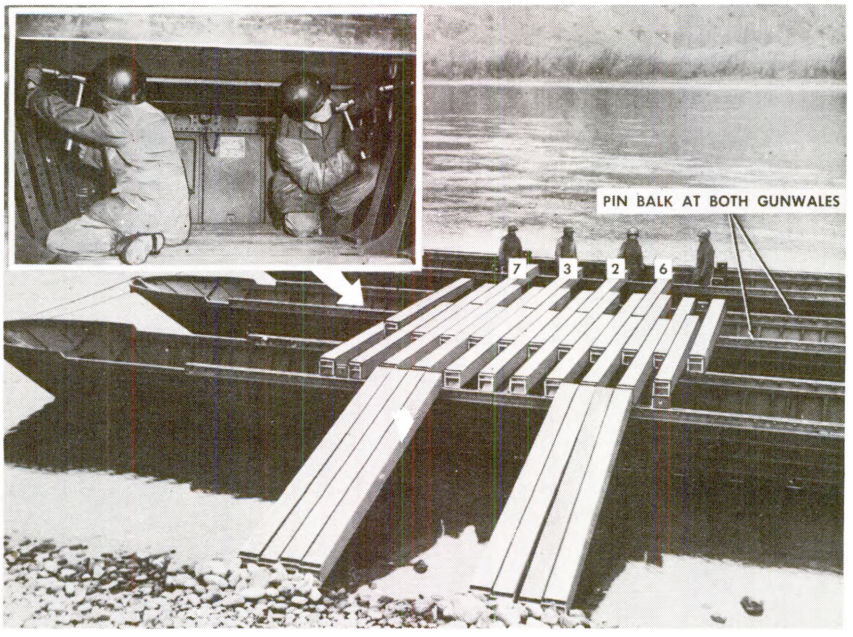
(1) *Step 1.* Assemble a two-ponton raft (par. 47*a*, steps 1 to 5). Lay 8 or 10 balk from shore to first ponton to provide a walkway for balk carriers.



Step 1. Two-ponton raft with temporary ramps

Figure 65. Raft assembly.

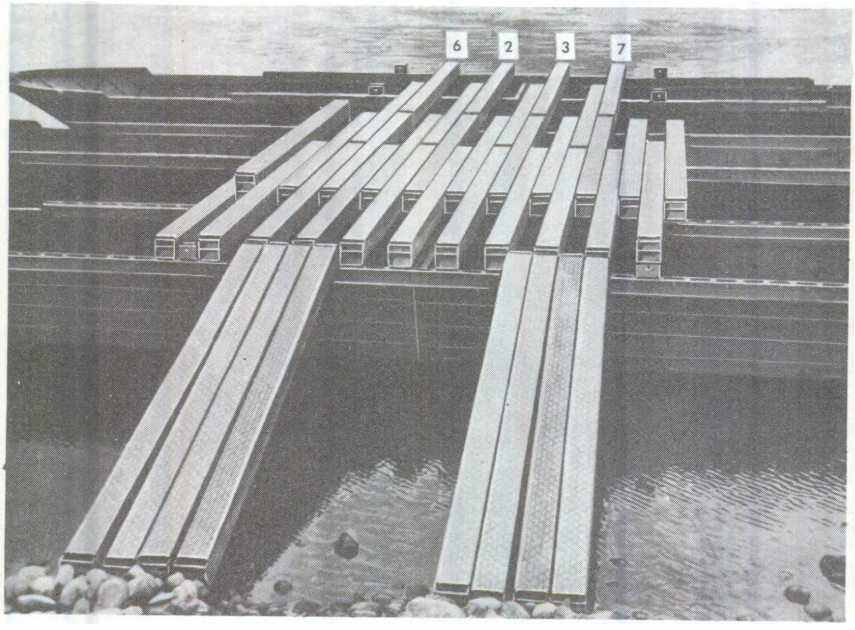
(2) *Step 2.* Bring another whole ponton alongside the second ponton. Lay four far-shore balk across the second ponton (7 and 3 on the left; and 6 and 2 on the right) and pin at both gunwales of the second ponton.



Step 2. Adding third ponton

Figure 65—Continued.

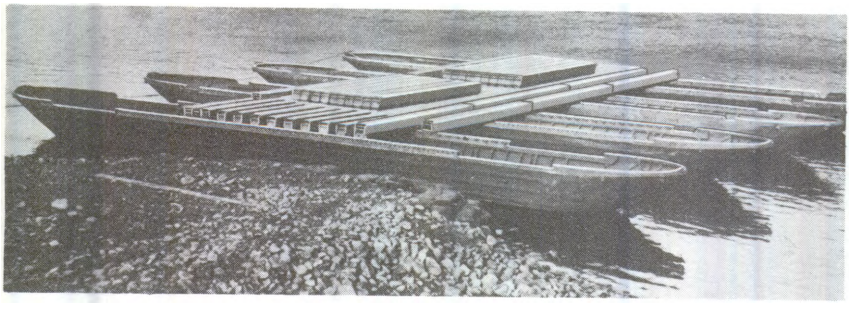
(3) *Step 3.* Lay four near-shore balk (6 and 2 on the left; 3 and 7 on the right) across the third ponton. Pin at second ponton and only at interior lugs. Add the fourth ponton in the same manner as the third. Lay remaining balk on the raft and pin where two balk meet and only at interior lugs.



Step 3. Laying balk on third ponton

Figure 65—Continued.

(4) *Step 4.* Load the raft with 22 extra balk.



Step 4. Completed raft with 22 extra balk

Figure 65—Continued.

59. Adding Successive Rafts

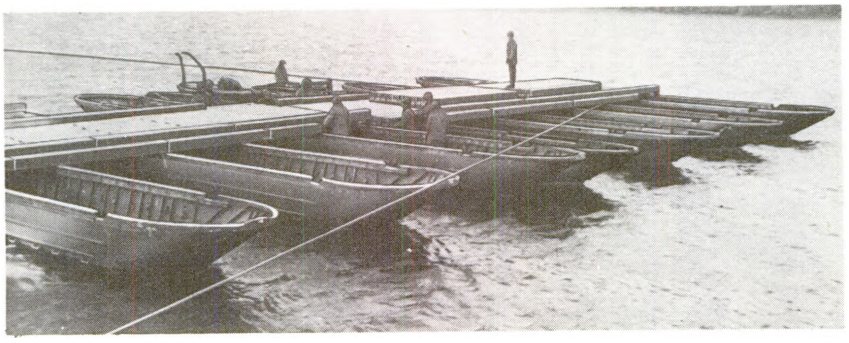
a. Bridge Erection Boat Connections. See chapter 6 for a discussion of connecting bridge erection boats to rafts.

b. Anchoring Rafts. Attach all bridle lines to each raft as it is

installed. Bridle lines are attached directly from the raft by moving the raft up to the anchor cable. They can also be attached by a bridge erection boat which is fastened to the anchor cable by a safety line to keep it from floating into the bridge if the power fails.

c. Connecting Rafts (fig. 66, steps 1 to 3).

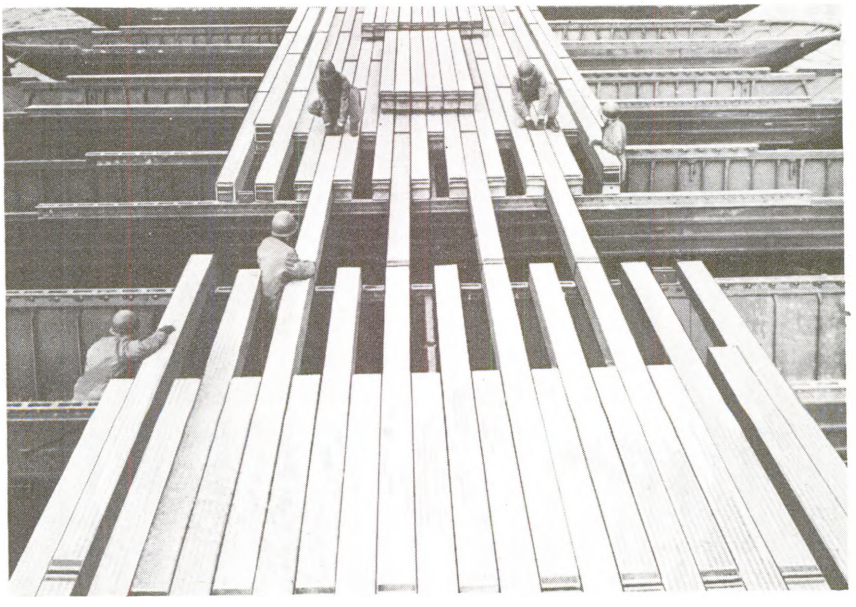
(1) *Step 1.* Anchor the raft at the end of the bridge.



Step 1. Raft anchored at end of bridge

Figure 66. Connecting rafts.

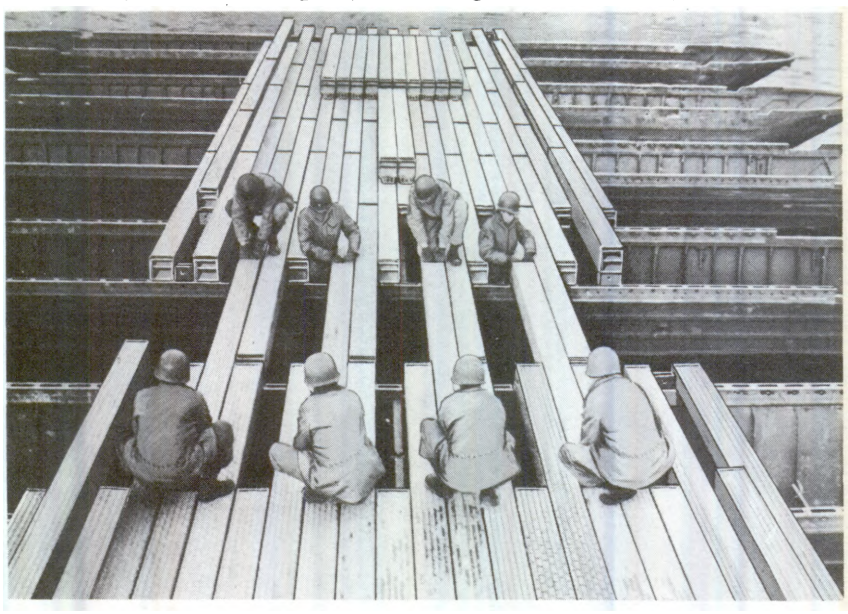
(2) *Step 2.* Space the raft from the end of the bridge with four near-shore balk from the shoreward ponton of the raft (6 and 2 on the left; 3 and 7 on the right). Pin interior and end lugs.



Step 2. Spacing raft from bridge

***Figure 66*—Continued.**

(3) *Step 3.* Lay four far-shore balk on the riverward ponton of the bridge and pin interior and end lugs. Complete the span, check all pins, and bring next raft into position.



Step 3. Laying balk in span

***Figure 66*—Continued.**

60. Closing the Bridge

The procedure for closing the bridge is the same as in assembly by successive ponton (par. 50).

61. Variations in Assembly

a. Direction of Assembly. The bridge can be assembled from the near shore, from the far shore, or from both shores at the same time. The choice depends upon the amount of work required on abutments or trestles, on the length of the bridge, on the tactical situation, and on the current velocity.

b. Other Variations. The variations discussed under assembly by successive pontons also apply to assembly by rafts (par. 51).

62. Final Inspection of Bridge

As each ponton is added to the bridge and after the balk have been laid in the closing span, the pin-checking detail uses a balk-depressing lever to insert all gunwale pins which balk layers were unabe to fasten. Light traffic on bridge aids insertion of most difficult pins. Remaining handrail and approach posts and handrail lines are placed. Horizontal connectors on pontons are checked.

CHAPTER 5

REINFORCED BRIDGES

63. General

a. Assembly. The M4 floating bridge is reinforced (fig. 67) to provide for the crossing of vehicles that are too heavy to cross the bridge as normally assembled. In order to keep assembly methods similar and transportation requirements at a minimum, only component parts of the basic bridge set are used in assembly.

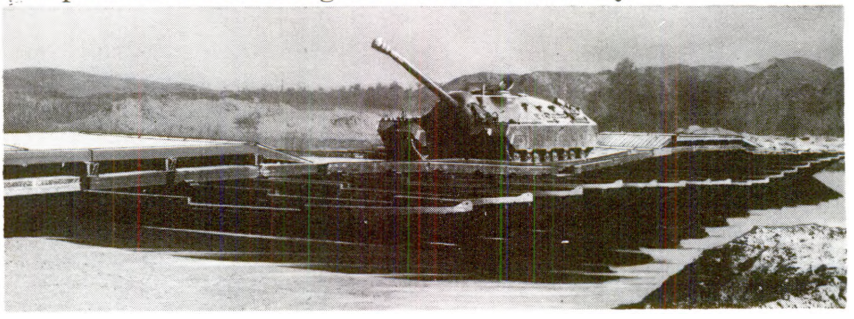


Figure 67. Tank loaded to 94 tons crossing a fully reinforced M4 floating bridge.

b. Design.

(1) To gain width and strength the deck is 24 balk wide with a roadway width of 20 balk (185 inches), and the end spans are 22 balk wide with a superimposed deck. Reinforcing pontons are added between normal pontons and are connected and spaced by reinforcing-ponton spacers (fig. 18). A comparison of the maximum lengths of the various types of floating bridges which can be assembled using only the component parts of one basic bridge set is given in table XII.

Table XII. Lengths, in Feet, of Bridge Assembled With One Basic Bridge Set

Bridge set	Normal assembly	100 percent reinforced w/full pontons	50 percent reinforced w/full pontons	100 percent reinforced w/pneumatic floats
W/water-level accommodation sections	608	345	398	413
W/o water-level accommodation sections	428	255	308	323

(2) The three methods of reinforcing an M4 floating bridge, in order of preference and as shown in figure 68, are—
   (*a*) 100 percent with whole pontons.
   (*b*) 50 percent with whole pontons.
   (*c*) 100 percent with pneumatic floats.

(3) The bridge 100 percent reinforced with whole pontons is only one capable of carrying loads of class 80 or more in stream currents of 8 feet per second or greater. Of the other methods, the bridge 50 percent reinforced with whole pontons is the better bridge, and it can be reinforced quickly with a minimum of traffic stoppage. The last method is used only when the others are impracticable. It results in a bridge that is less stable. Also, the pneumatic floats must be removed before the bridge can be changed to one reinforced with whole pontons.

(4) The best shore connection for most conditions is a normal 23-foot continuous-deck end span reinforced by a superimposed 38-foot deck-balk simple span (fig. 71). For long spans requiring trestles, water-level accommodation can be provided by placing trestles, thoroughly braced, 8 feet 6 inches apart.

64. Types of Assembly

The three types of reinforced bridges (fig. 68) are assembled as follows:

a. The bridge is 100 percent reinforced with whole pontons (fully reinforced) when whole pontons are spaced on 7-foot 6-inch centers from shore to shore. When reinforcing normal assembly, insert whole pontons in all spaces.

b. The bridge is 50 percent reinforced with whole pontons when three whole pontons are assembled on 7-foot 6-inch centers and these assemblies are placed one ponton space (8 feet 4 inches) apart. To reinforce normal assembly, add whole pontons in alternate spaces.

c. The third type is assembled by alternating whole pontons with pneumatic floats on 7-foot 6-inch centers. The balk are pinned to the whole pontons and not to the pneumatic floats. Normal assembly is reinforced by adding pneumatic floats to all spaces.

65. Assembling End Spans

The sequence of operations for assembling a superimposed end span (figs. 69 and 71) is as follows:

a. Step 1. Assemble a 23-foot continuous-deck end span as for normal assembly (ch. 4) with these exceptions:

(1) The abutment sill is reinforced to support a 100-ton load.

(2) A curb is not used since it will obstruct the superimposed deck transverse stiffeners.

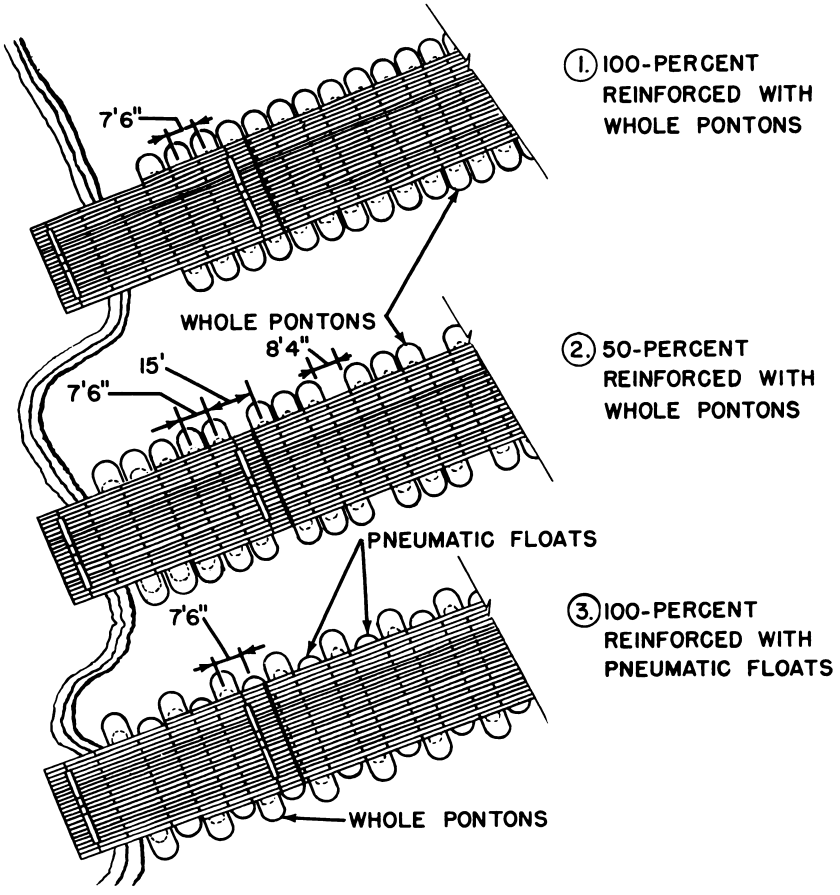


Figure 68. Types of reinforced assembly, M4 floating bridge.

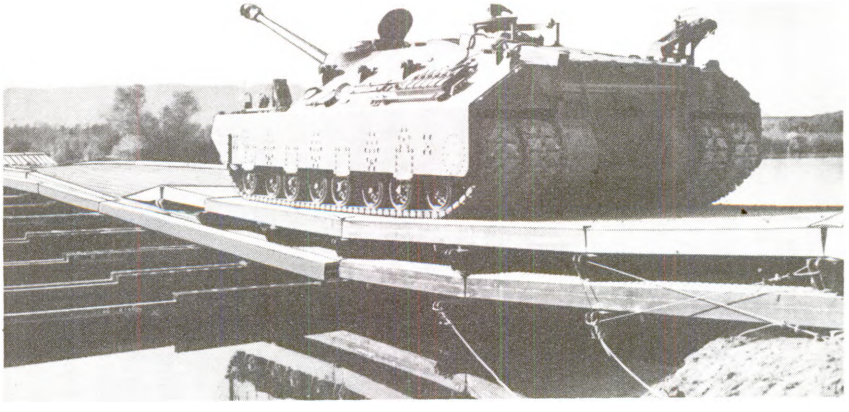


Figure 69. Heavily loaded tank crossing a superimposed end span.

b. Step 2. Place seven transverse stiffeners on this deck starting about 12 inches in from the end of the end span and spaced alternately 8 feet 4 inches and 6 feet 8 inches.

c. Step 3. Construct a reinforced abutment sill centered 8 feet 4 inches from the shoreward stiffener. Center a transverse stiffener on this sill. If normal balk are to be used in the transition span, center this sill 15 feet from the shoreward stiffener.

d. Step 4. Beginning at the centerline, working toward both sides from the center and pinning each joint as it is completed—

(1) Lay 22 tapered balk for the shore approach. Place a sill under the shoreward end of these balk.
(2) Lay 22 short balk for the shore transition span. Normal balk may be used if necessary.
(3) Lay 22 short and 44 normal balk in a normal staggered pattern to form a 38-foot superimposed deck.
(4) Lay 22 short balk for the deck transition span. Normal balk may be used if necessary.
(5) Lay 22 tapered balk for the deck approach.

e. Step 5. Check all lugs to make certain they are securely pinned; place cover plates at all hinge joints.

f. Step 6. Fasten the wire-rope lashings to the transverse stiffener ends to hold the superimposed deck in place. Figure 70 shows this lashing and an expedient tie rod which controls end span tipping and rocking.

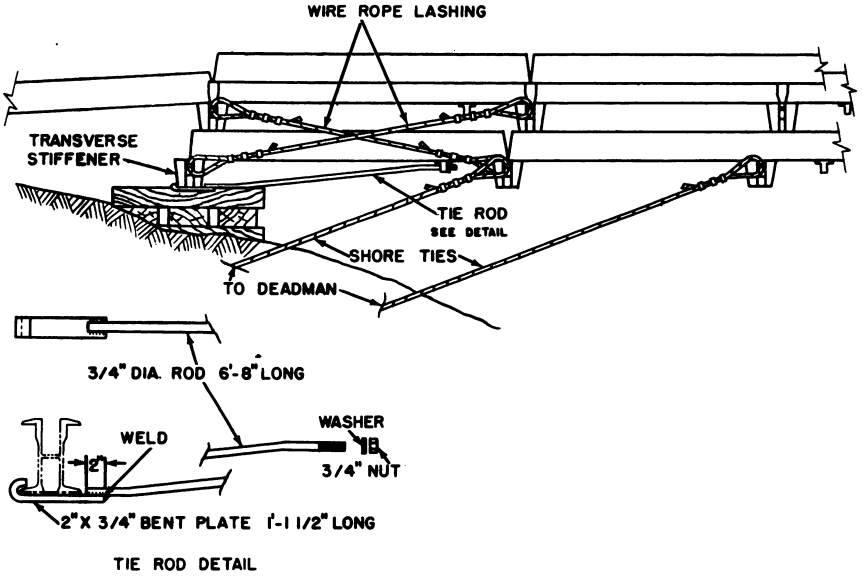


Figure 70. Bracing scheme, superimposed end span, reinforced M4 floating bridge.

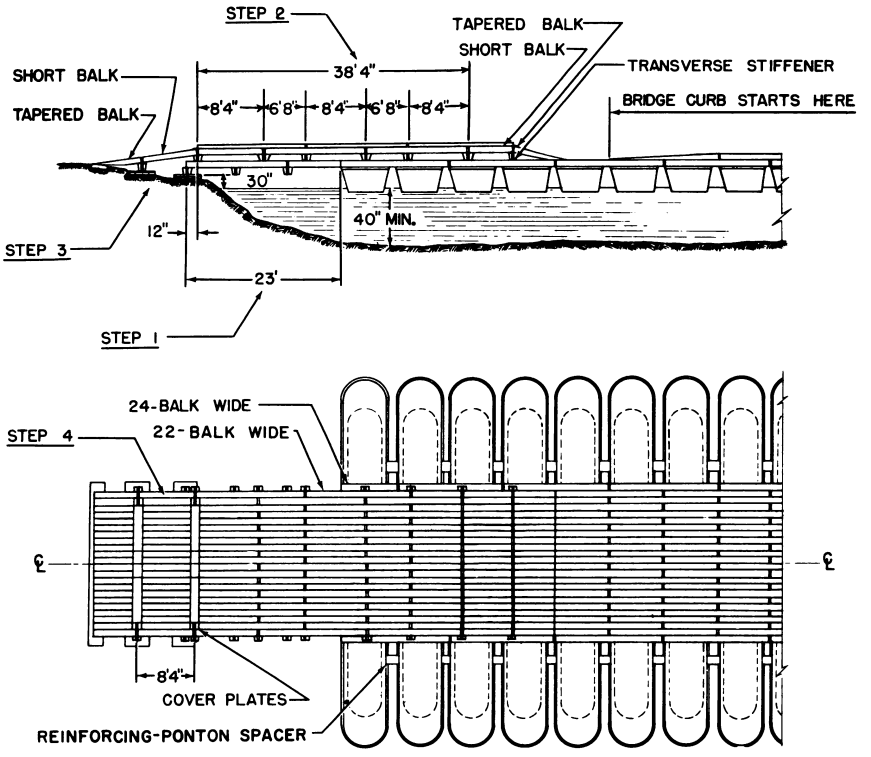


Figure 71. Twenty-three-foot end span with a 38-foot superimposed end span.

66. Reinforcement After Normal Assembly

a. Bridge. The floating section is reinforced by adding whole pontons, or pneumatic floats, as required. After they are assembled at a downstream site, the pontons or floats are loaded with men or water so that they will pass between the normal pontons and under the bridge deck. These are then connected in place with reinforcing-ponton spacers and the men or water unloaded.

b. End Spans. The superimposed deck is assembled on the normal end span (par. 65). If a water-level accommodation section is required, 50-ton trestles are added between normal trestles.

c. Anchorage. The existing system of anchoring the bridge should be used if possible, but it will be necessary to strengthen this system. In the case of an anchor cable system this is done by increasing the holding power of existing deadmen (see par. 43*i* and TM 5–225) by adding more deadmen, or by constructing a multiple-cable system. Any change in the anchorage system must be made during reinforcing operations.

290471 O—54——9

67. Assembly as a Reinforced Bridge

a. Narrow Streams. When a stream is 300 feet wide, or less, it is usually quicker to assemble the bridge by successive pontons. Assembly procedure and crews are the same as for normal assembly except that: the end section raft is reinforced initially, reinforcing pontons or floats are placed as assembly proceeds rather than floated in later, and all other assembly is reinforced immediately. If a superimposed deck is to be used, the end span is reinforced after it is in place (par. 65).

b. Wide Streams. For streams which are more than 300 feet wide, assembly by rafts is more expedient because it reduces the distance balk must be carried. The two methods of assembly by rafts are:

(1) If personnel are available, assemble a normal bridge raft (ch. 4) with the deck 24 balk wide, and with reinforced shore and anchorage construction. Then assign additional crews to add the reinforcing pontons or floats as assembly on the normal bridge proceeds. If a superimposed end span is to be used, add the superimposed deck after other assembly is complete.

(2) If extra personnel are not available, assemble by rafts as for a normal bridge (ch. 4) adding the reinforcing pontons or floats at the raft assembly site. The rafts are shortened for ease of handling and the deck is 24 balk wide. All shore and anchorage construction is reinforced initially. When a superimposed end span is to be used, the end-section raft is reinforced after it is in place at the bridge.

68. Anchorage

a. Guy Lines. Beginning at the sixth ponton, guy lines are attached from the shore to every sixth normal ponton on the upstream side and to every twelfth normal ponton on the downstream side. The guy lines should be $\frac{5}{8}$-inch wire rope for currents up to 10 feet per second and $\frac{3}{4}$-inch wire rope for currents over 10 feet per second. Guy lines are used also to hold the bridge during assembly.

b. Bed Anchors. This type of anchor is used only if it is not possible to install a cable anchorage system. If a bed anchor must be used, extremely heavy improvised anchors are required to provide sufficient holding power. Precautions must be taken to keep debris from fouling and breaking the anchor cables.

c. Cable Anchorage. The best system of anchorage for a reinforced bridge is the dual cable anchorage system. All bridle line should be kept taut to eliminate surge effects. The span of a cable anchorage system is limited to about 1500 feet between towers and about 20 percent of the span will be on shore. Bridle lines are $\frac{3}{4}$-inch fiber

rope. The stress in the cable and deadmen is computed as for normal bridging systems but the result is doubled because of the reinforcing pontons. The size of cable required for single and dual cable anchorage systems can be obtained from tables XIII and XIV.

Table XIII.—Cable Requirements for Single Cable Anchorage

Span in feet	Cable size in inches for various current velocities in feet per second			
	5	7	9	11
400	5/8	3/4	7/8	1
600	3/4	7/8	1	1 1/8
800	7/8	1	1 1/8	Unsafe
1,000	1	1 1/8	Unsafe	Unsafe
1,200	1 1/8	Unsafe	Unsafe	Unsafe

Table XIV. Cable Requirements for Dual Cable Anchorage

Span in feet	Cable size in inches for various current velocities in feet per second			
	5	7	9	11
400	1/2	5/8	3/4	7/8
600	5/8	3/4	7/8	1
800	3/4	7/8	1	1 1/8
1,000	7/8	7/8	1	Unsafe
1,200	7/8	1	1 1/8	Unsafe

CHAPTER 6

FERRIES

69. Types

Ferries to ferry vehicles, troops, and supplies can be assembled from M4 floating bridge equipment. Ferries may be operated as trail ferries, flying ferries, or as free ferries propelled by bridge erection boats or outboard motors. With overhanging ends added to the deck for operating at sites with shelf approaches, the four-ponton ferry used in floating bridge assembly is the basic ferry for ferrying operations. If the overhanging ends are removed, the ferry may be used in the assembly of a floating bridge. The basic four-ponton ferry can be converted to a reinforced ferry with greater load capacity by adding reinforcing pontons. Shortened four- and five-ponton ferries, more compact and easier to maneuver than normal ferries, also can be assembled from M4 bridge equipment. The recommended types of ferries which can be assembled from M4 bridge equipment are:

a. Four-ponton ferry, 15-foot spacing.

b. Normal ferries, reinforced.

(1) Five-ponton.

(2) Six-ponton.

(3) Seven-ponton.

c. Shortened ferries.

(1) Four-ponton.

(2) Five-ponton.

70. Classes

a. Normal Ferries. Classes of the basic four-ponton ferry and the six- and seven-ponton ferries are given in table II. The classes are based on loads with center of gravity 6 inches downstream from the centerline of the ferries. Extreme caution is required in loading and unloading vehicles weighing 70 tons or more.

b. Shortened Ferries. Shortened type ferries with actual tank loads, pushed by one 27-footbridge erection boat in still water, indicate safe and risk classes as given in table XV.

Table XV. Classes for Shortened Ferries

Type	Stream velocities in feet per second									
	Safe					Risk				
	3	5	7	9	11	3	5	7	9	11
4 pontons	55	55	55	55	50	60	60	60	60	55
5 pontons	75	75	75	70	55	80	80	80	80	60

71. Assembly

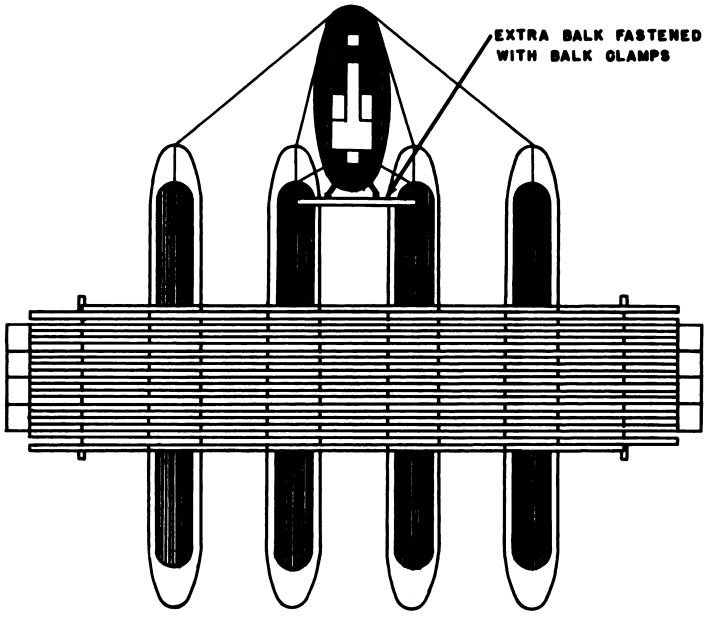
a. Materials Required. A bill of materials for the assembly of M4 ferries is given in table XVI.

Table XVI. Bill of Materials, M4 Ferries

Item	Normal ferries	Normal ferries, reinforced			Shortened ferries	
	4-ponton	5-ponton	6-ponton	7-ponton	4-ponton	5-ponton
Adapter, curb	20	20	20	20	16	16
Balk, deck:						
Normal	110	110	110	110	88	88
Shortened	------	------	------	------	16	16
Tapered	16	16	16	16	------	------
Gunwale, ponton, removable	16	20	24	28	16	20
Ponton, half	8	10	12	14	8	10
Post, handrail	10	10	10	10	8	8
Ramp, ferry	8	8	8	8	8	8
Spacer, reinforcing-ponton	------	4	8	12	------	4
Stiffener, transverse	2	2	2	2	2	2

b. Time and Manpower Requirements. The amount of time and the number of trained men required for the assembly of M4 ferries are given in table IV. Assembly time is figured from the time of arrival of equipment at the site, including unloading. It does not include time for preparing landing site, landing stage, or approach roads.

c. Four-Ponton Ferry, 15-Foot Spacing (fig. 72). The four-ponton normal ferry is assembled by adding 15-foot overhanging ends to the raft used in assembling the M4 floating bridge by rafts. Equipment for one ferry can be transported on five 2½-ton bolster-body trucks with bolster trailers. Additional transportation is required for construction equipment and troops.



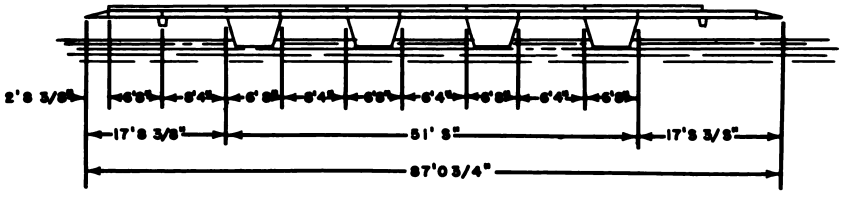
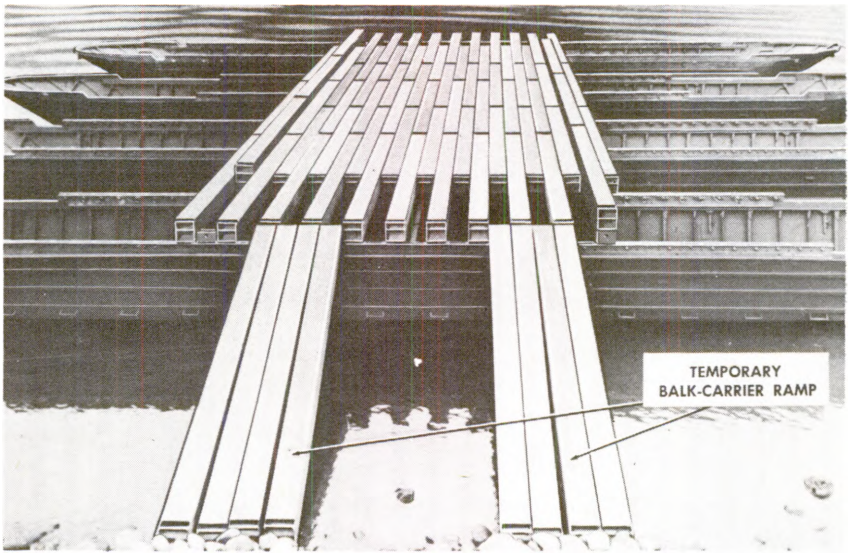


Figure 72. Four-ponton ferry, 15-foot spacing.

d. Method of Adding Overhanging Ends (fig. 73, steps 1 to 12).

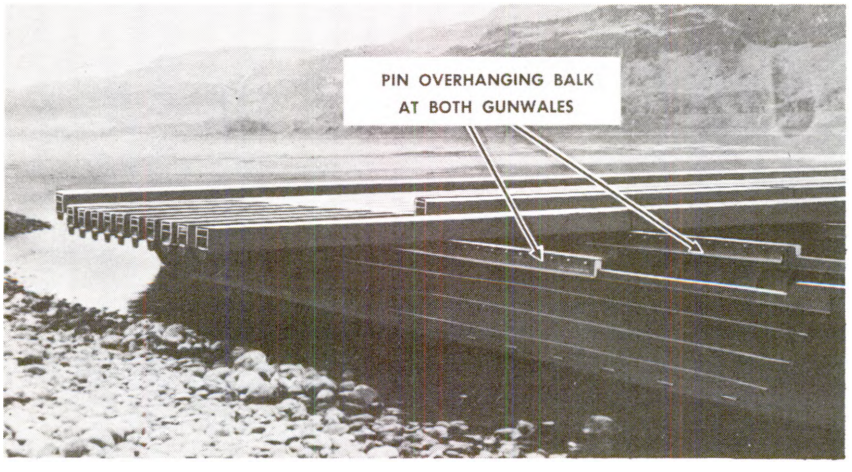
(1) *Step 1.* Begin by assembling the basic ferry (par. 58, ch. 4). Do not pin outside pontons except at interior lugs. Lay eight or ten balk as temporary ramps for balk carriers.



Step 1. Basic four-ponton ferry with temporary ramps installed

Figure 73. Method of adding overhanging ends.

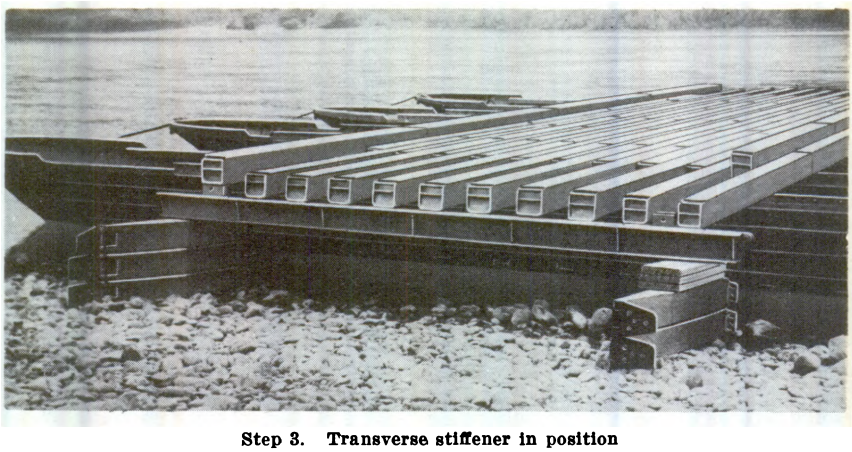
(2) *Step 2.* Lay 11 near-shore balk over inshore ponton and pin at both gunwales.



Step 2. Eleven near-shore balk in place and pinned

Figure 73—Continued.

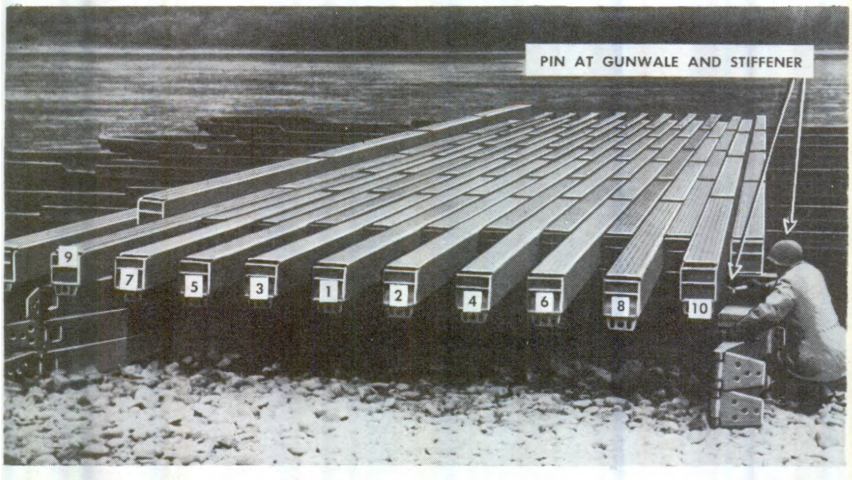
(3) *Step 3.* Place a transverse stiffener on cribbing under inshore ends of overhanging balk.



Step 3. Transverse stiffener in position

***Figure 73*—Continued.**

(4) *Step 4.* Lay 11 balk from inshore gunwale across stiffener toward shore. Pin at interior lugs.



Step 4. Pinning interior lugs at transverse stiffener. Lugs at inshore gunwale pinned

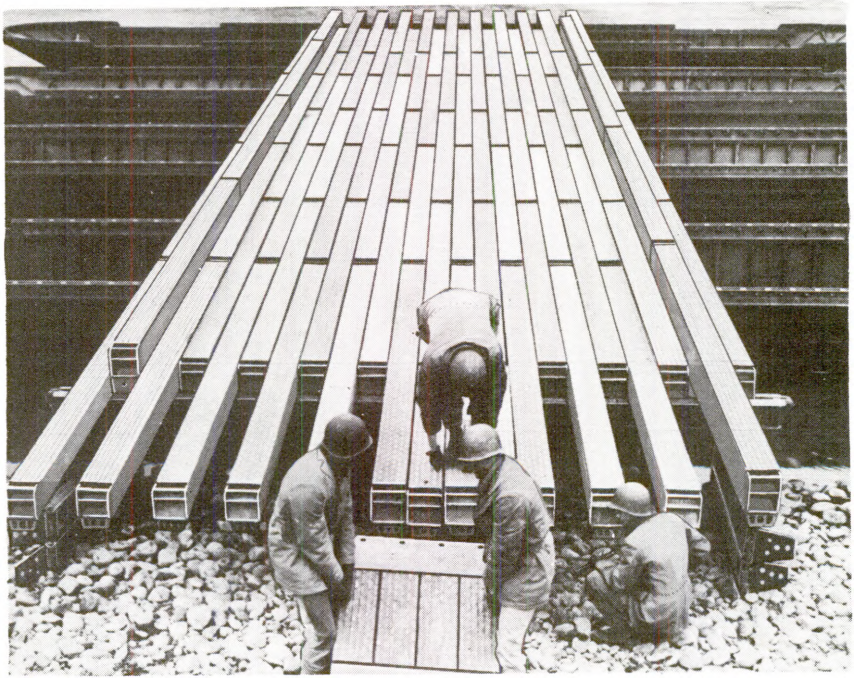
***Figure 73*—Continued.**

(5) *Step 5.* Install two tapered balk (1 and 3 on right side of centerline). Pin at stiffener.

Step 5. Placing tapered balk

Figure 73—Continued.

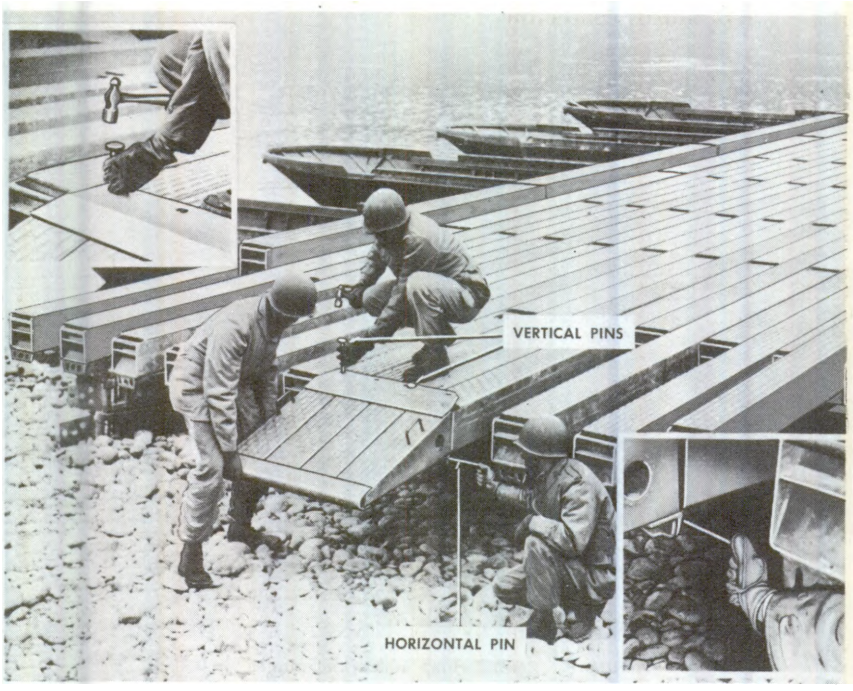
(6) *Step 6.* Slide ramp over ends of first four balk on right side of centerline.



Step 6. Placing ramp

Figure 73—Continued.

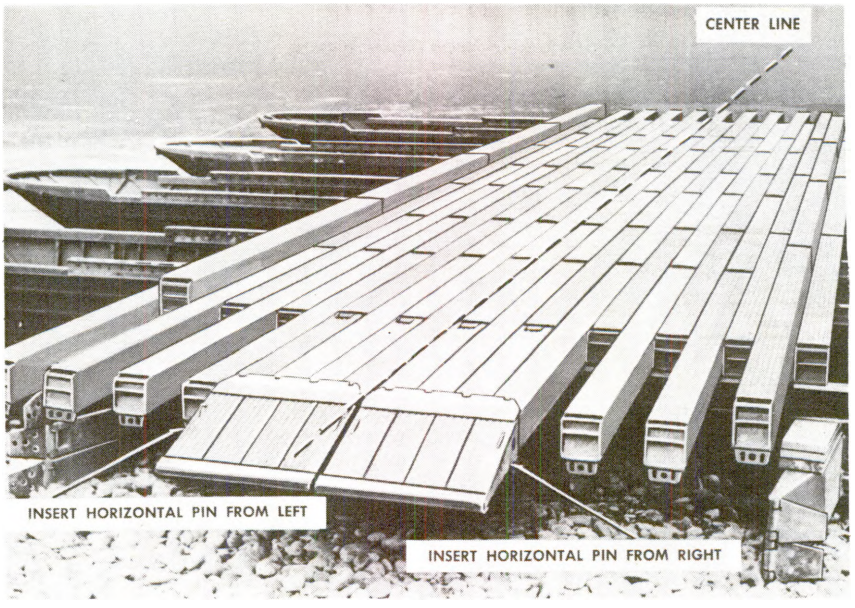
(7) *Step 7.* Pin ramp with two vertical pins through tapered balk and a horizontal pin through lugs at bottom of ramp.



Step 7. Pinning ramps

Figure 73—Continued.

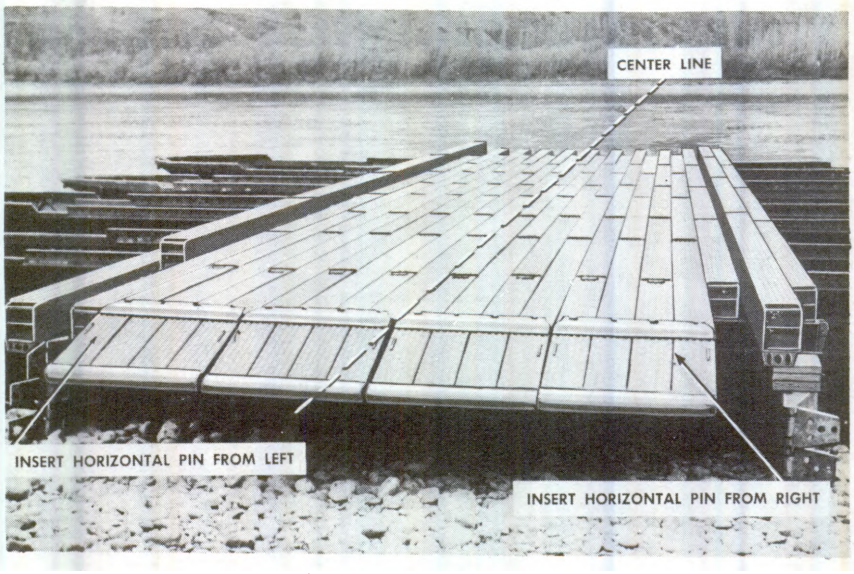
(8) *Step 8.* Install and pin two tapered balk on left side of centerline, and add and pin ferry ramp to first four balk on left side of centerline.



Step 8. Second ramp added and pinned

***Figure 73*—Continued.**

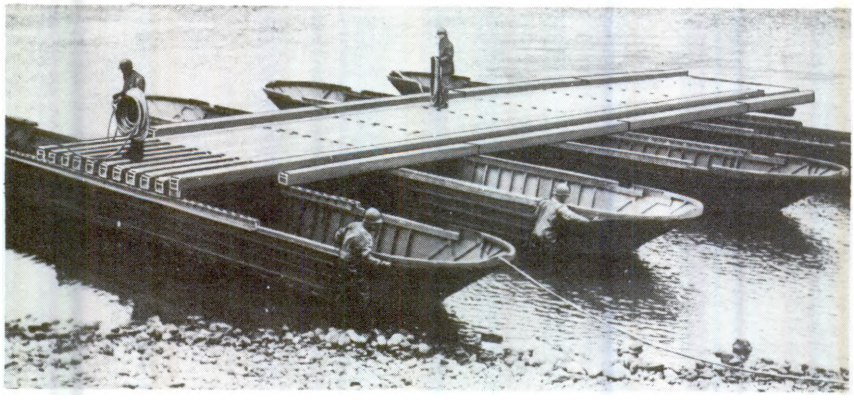
(9) *Step 9.* Install four remaining tapered balk, and add and pin two more ferry ramps outside first pair. If a deck 18 balk wide is used, eliminate one normal balk and one tapered balk from the outside of the overhang.



Step 9. Completed overhanging end

Figure 73—Continued.

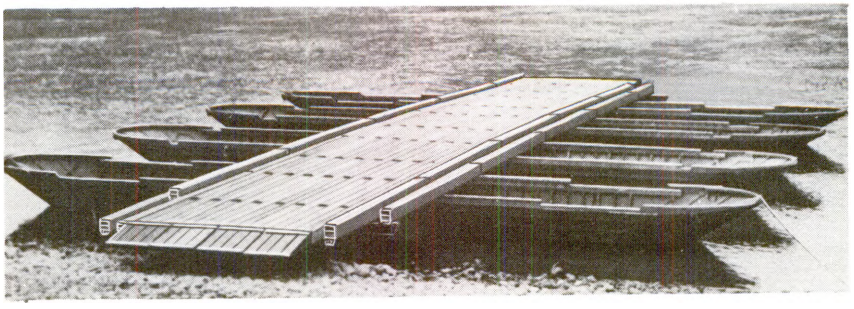
(10) *Step 10.* Remove cribbing from under overhang and turn ferry around.



Step 10. Turning ferry around

Figure 73—Continued.

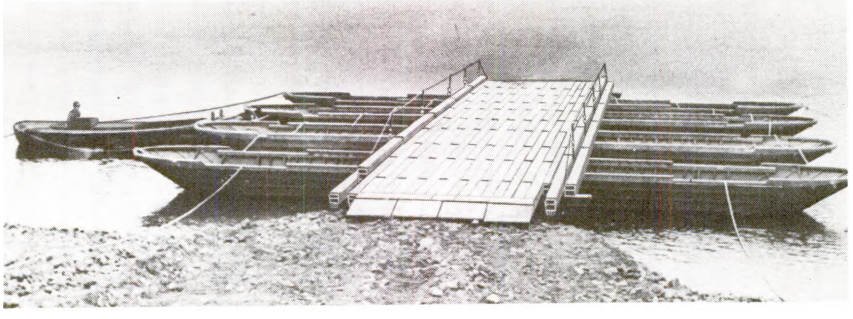
(11) *Step 11.* Construct overhang on other end of ferry. Check all pins.



Step 11. Overhanging ends completed on both ends of ferry

Figure 73—Continued.

(12) *Step 12.* Place handrail posts and handrail lines, and attach bridge erection boat.

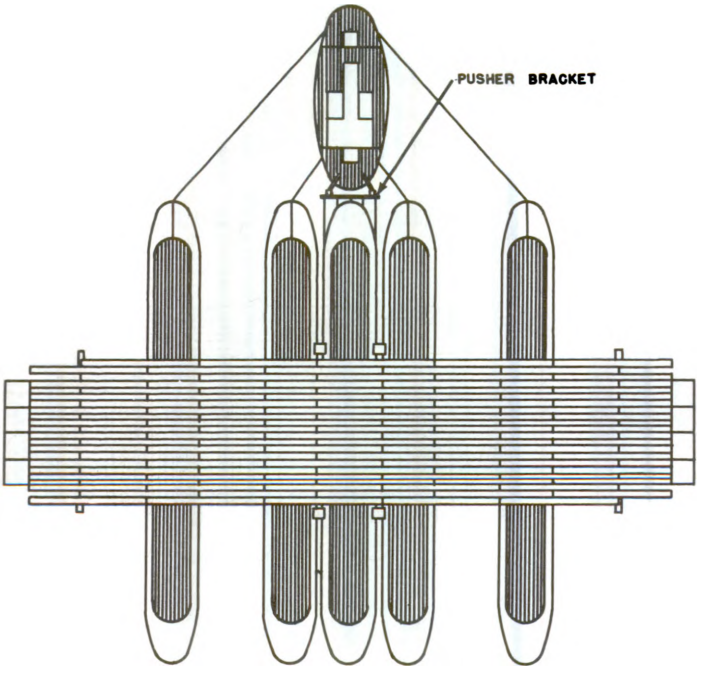


Step 12. Completed four-ponton ferry

Figure 73—Continued.

e. Normal Ferries, Reinforced.

(1) The five-ponton ferry (fig. 74) is assembled by adding one whole ponton to the four-ponton ferry. The reinforcing ponton is centered between the center pontons and fastened to them by four reinforcing-ponton spacers (fig. 18). Five 2½-ton bolster-body trucks with bolster trailers are required for transportation.



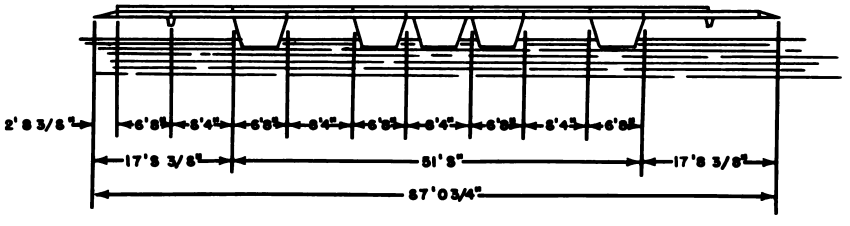


Figure 74. Five-ponton ferry, reinforced.

(2) The six-ponton ferry (fig. 75) is assembled by adding two whole pontons to the four-ponton ferry. The reinforcing pontons are centered between the outer pontons and fastened to adjacent pontons by reinforcing-ponton spacers. Six 2½-ton bolster-body trucks with bolster trailers are required for transportation.

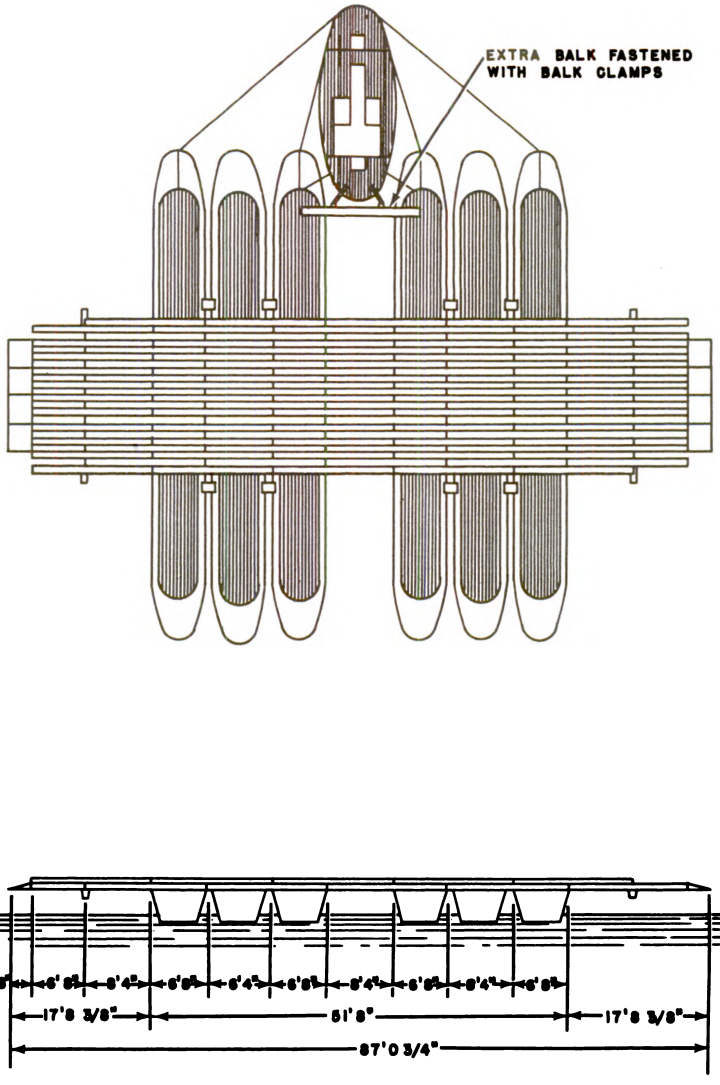
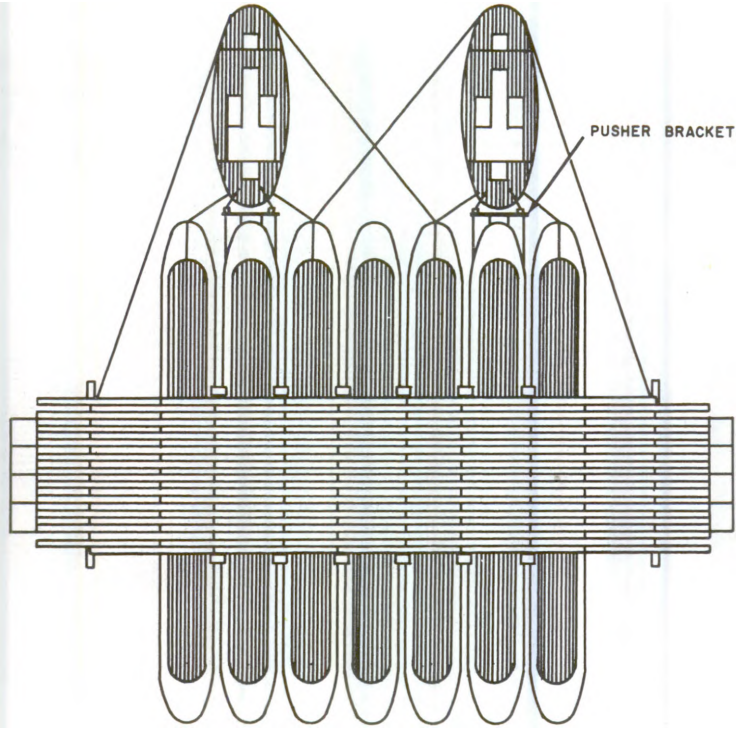


Figure 75. Six-ponton ferry, reinforced.

(3) The seven-ponton ferry (fig. 76) is assembled by adding one whole ponton to the center of the six-ponton ferry and fastening this ponton to adjacent pontons by four reinforcing-ponton spacers. Seven 2½-ton bolster-body trucks with bolster trailers are required for transportation.



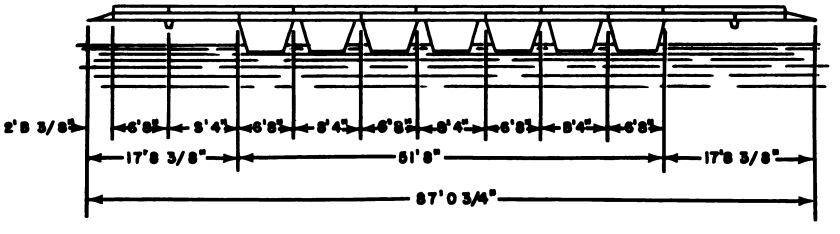
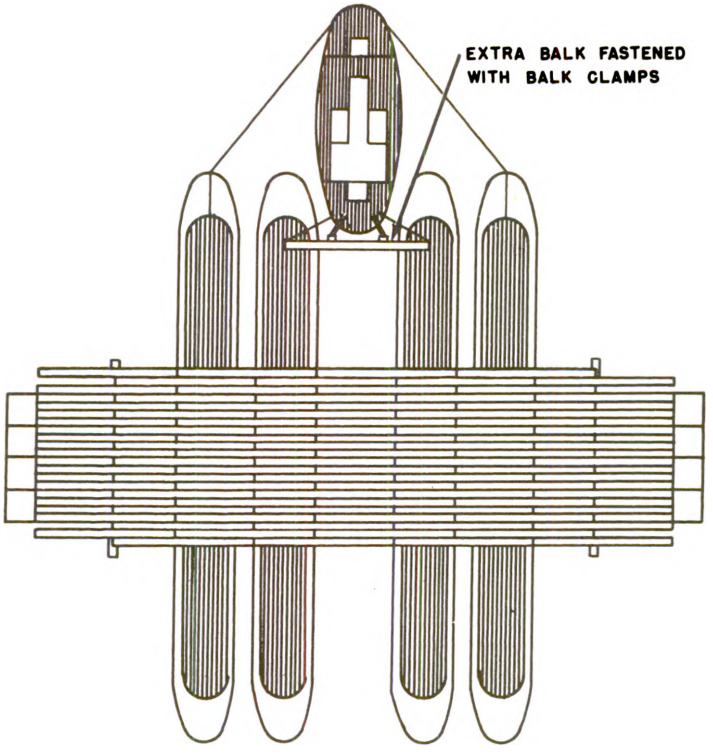


Figure 76. Seven-ponton ferry, reinforced.

f. Shortened Ferries.

(1) The four-ponton shortened ferry (fig. 77) is different from the basic normal ferry in the arrangement of pontons and length of deck. While the normal center gap of 8 feet 4 inches between the inner two pontons is the same as in normal assembly, the outer pontons are placed on 7-foot 6-inch centers



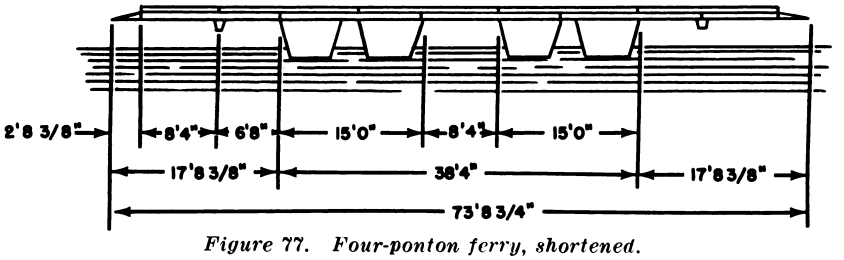


Figure 77. Four-ponton ferry, shortened.

290471 O—54——10

(1-foot 7-inch gap) with the inner pontons. The deck is about 13 feet shorter and uses 22 less deck balk than the normal ferry. Overhanging ends are assembled in the same manner as for a normal ferry except that short balk are used instead of tapered balk.

(2) The five-ponton shortened ferry (fig. 78) is made by adding a center ponton to the four-ponton shortened ferry and fastening this ponton to adjacent pontons by four reinforcing-ponton spacers.

72. Site Requirements

a. Shelf Approach. The standard M4 ferries have an overhanging deck to permit loading or unloading directly on a bank that is level with or slightly lower than the ferry deck. The bank or shelf approach may be natural or constructed with a bulldozer. The shelf is graded downward slightly to the water edge to receive the overhanging deck when the ferry is lightly as well as heavily loaded. On soft ground an abutment sill may be used on the shelf. Figure 79 shows a standard M4 ferry ready to unload on a shelf approach.

b. Ferry Site. For information and details concerning the requirements of a desirable ferry site, refer to TM 5–260.

c. Loading and Unloading Points. For information and details concerning the location of loading and unloading points and the use of multiple and single loading and unloading points, refer to TM 5–260.

73. Pusher Connections

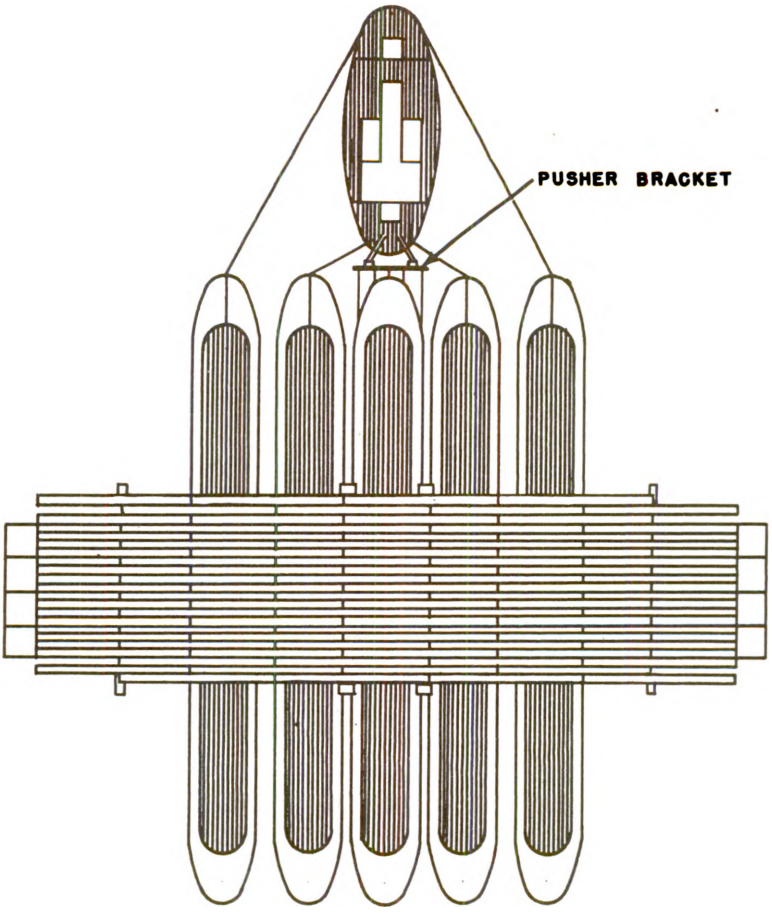
a. General. The following principles are observed in connecting the bridge erection boat to ferries:

(1) Ferries are pushed, not pulled. Pushing permits positive backing and direct steering of the ferry, resulting in shorter turning radius and better control.

(2) Ferries must have a flat surface, or a pushing beam, strong enough to receive the thrust of the bridge erection boat.

(3) The bridge erection boat should be in the center of the ferry to steer the ferry in either direction.

(4) The bridge erection boat is connected to the ferry so that the steering and backing thrust of the boat are effectively transferred to the ferry. It must be held so it cannot move sideways. Rigging lines are of at least 1-inch rope in good condition, and are wet before using to reduce stretch. Watch all lines closely and take up stretch during operation. Loose lines allow impact between boat and ferry and mean loss of maneuverability. Impact can break a line and cause a serious accident.



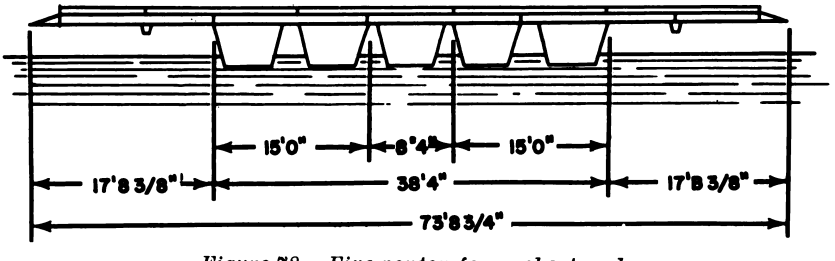


Figure 78. Five-ponton ferry, shortened.

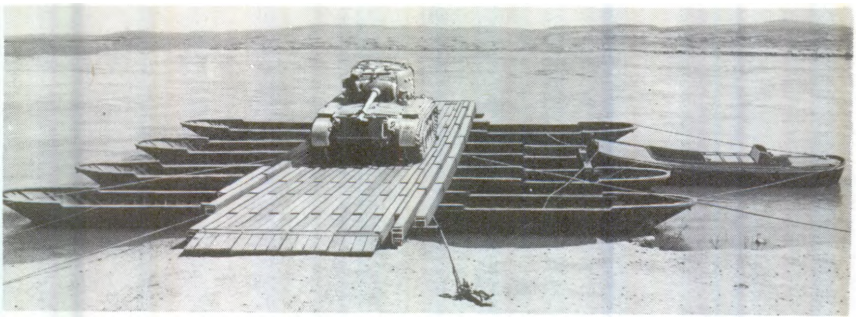


Figure 79. M4 ferry ready to unload on a shelf approach.

b. Bridge Erection Boat Connections. Because of the shape of the ponton bow, special attachments are needed to provide a surface against which bridge erection boat pusher knees can act.

(1) *Pusher balk.* By use of a pusher balk clamp (fig. 19) fasten a deck balk across the gap between the pontons. It is fastened on the downstream side of the ferry near the point where ponton bows begin to curve. Hook the clamps over the balk and under the gunwale proper of each ponton.

(2) *Pusher bar.* An expedient bar (fig. 80) fabricated in the field can be used if clamps are not available. It consists of a 3-inch iron pipe or I-beam of equal strength, with lugs welded at each end. The bar extends between the outboard motor bracket attachments on the sterns of the inside whole pontons. A hole is drilled in the lug at each end of the bar to match the hole in the bracket attachment. The bar and bracket attachment are bolted together. In slow currents, this bar has been used to push ferries loaded to 40 tons. It should, however, be used with caution and only when other means are not available.

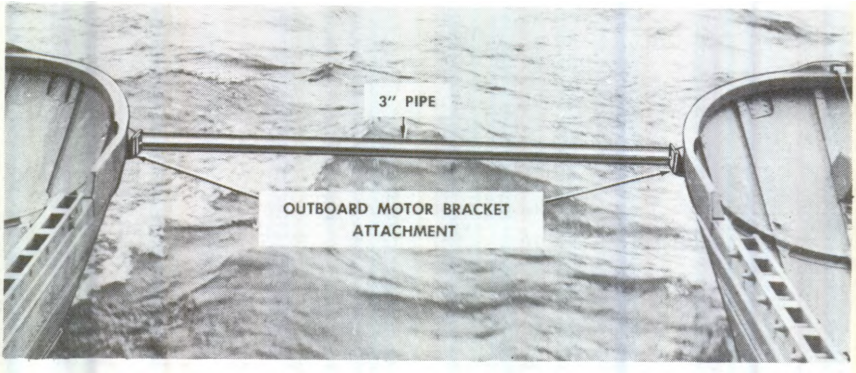


Figure 80. Expedient pusher bar for connecting bridge erection boat to ferry.

(3) *Pusher bracket.* A pusher bracket (fig. 81) may be improvised for attachment at the stern of pontons in reinforced ferries so that they can be pushed by bridge erection boats. This pusher bracket provides a bearing surface against which the standard pusher knee mounted on the bridge erection boat may act. Figure 82 shows construction details of this pusher.

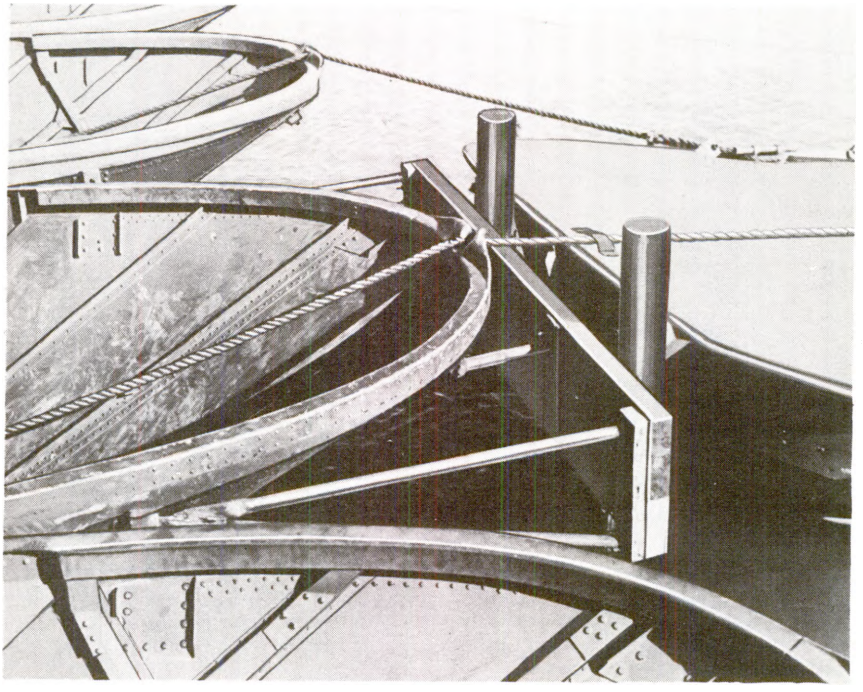


Figure 81. Pusher bracket

c. Outboard Motor Bracket. When the outboard motor is used to propel pontons, ferries, or rafts, it can be attached to pontons by a bracket (fig. 38) which is adaptable for bow or stern connection.

74. Operation

a. General. All M4 ferries have overhanging decks for operation at sites with shelf approaches. Safe operation of ferries, especially in swift currents, requires sufficient, dependable power. Bridge erection boats and outboard motors are used to propel ferries. Operators are trained to meet the sudden emergencies that arise in ferrying. These include the effects of debris, waves, fast currents, rapid changes in water level, and variations of the main course of the current, as well as motor failure, and operation at difficult landing sites. Safety precautions are observed at all times, especially when ferrying in swift currents. The steering and backing lines are kept as tight as possible at all times. Pontons should never be permitted to ground.

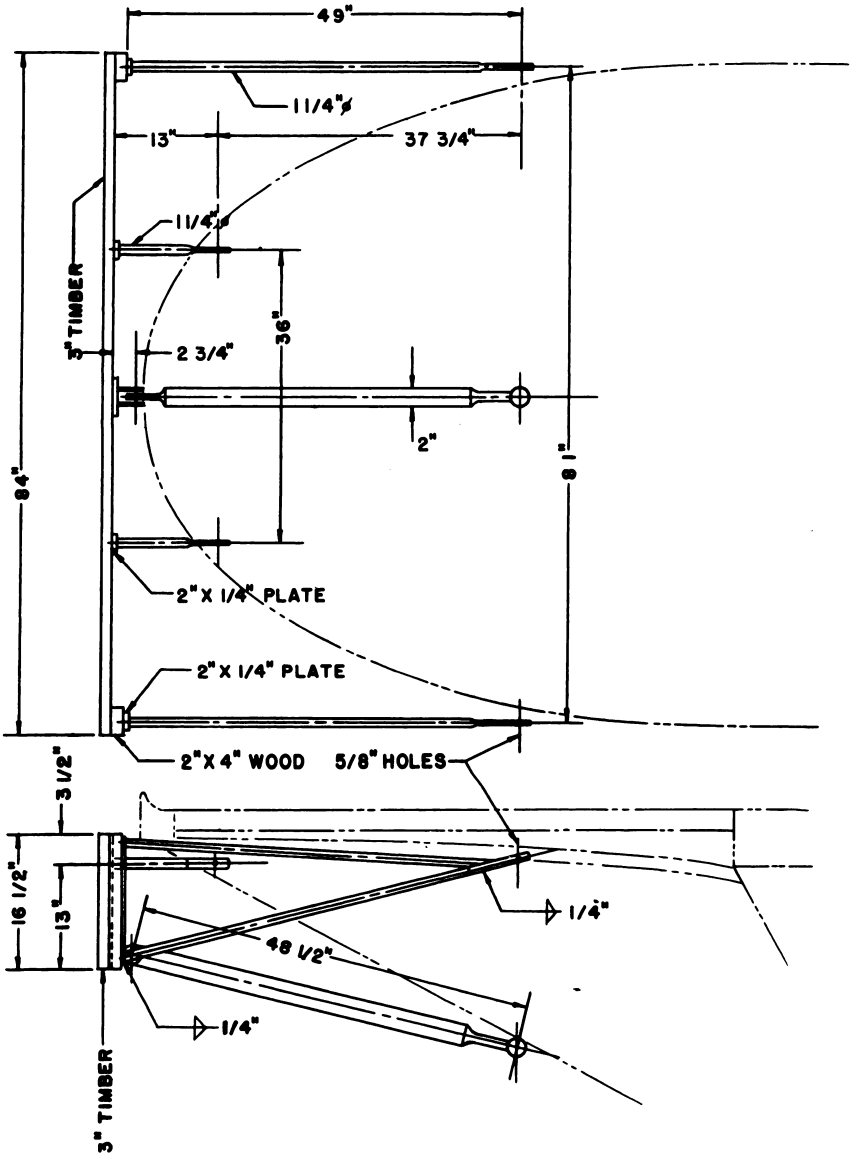


Figure 82. Detail drawing of pusher bracket.

All ropes are kept ready and properly coiled. The ferry is kept headed into the current and vehicles on the ferry are always chocked. For details pertaining to the operation of ferries, refer to TM 5–260.

b. Power. The number of 27-foot bridge erection boats required to propel the various ferries is given in table II. Generally, it requires two 19-foot bridge erection boats to replace one 27-foot boat. One 25-horsepower outboard motor has only about 10 percent of the

power provided by one 27-foot bridge erection boat, and 20 percent of that of a 19-foot bridge erection boat. Outboard motors are useful in providing a source of auxiliary power for the operation of trail ferries. When using the outboard motor, clamps of the motor attachment bracket should be checked for tightness, and the motor tied with a safety rope to avoid loss of the motor in case the clamps work loose. Operators should never cast off without the outboard motor operator's kit, which contains essential tools and repair parts for the repair of most stoppages.

75. Trail Ferry

Any type of M4 ferry assembly can be rigged with a bicycle traveler (fig. 24) to be used as a trail ferry. The trail ferry is generally used only when sufficient motive power is unavailable or if tactical requirements, such as silent operation or complete blackout, dictate. It is also useful in night operations to guide bridge erection boat and outboard motor operators to landing points. For details on the use and operation of trail ferries, refer to TM 5–260.

CHAPTER 7

FIXED BRIDGES

76. General

a. Component parts of the M4 bridge set can be used to assemble sections of fixed bridges across narrow streams and dry gorges (fig. 2). Deck-balk simple spans can be assembled from 15 to 45 feet long. Fixed bridges over 45 feet long can be assembled using trestles or piers as intermediate supports. Lengths of fixed spans are determined by the distances between lugs of the normal balk. Short balk are used as both ends of the 23-foot 4-inch and 38-foot 4-inch spans to fill the gaps between normal balk, while 30- and 45-foot spans require short balk at one end and tapered balk at the other. Fixed bridges are anchored at both ends to prevent longitudinal movement. See table III for capacity of deck-balk simple spans.

b. The best method for launching a deck-balk simple span is by means of a crane, but it may be launched by hand, truck winch and shears, or by using a front-mounted A-frame on the 5-ton bridge truck. Details of launching methods are discussed in paragraph 79.

77. Assembly

a. Fifteen-Foot Span (fig. 83). This is the simplest span to assemble, and consists of placing 22 normal balk across the gaps, pinning the balk to transverse stiffeners at each end, and adding ramps of tapered balk or earth. The stiffeners and tapered balk rest on sills and the ends of the span are anchored to prevent longitudinal movement.

b. Twenty-Three-Foot Four-Inch Span.

(1) Lay out on the ground four transverse stiffeners spaced as in figure 84. Connect these with four normal balk, numbers 8 and 7 on the left, and 7 and 8 on the right. Pin all lugs. This frame may now be launched and the bridge completed in place. The completed span, less tapered balk ramps, weighs about 12,000 pounds. The decision to launch a skeleton frame or completed span depends on the availability of a suitable crane.

(2) If sufficient short balk are not available, a 21-foot 8-inch span can be assembled by using tapered balk to fill in between the normal balk.

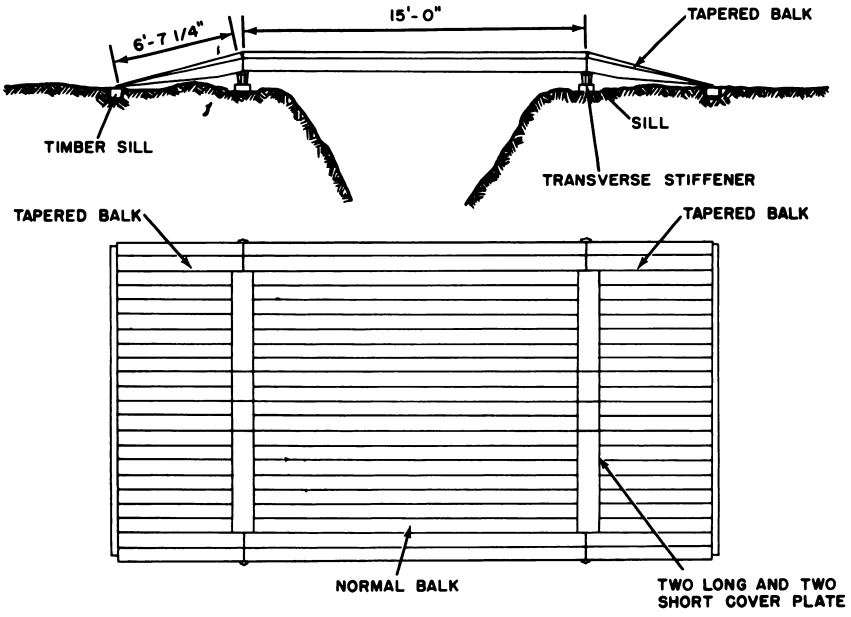


Figure 83. Fifteen-foot fixed bridge.

c. Thirty-Foot Span. This span is assembled in a manner similar to the 23-foot span. One additional transverse stiffener is used, extending the length of the bridge by 6 feet 8 inches (fig. 85). Curb adapters are placed in the number 10 recesses, and the bridge is assembled the full 22-balk width.

d. Thirty-Eight-Foot Four-Inch Span.

(1) This span, less ramps, weighs about 6¼ tons. For ease in launching, a skeleton frame is assembled and launched, and the remainder of the balk and ramps are added after the frame is positioned. See figure 86 for layout of frame for launching, and figure 87 for layout of complete span.

(2) Tapered balk may be substituted for short balk in the 38-foot span resulting in a 36-foot 8-inch span.

e. Forty-Five-Foot Span. The 45-foot span, less ramps, weighs about 8¼ tons. It is assembled similarly to the 38-foot span but has an additional transverse stiffener and additional balk. A larger crane will be required to launch the 45-foot span than those for launching the shorter spans, or temporary cribbing can be placed to shorten the launched span.

78. Assembly Party

A suggested breakdown of working parties to assemble fixed spans is shown in table XVII.

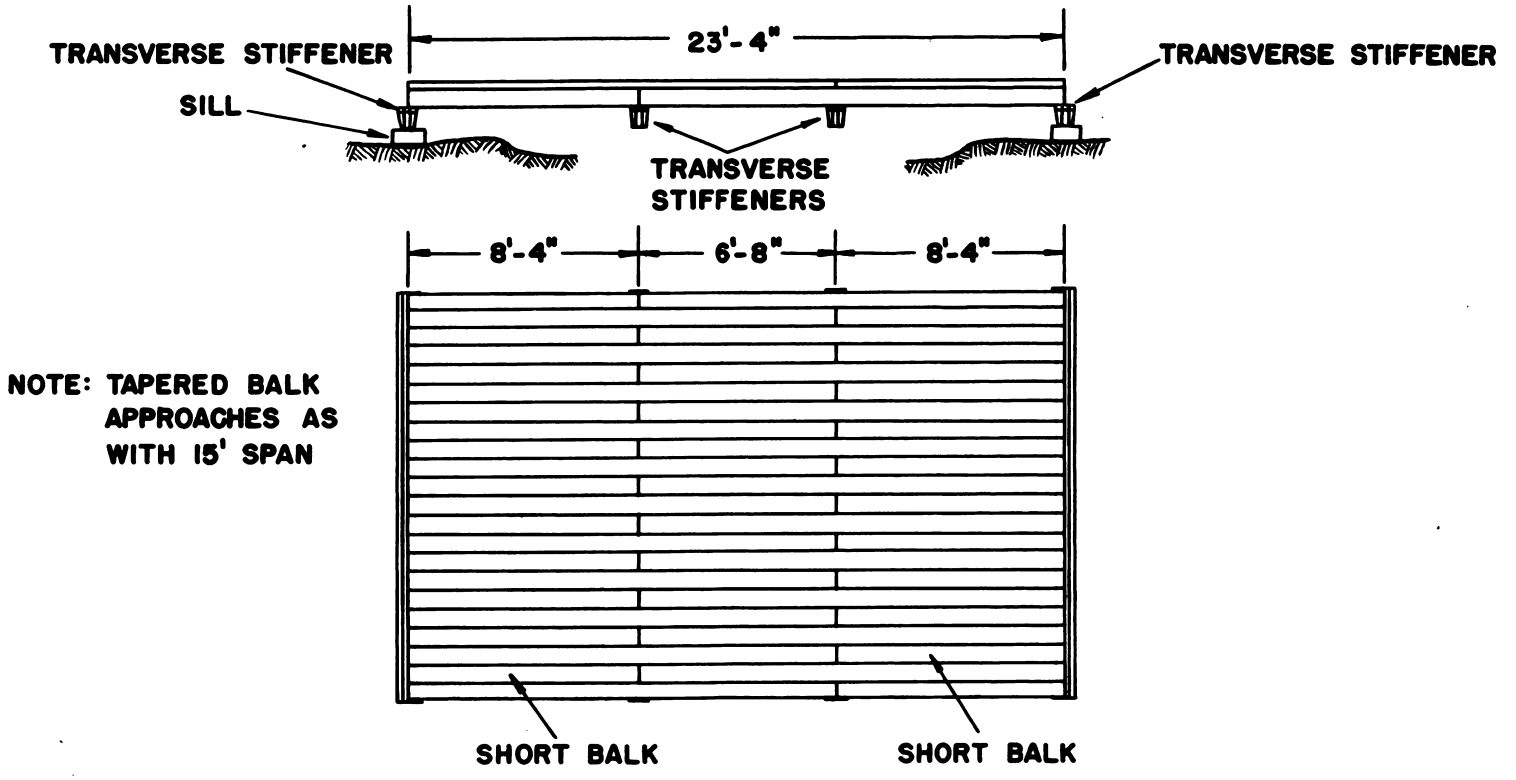


Figure 84. Twenty-three-foot four-inch fixed bridge (using short balk).

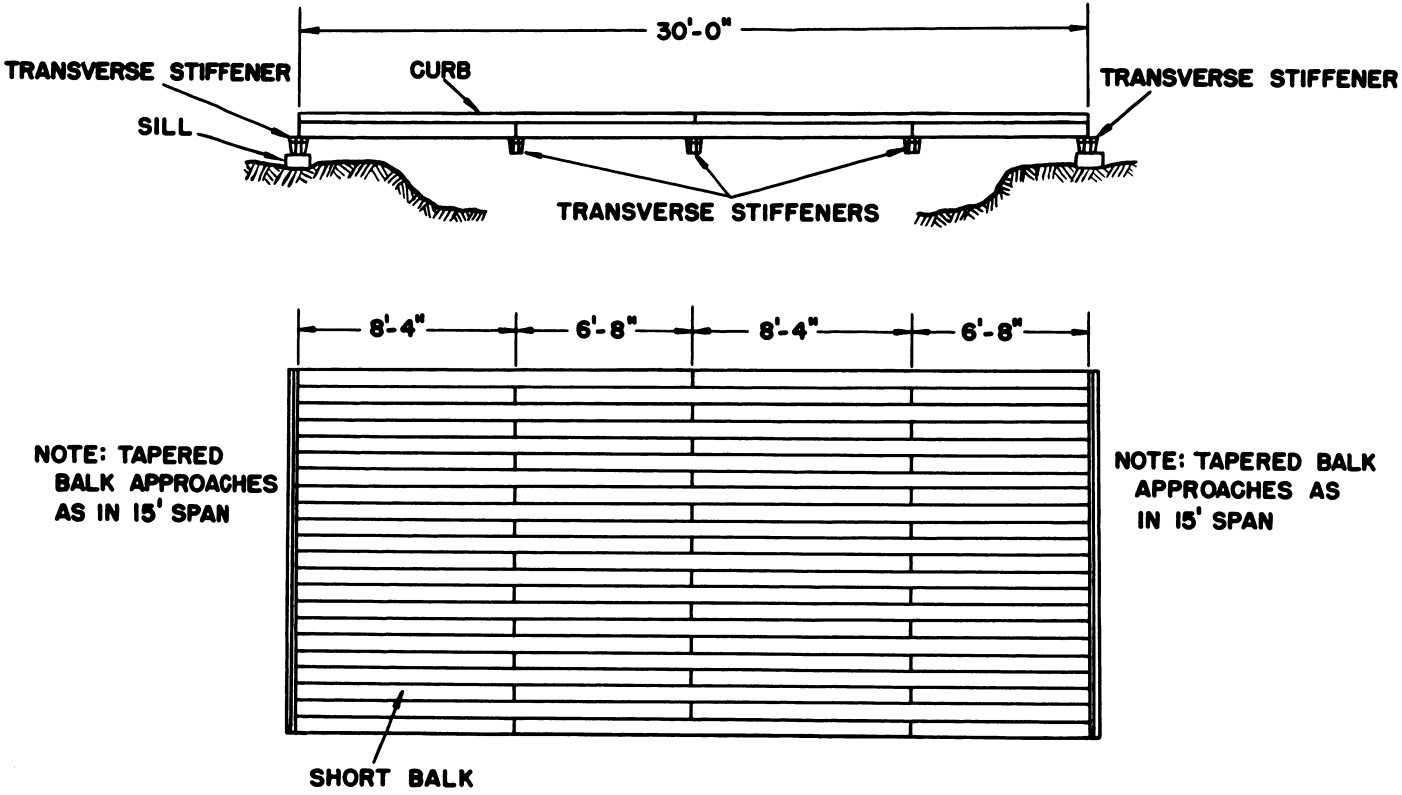


Figure 85. Thirty-foot fixed bridge.

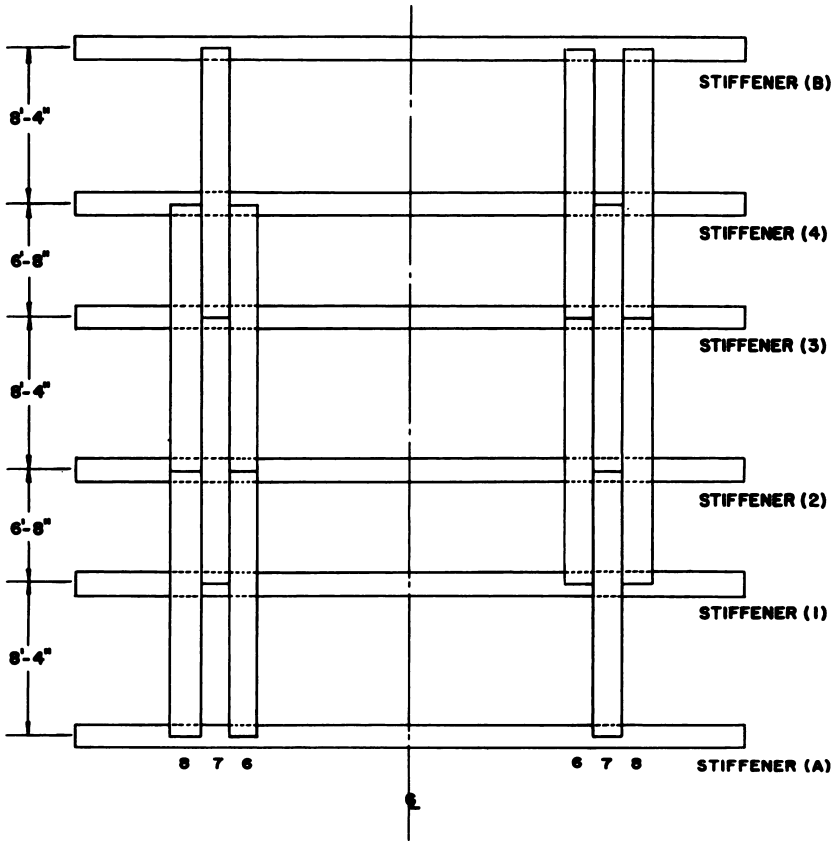


Figure 86. Frame for launching 38-foot 4-inch span, fixed bridge.

Table XVII. Working Parties for Fixed Spans

Detail	NCO	EM
Balk pinners	1	4
Balk layers	1	8
Balk carriers	1	*24
Guy line crews		4

*This crew also carries and places transverse stiffeners and abutment shoes.

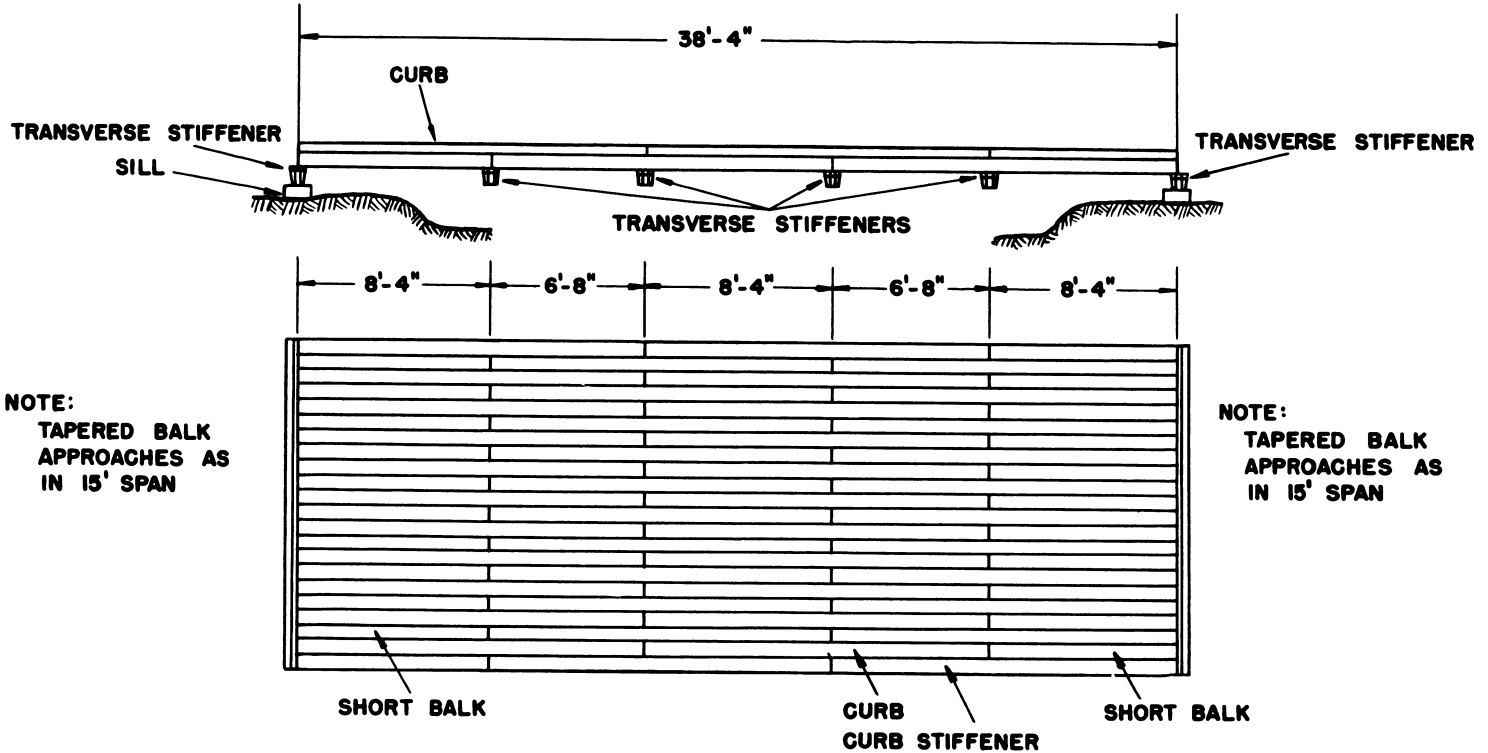


Figure 87. Thiryt-Eight-foot four-inch span fixed bridge.

79. Launching Methods

a. Crane. As noted above, the degree of completion of a span to be launched depends on the hoisting equipment available. The 15- and 23-foot spans, less ramps, can usually be lifted and launched complete. The span is lifted with a chain or wire rope sling attached to the stiffeners (fig. 88).

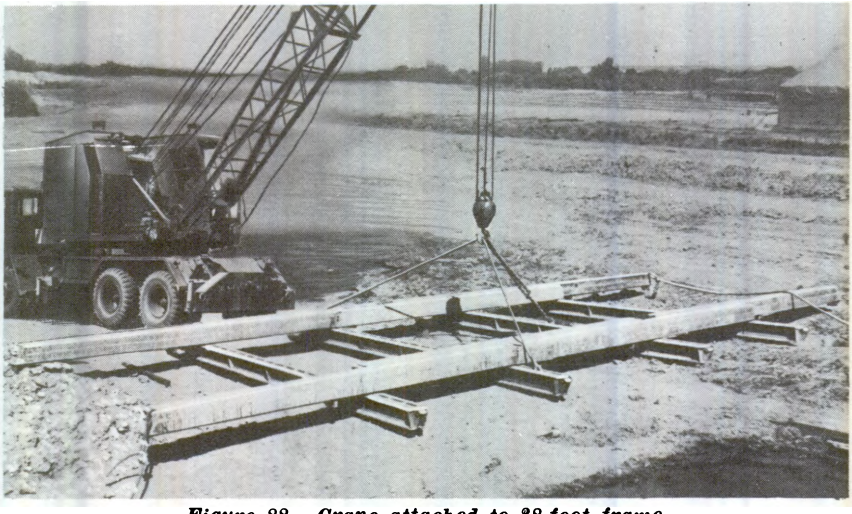


Figure 88. Crane attached to 38-foot frame.

b. With Winch. If the span is to be launched by winch it should be built on skids or rollers. The winch cable is run through a block on shears on the far shore and then fastened to the stiffeners. The shears are used to give lift to the nose end of the frame and direction to the winch cable (fig. 89).

c. Pinning. Some difficulty will be found in pinning the remaining balk to a skeleton frame after it has been launched because of the sag caused by the weight of the span. This can be overcome by use of a crane and sling to hold the frame work in a level position until all balk are in place and pinned. A more efficient balk-depressing device than that shown in figure 28 can be used to overcome this difficulty. The device shown in figure 90 can be made in the field and can be used with any type of hydraulic jack. This device consists of an I-beam having a length equal to the width of five balk. A chain and hook are attached to the ends of the beam or at intermediate points to engage the handles of alternate balk. The hydraulic jack is used against the center of the beam to exert pressure against the balk to be depressed.

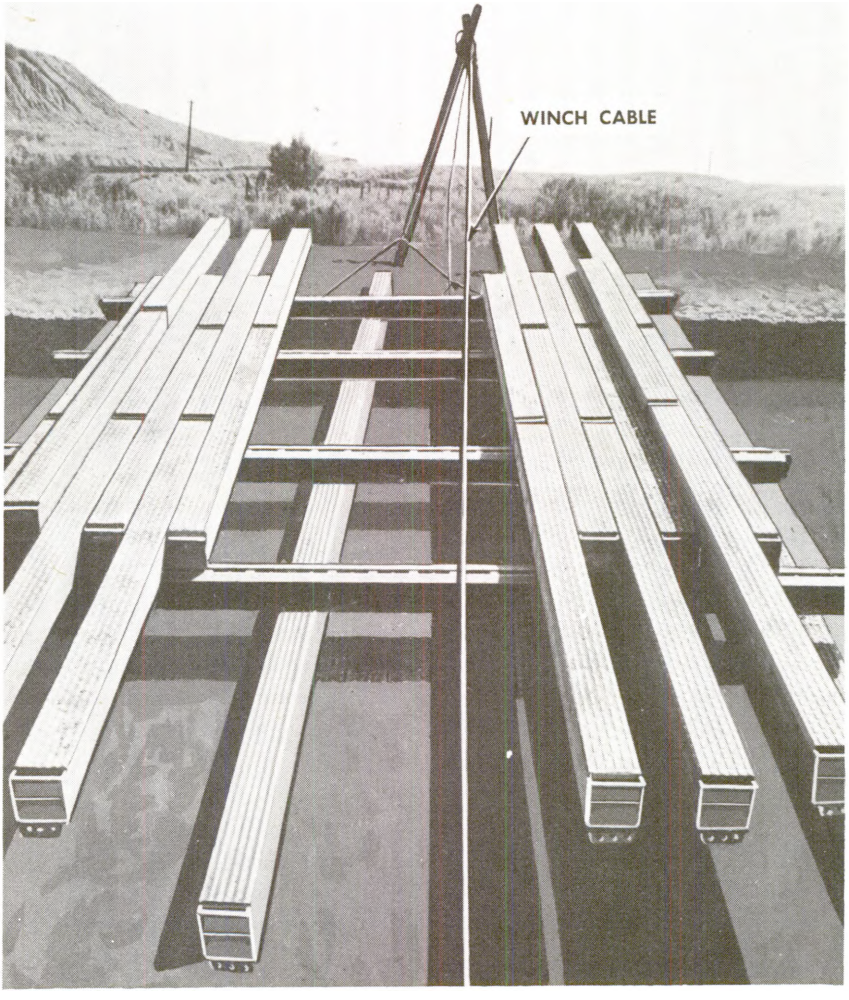


Figure 89. Launching frame with winch and shears.

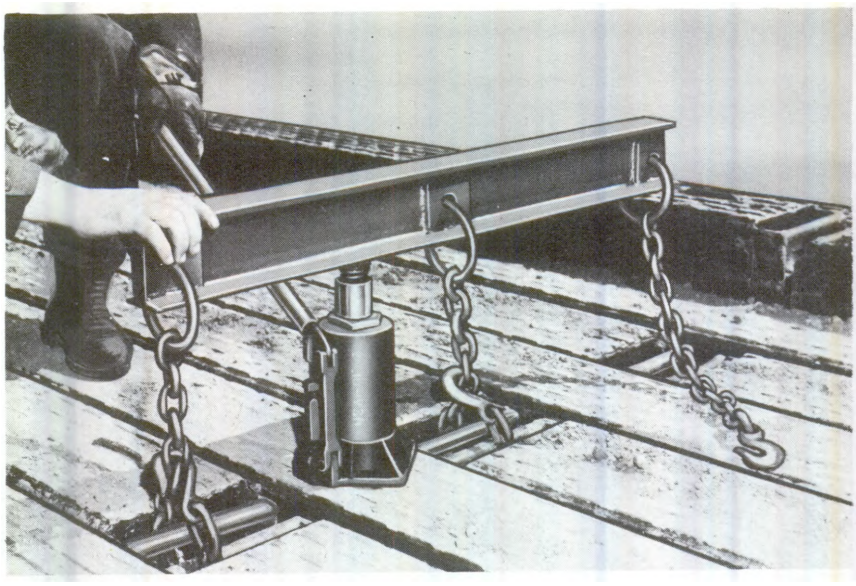


Figure 90. Balk-depressing device.

80. Reinforcement

a. Simple Spans. Deck-balk simple spans can be reinforced by use of trestles, cribbing, piers, or by double-deck assembly.

b. Existing Bridges. A quick temporary method of reinforcing an existing bridge which is only slightly damaged is to assemble a deck-balk simple span on top of the existing span. The advantage of this type of assembly is that it is easy to lay down and pick up again. The capacity of the reinforced structure is considered to be the same as the capacity of the deck-balk simple span.

CHAPTER 8

TRESTLES

81. General

The 50-ton trestle (fig. 20) which is a component part of the M4 bridge set can be used singly or in groups in the construction of fixed and floating bridges, and in reinforcing existing fixed bridges. In all trestle construction, care must be taken to provide firm footing, secure bracing, and allowance for settling. On muddy, icy, or sloping ground trestle shoes are anchored to prevent slipping. On semistable and unstable bottoms the trestle shoe is provided with a suitable spread footing. See TM 5–260 for calculation of footings in various types of soil. Figure 91 shows a 50-ton trestle assembly. When trestles are first put in service, they should be loaded progressively, starting with light loads. Bracing will have to be checked continuously and bracing clamps tightened after the first few loads and intermittently thereafter. Under continuous heavy traffic, a man is assigned to each trestle to watch for damaged or loosened clamps and connections. If trouble occurs, traffic must be stopped immediately until the necessary repairs are made.

82. Assembly and Launching

(figs. 91 and 92)

Unload transom with a crane and place it on cribbing. Insert a full column in each end of the transom and pin with one transom pin.

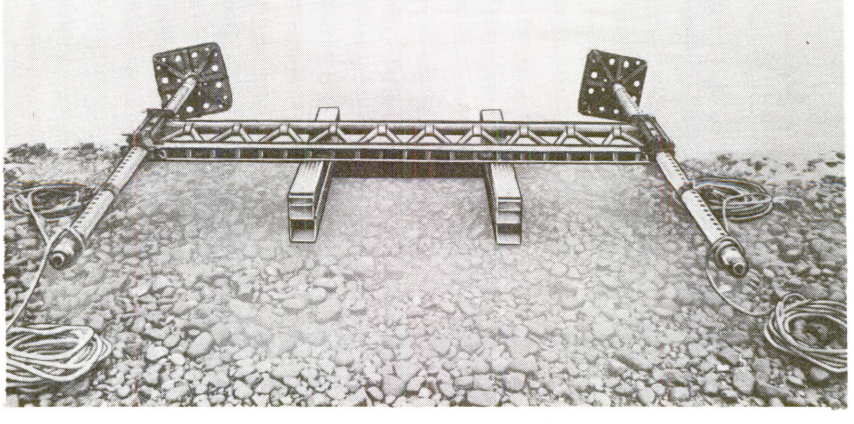


Figure 91. Trestle assembly.

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Attach shoes and tighten securely using the special wrench. Pin chain hoist brackets on each column and attach ratchet chain hoist. Attach a sling to each end of transom and lift entire trestle and place in position. Release tension on ratchet chain hoists after positioning transom. Steady trestle with guy lines until bracing can be installed. Figure 92 shows the method of launching by hand.

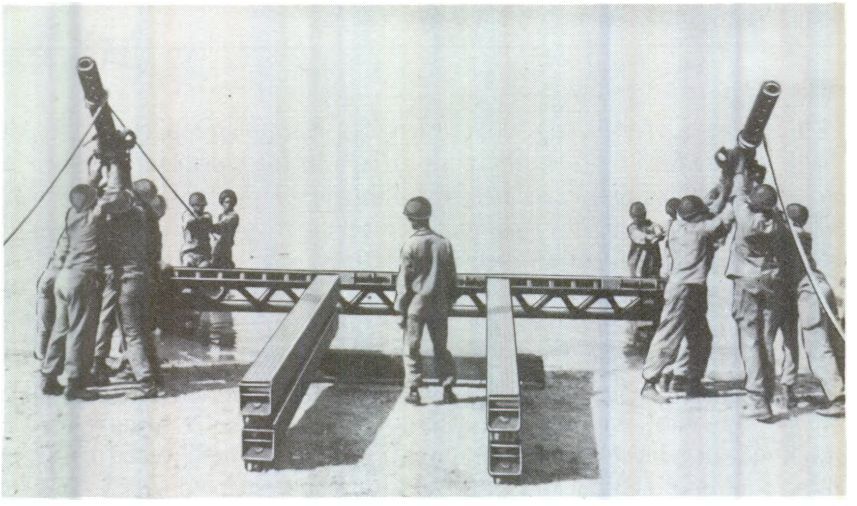

Figure 92. Launching trestle by hand.

83. Employment

a. Floating Bridges.

(1) Trestles can be used with the end section of a floating bridge to make adjustments for a rise and fall of tide up to 10 feet.

(2) In cases where insufficient floating bridge is available, an extension may be assembled with a multiple-span fixed bridge using trestles (fig. 93).

(3) See chapter 5 for use of trestles with reinforced M4 floating bridge.

b. Multiple-Span Fixed Bridges. Figure 93 shows the assembly of a multiple-span fixed bridge using deck balk on 50-ton trestles. In this bridge the spans are all 15 feet long and the deck balk are pinned to the transoms. Another form of assembly is with a continuous deck, with the balk pinned to transverse stiffeners and the trestles used as intermediate supports. Reinforcement can be obtained by placing trestles with 8-foot 4-inch and 6-foot 8-inch spans with deck balk pinned to transoms. This is necessary for loads over 60 tons.

c. Reinforcing Existing Fixed Bridges. An existing bridge can be reinforced by assembling one or more 50-ton trestles under the span and raising the transom by ratchet chain hoist to a firm position under the bridge. Relieve tension on ratchet chain hoist and pin. The

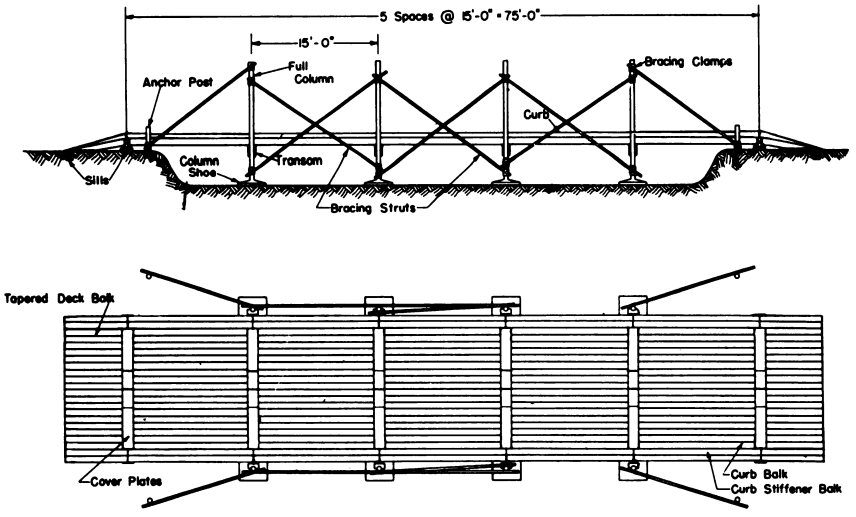

Figure 93. Multiple-span fixed bridge.

length of unsupported span and type of assembly determines the number of trestles to be used. This method is limited to bridges which will fit the 204-inch-wide trestle transom.

CHAPTER 9

MAINTENANCE, REPAIR, HANDLING, AND STORAGE

Section I. MAINTENANCE OF ASSEMBLED BRIDGE

84. Traffic Effect

a. Floating Section. The passage of light vehicles over the M4 bridge will rarely cause overloading or damage. Heavy vehicles, such as tanks, cause large stresses in the bridge. When vehicles cross the floating section of the bridge their weight forces the pontons down into the water. The greatest downward force usually occurs at the first ponton from shore. The balk act as a rigid beam which tends to resist the downward force and spread the load over many pontons. Under these conditions, large stress is set up in the balk, balk lugs, gunwale pins, hold-down levers, pontons, and ponton connections. The bridge is designed to withstand all this stress as long as the pontons have freeboard. Vibration and continuous motion may work out gunwale pins, which must be replaced as soon as possible. Where grounded pneumatic floats are used to reinforce end sections, traffic may cause the bottom of the float to scrape and rub against the stream bed.

b. Trestles. Under traffic, trestles will tend to settle and slip and trestle bracing will loosen.

c. Abutments. Wave action and stream currents tend to undercut the abutments. There is a tendency for continuous-deck end spans to rise off the abutments, especially during rapid crossing of tanks. Constant pounding of traffic will cause holes and settlement of the abutment.

d. Approaches. Traffic will rut the road because all vehicles use the same lane going on and off the bridge.

e. Anchorages. Over a period of time continuous traffic or overloading contributes to the failure of bridle lines, anchor lines, and holdfasts.

85. Changes in River Conditions

a. Definitions. Normal change in stage in a body of water refers to the normal periodic and frequent or seasonal changes in the water level as caused by tides, winds, rainfall, snowmelt, or operation of dams. This differs from floods in that it is not nearly as severe, is

usually regular or predictable, and is a normal rather than an emergency occurrence.

b. Tidal Effect on Floating Bridges. In tidal streams the rise and fall of the water, combined with the reversal of flow, may have a severe undercutting effect on abutments and trestle footings. Rapid and frequent changes of stage may make the use of trestles necessary. Frequent adjustment of upstream and downstream anchors or bridle lines is usually necessary in tidal waters.

c. High Water and High Stream Velocity. As a stream rises its velocity increases causing a reduction in ponton freeboard (fig. 94) which reduces the bridge class and increases the forces tending to wash the bridge downstream. This increase in force places a greater strain on all parts of the bridge, shore connections, bridle lines, anchor cables, and guy lines. During flood stage it may be helpful to record stream behavior by taking periodic measurements of current velocity, and readings of a staff gage. (A staff gage is a stick or pole marked in units such as feet or inches, used to measure the rise and fall of the water.) An upstream warning station should be established so that bridge personnel will receive advance notice of approaching flood conditions.

d. Debris. Floods usually carry large amounts of debris, such as trees, parts of buildings, and brush. There is greater damage from

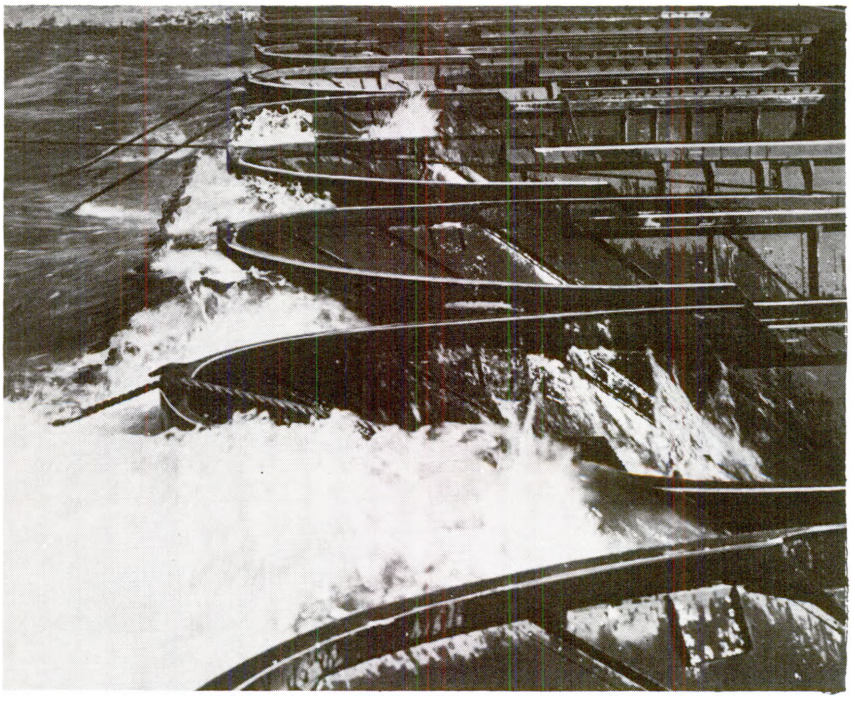

Figure 94. Critical ponton freeboard at upstream end in current of 11 fps.

light debris when current velocity is from 4 to 6 feet per second than when the current is more rapid, because the current is not fast enough to carry the debris through the bridge. This will cause jamming. If jamming occurs, ponton bows may be damaged and anchorages may be torn out. When high-current-velocity floods carry great quantities of heavy debris, such as large trees, the bridge should be tied against the shore in sections.

86. Maintenance

a. Maintenance Detail. A qualified engineer officer, with a detail of engineer troops, is assigned the mission of supervision and maintenance of the completed bridge. One squad is a minimum for this assignment; unusual conditions, such as flood, debris, and floating mines will warrant a considerable increase in the size of the detail.

b. Duties of the Maintenance Detail.

(1) To give technical advice to traffic control personnel on the controlled crossing of vehicles of doubtful classification.
(2) To change the posted capacity of the bridge when indicated by a change in current velocity.
(3) To notify higher headquarters of the change in posted capacity.
(4) To inspect regularly all parts of the bridge, abutments, approaches and protective devices, and to perform promptly all maintenance necessary to keep the bridge in a safe operating condition.
(5) To direct traffic until the arrival of assigned traffic control personnel.

c. Repair Parts and Tools. Repair parts and tools must be immediately available to the maintenance detail. Pontons and other bridge parts should have about 25 percent spares. An important bridge may require up to 100 percent spares. All repair parts should be stockpiled in a safe location near the site. The following is a list of the commonly needed equipment, tools, and supplies:

(1) *Equipment.*
Air compressor
Inflation manifold
Powerboat
Truck crane
Bulldozer
Aluminum repair kit
Pneumatic float repair kit
(2) *Bridge parts.*
Pontons
Pneumatic floats w/saddles
Balk

Gunwale and transom pins
Anchors
Trestle bracing

(3) *Tools.*
Balk-depressing levers
Sledges
Hammers
Axes
Crowbars
Holdfasts and pickets
Picks
Shovels
Ratchet chain hoists
Wrenches
Blocks for fiber & wire rope

(4) *Supplies.*
Rope
Wire rope
Cable clips
Sandbags
Cribbing and lumber
Gravel

d. Superstructure. Inspect regularly and tighten or replace balk, gunwale pins, hold-down levers, and ponton connections. This inspection and maintenance is always performed before and after risk crossings, before other traffic is permitted to cross. The luminous markers on the handrail and approach posts are kept clean, or replaced when broken or knocked off.

e. End Sections.

(1) *End span.* Paragraph *d* above applies to maintenance of end sections. To overcome the tendency of the continuous-deck end span to rise off the abutment, raise the abutment not more than 12 inches, or use a 15-foot simple span extending beyond a "floating sill" to a fixed abutment sill.

(2) *Trestles.* Transoms are raised when the trestle shoes settle into the bottom material. Additional trestle bracing is usually required after initial settlement. After a little traffic the bracing clamps are loosened and then tightened to release any bending caused by movement in settling. Use sandbags, wire netting, landing mat, or rock to protect trestle footings from the undercutting action of the current.

f. Abutments and Approaches.

(1) Check abutment shoes and sills to insure that they are level and that settlement does not occur. Build up settled abutments with gravel, additional footings, or cribbing. The

bank revetment is checked frequently and riprap added when needed. Change in water level must be anticipated. A rise of water level requires lengthening the bridge or adding trestles. A fall in water level may ground the shoreward pontons. Grounded shoreward pontons are replaced with pneumatic floats or trestles.

(2) Approaches must be in good condition so that traffic will not be limited or held up because of a stuck vehicle. Fill ruts with suitable material which should be stockpiled nearby.

g. Pontons and Pneumatic Floats.

(1) *Pontons.* Check pontons frequently for water content, and pump them dry when necessary. Pontons can be damaged by debris, small-arms fire, shell fragments, or explosives. Minor repairs are made in several ways:

(*a*) Stuff the hole (fig. 95) with wadded fabric, forcing it through in the direction from which hole was made, and leaving enough material on both sides to insure keeping the material about the hole. Impregnate the wadded fabric with grease or a sealing compound before insertion.

(*b*) For round holes (fig. 95) drive a tapered plug of wood into the hole in the direction from which the puncture occurred.

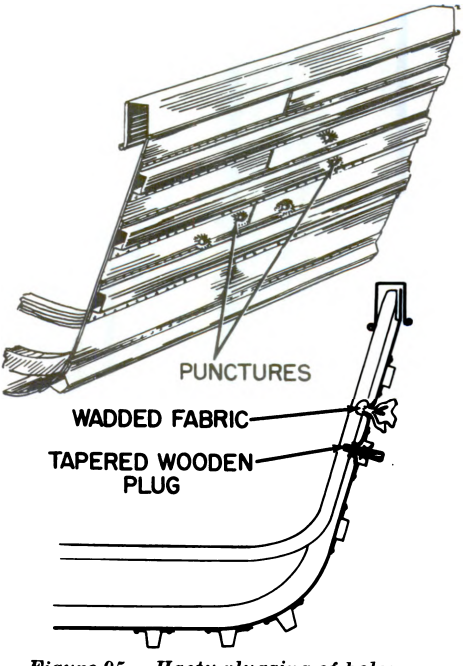

Figure 95. Hasty plugging of holes.

(*c*) Short and regular tears above the water line can be peened sufficiently watertight to make a temporary repair. First, flatten the dent in the material around the tear. Then hold a flat dolly on one side of the torn surface, and close it by hammering on the other side just above and below the tear with the ball end of a peen hammer. The peening forces the material at the tear together so that the application of a coat of bituminous plastic cement forms a temporary watertight joint (fig. 96). Clean area around tear thoroughly before coating with bituminous compound.

(*d*) For a more permanent hasty repair of holes, place a board over the opening with a piece of impregnated fabric between the wood and the aluminum skin. Bolt or nail the board over the hole; if nailed, the nails are driven through the aluminum skin and clinched to the wood (fig. 96). The fabric and bituminous plastic cement are furnished with the aluminum repair kit. A piece of canvas impregnated material, or gasket material, is a satisfactory substitute.

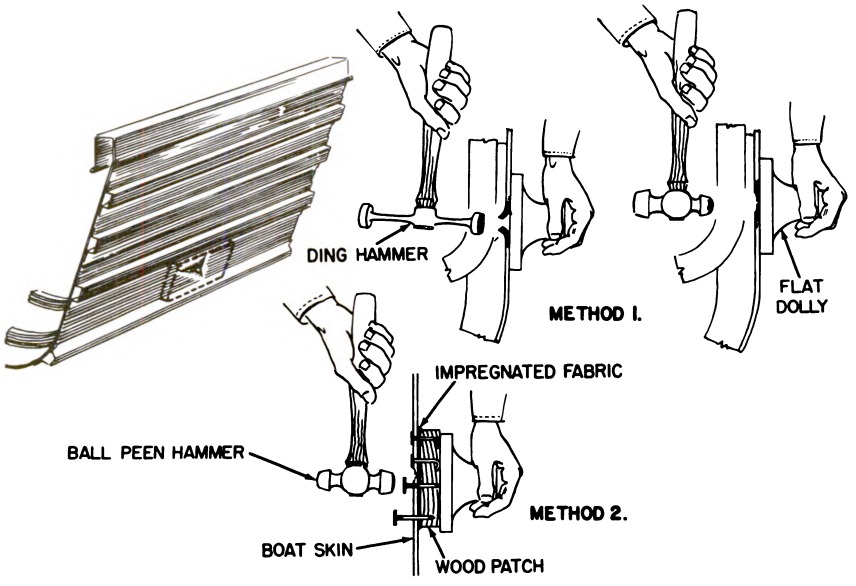

Figure 96. Methods of making a temporary watertight joint.

(*e*) Badly damaged and leaking pontons can be replaced (fig. 97). To avoid breaking the bridge, unfasten all gunwale hold-down levers which hold the damaged whole ponton in place and allow it to float downstream. Weight ponton with men or water, push or pull it into position from downstream side, remove weight and fasten ponton to the gunwales with hold-down levers. The bridge should be closed to traffic during the period of ponton replacement.

① New ponton being pulled under removable gunwale from downstream side

② New ponton in approximate final position

Figure 97. Replacement of damaged ponton.

(2) *Pneumatic floats.* The air pressure in pneumatic floats changes with temperature, sunshine, and the weather. The floats are inspected frequently and inflated or partially deflated to keep the pressure of 2 p. s. i. constant. Temporary repairs to floats are limited to plugging small holes with the tapered plugs supplied in the emergency repair kit which is furnished with each float. If a float is damaged beyond the capacity of the emergency repair kit, another float may be installed without breaking the deck connections.

(*a*) *Step 1.* Remove the pins holding the saddle adapter to the saddle beam and withdraw the damaged float.

(*b*) *Step 2.* Pull a partially inflated float complete with saddle beams under the bridge.

(*c*) *Step 3.* Work the saddle beams into position under the saddle adapters and replace the four pins.

(*d*) *Step 4.* Inflate the float and adjust anchorage lines.

h. Anchorage System.

(1) *General.* Inspect and adjust all lines continually to maintain proper tension and keep the bridge straight. Adjust anchor lines with the capstans; do not attempt to haul in by hand alone. Adjust overhead anchorage cable within the limits of 2 percent to 5 percent sag. Check deadmen and holdfasts to insure holding, and be prepared to install additional deadmen, holdfasts, and anchor cables if flood and increased stream velocities are expected. It is emphasized that increase in stream velocities must be anticipated and anchorage systems made ready and installed. It is difficult, sometimes impossible, to install additional anchorage when the current has increased to more than normal. Overhead anchor cable deadmen and towers should be placed well above high water and protected against scour.

(2) *Bridle lines.* Broken bridle lines of fiber rope can be repaired by tying a square knot or by splicing, but should be replaced.

(3) *Bed anchors.* Kedge anchors may fail by breakage of the line or by dragging on the bottom. Extra anchors with attached lines should be available for immediate replacement.

(4) *Improvised anchors.* Comments relating to kedge anchors also apply to improvised or expedient anchors. However, these anchors are sometimes so large or require so many man-hours to replace that it may be desirable to send a diver down to attach another line. A diver's set is supplied with the M4 bridge. Diving can be done only in calm weather in low-velocity current.

(5) *Shore guy lines.* During times of heavy debris, shore guy lines should be elevated above water level with **A**-frames or floating supports.

i. Emergency Action. In flood velocities or heavy debris conditions when there is danger of losing the bridge it may be necessary to close the bridge. The removal of pontons is only necessary when the water has such turbulence that swamping of the pontons may occur. If velocities above 15 feet per second are expected, the bridge should either be removed from the water or broken up into rafts that are tied along the shore. This should be done before the current velocity reaches the bridge site.

Section II. REPAIR, HANDLING, AND STORAGE OF DISASSEMBLED BRIDGE

87. Repair

a. General. The time for general inspection and renovation of all the parts, tools, and accessories is when the bridge is disassembled, and before storing or transporting. Thorough repair work is important because, to keep weight down, the factor of safety in all parts is small. In general, the various mechanical devices are designed to operate satisfactorily without lubrication. This applies particularly to threaded parts. Experience has shown that in military use lubricants accumulate dirt and dust which are likely to cause fouling. Lubricants should be used for long-term storage, however.

b. Pontons. The aluminum is subject to corrosion which weakens the metal and causes pits and holes. This action is particularly severe near the waterline and is accelerated by salt or brackish water. Before inspection and repair, wash and dry inside and out. Remove and clean duckboards. Major and permanent repairs can be made with the aluminum repair kit No. 10, which is supplied with the bridge set. Patching with sheet aluminum, with impregnated fabric between the patch and the skin of the ponton, is the most permanent method of repair. The procedure is as follows:

(1) *Step 1* (fig. 98). Flatten and smooth the distorted metal which is around the tear and which will be under the patch, and trim all frayed edges and burrs. The patch is always placed on the outside of the ponton.

(2) *Step 2.* Cut an aluminum patch large enough to cover the hole and provide space for the rivets to hold the patch in place. Galvanized iron or plain sheet steel can be used in place of aluminum, but aluminum should be used whenever possible.

(3) *Step 3.* Using the patch as a template, cut a canvas gasket and coat it with bituminous cement.

(4) *Step 4.* Check the inside of the ponton for interference of structural members or stiffeners; space rivets accordingly. Hold the patch against the ponton to lay out the spacing.

Lay out the rivet spacing on the patch: center punch the location for each rivet.

(5) *Step 5.* Drill one hole in the patch, and then drill its corresponding hole in the ponton. Clean off burrs around drilled holes. Temporarily bolt the patch in place. Repeat this drilling, and bolt as necessary to hold the patch in place. Remove the patch and reattach with the gasket between it and the ponton. To make a watertight joint, spacing must be exactly the same on the patch and ponton because the drilled holes are only $\frac{1}{64}$-inch larger than the rivets.

(6) *Step 6.* Punctures of less than $\frac{5}{16}$-inch diameter are closed by flattening the metal around the hole, removing burrs, drilling and reaming the hole. Then drive in the proper size rivet.

(7) *Step 7.* Wire brush any parts of the ponton from which the paint has been removed. Cover with a primer base, and then paint.

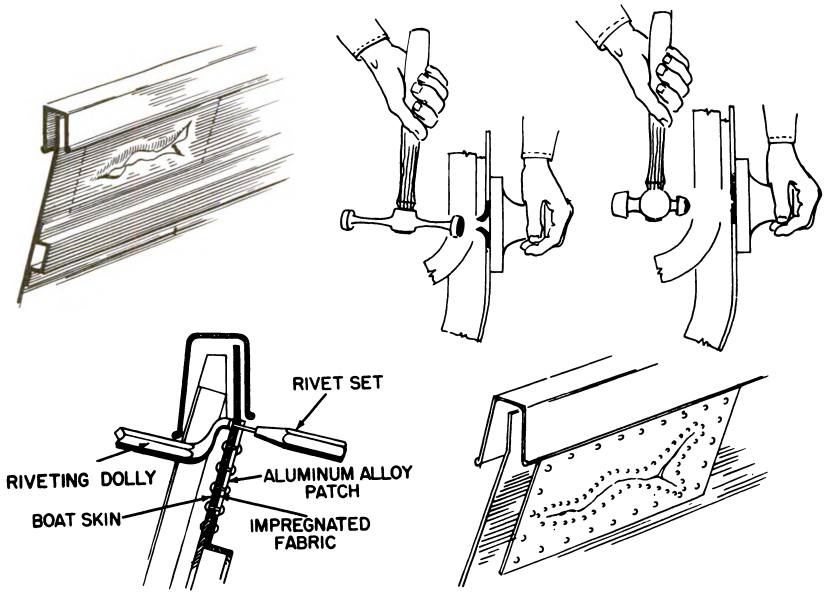

Figure 98. Method of making permanent repairs to pontons.

c. Deck Balk.

(1) Balk will probably be permanently deformed only by severe impact, overloading, or explosives. Bent balk cannot be straightened properly and must be salvaged. Small holes caused by bullets or shell fragments can be repaired by welding in an aluminum plug or filling the hole with weld metal, if the welder is experienced with aluminum.

(2) Carrying handles might be bent. Slightly bent handles need no repair. Badly bent handles are replaced.

(3) Balk lugs can be bent or broken by overloading. If the lug is bent so that it will not fit properly into the recess or if it is broken, repairs must be made in a properly equipped shop.

(4) Coat with primer base, and then paint all places from which the paint has been removed.

d. Handrail and Approach Posts. Straighten badly bent posts, paint if chipped, and replace broken or missing luminous markers.

e. Transverse Stiffeners and Abutment Shoes. Wire brush bare spots and cover with primer base: then paint.

f. Ferry Ramps. Ramps require the same care as deck balk in *c* above. Inspect horizontal pins and straighten or replace as required.

g. Pneumatic Floats. Clean and dry thoroughly. Inspect and repair all cuts and tears with the material and tools in pneumatic float repair kit No. 7. Replace broken or missing D-rings. Replace worn-out saddle straps and buckles with 5/8-inch rope. (See TB ENG. 27.) Dry before placing in carrying case.

h. Saddles. Steel items, such as saddle beams and adapters, can be repaired with gas and electric welding methods. When the plywood bearing plates are broken or splintered they must be replaced.

i. Accessories.

(1) *Assault boat.* Clean and paint when necessary. Repair procedures for plywood hulls are given in TM 5–271.

(2) *Repair kits.* Keep kits ready for immediate use. Set up supply procedure so that expended repair material is replaced without delay. Keep all repair material clean and dry. Chest containing pneumatic float repair material must be kept cool and out of the sun to prevent deterioration of rubber.

(3) *Sign reproduction kit.* Instructions for maintenance are furnished with the kit.

(4) *Pioneer and rigging equipment sets.* The tools and equipment in the Pioneer Equipment Set No. 5 and the Rigging Equipment Set No. 1 are kept clean, oiled where applicable, and replaced when lost or broken.

j. Other Equipment. Gasoline engines are kept clean, properly oiled and lubricated, and the electrical system is kept dry. The detailed instructions for maintenance of the following items may be found in appropriate technical manuals: motorized equipment, outboard motors, smoke generators, bridge erection boats, pumps, air compressors, cranes, and trucks.

88. Handling

a. General. To avoid damaging bridge components it is important to use proper handling methods in moving them from storage to the finished bridge, from the bridge back to storage, or to another site. Chapters 3 and 4 detail the general handling procedures. This paragraph emphasizes the points necessary to maintain the bridge free from damage during handling.

b. Pontons and Boats. Do not drop or drag. Dragging will scratch off paint, injure the skin of pontons, and damage the hulls of boats. Whenever possible use a crane to load and unload pontons and boats, and to place them in the water. Attach crane slings to four points on the ponton, usually at the carrying handles. Twenty men each lifting about 90 pounds can hand carry a half-ponton. When transporting pontons, use the bolster trailers and insure that all binders are secure before moving the vehicles. Pin the gunwale hold-down levers in the closed position before handling.

c. Deck Balk. Use carrying handles to lift deck balk, either by crane or by hand. Individual balk are usually lifted by hand and require four men. Short balk require two men to lift them. Tapered balk can be lifted by one man. Three short cover plates or one long cover plate are one-man loads.

d. Transverse Stiffeners and Abutment Shoes. Each can be lifted by four men. When a crane is used to lift a transverse stiffener, attach the sling to the pins near the ends. Use this method also in lifting a portion of the bridge to which a transverse stiffener is attached (fig. 99).

89. Storage

a. General. Proper storage of bridge components is necessary to avoid failure or loss of any parts. Improper storage may result in weathering, corrosion, bending, breaking, or other damage. When open storage must be used, arrange parts of the equipment so that water will drain from the stacks, insure adequate ventilation, and keep pieces from direct contact with the ground. The parts of the bridge that are usually transported by bolster trailer can best be stored on these trailers. Jack the trailer off the ground during long storage periods.

b. Pontons. When storing outside, place the pontons bottom side up. They may be stacked; but place timber at least 4 inches thick on the ground under the first ponton. Remove bow duckboards before storing in the stacked position. When storing under cover, stack them upright, or inverted.

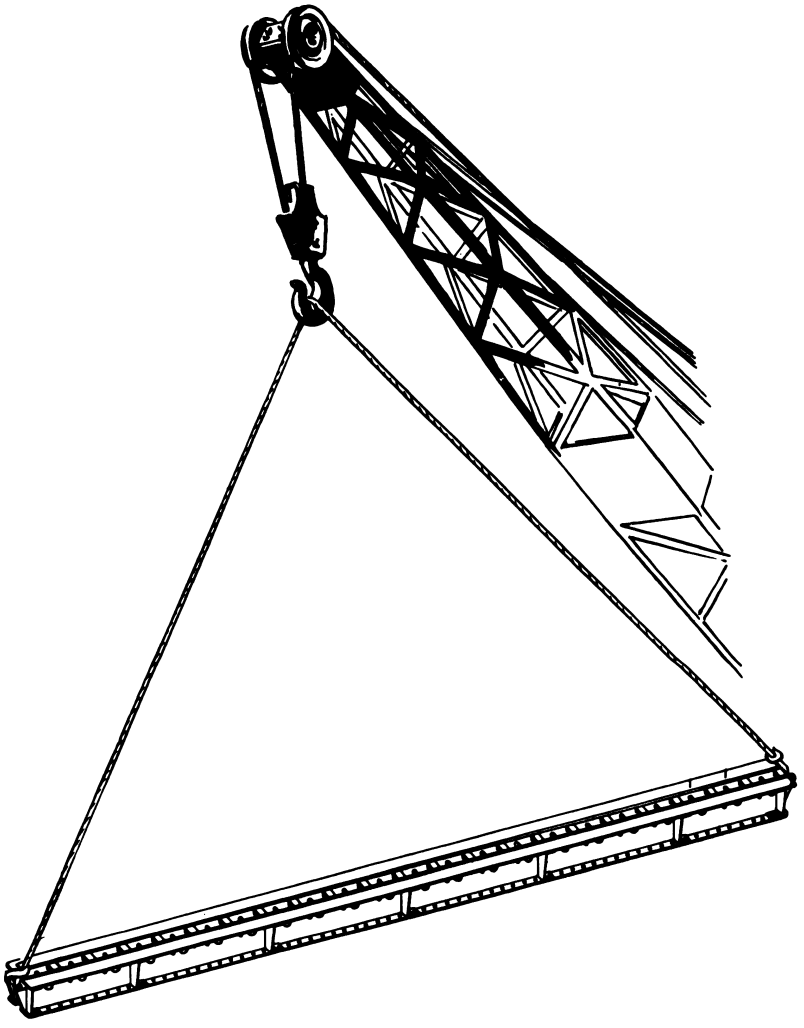

Figure 99. Method of attaching crane sling to transverse stiffener.

c. Floats. Before placing pneumatic floats in their carrying cases they must be dried thoroughly. Never place them in the carrying case when wet or damp, because the fabric will mildew and weaken the float. Store in a cool dark place.

d. Miscellaneous. Store rope, anchors, paddles, pickets, and other equipment neatly in any convenient fashion (fig. 100). Unlock anchor stocks and tie them to the shank. Wash rope free from grit and dirt before storing. Coil, handle, and store rope as prescribed in TM 5–225. Place a coating of lubricant on the outside layer of the reel of wire rope.

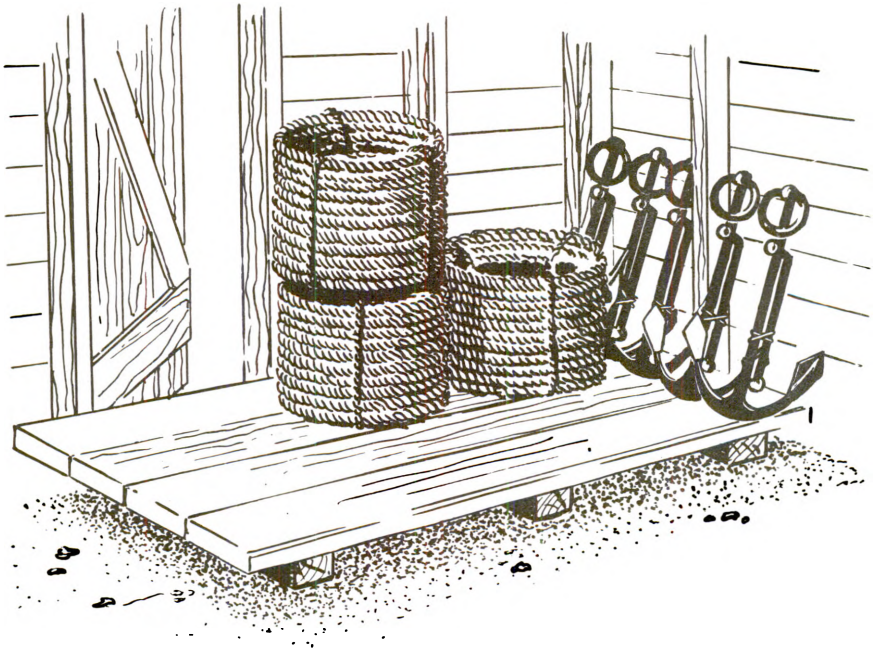

Figure 100. Coils of rope and anchors stored on wooden platforms.

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CHAPTER 10

FLOATING EXPEDIENTS

90. Footbridge

a. General. Component parts of the M4 bridge set can be used to assemble various types of expedient bridging. Figure 101 shows a type of expedient footbridge assembled primarily of deck balk. The bridge consists of a walkway two or three balk wide; the three-balk width is suggested for safety, especially at night and in swiftly moving streams. The walkway is connected to the float by means of an expedient adapter, made of removable gunwale sections. Each float consists of two normal balk.

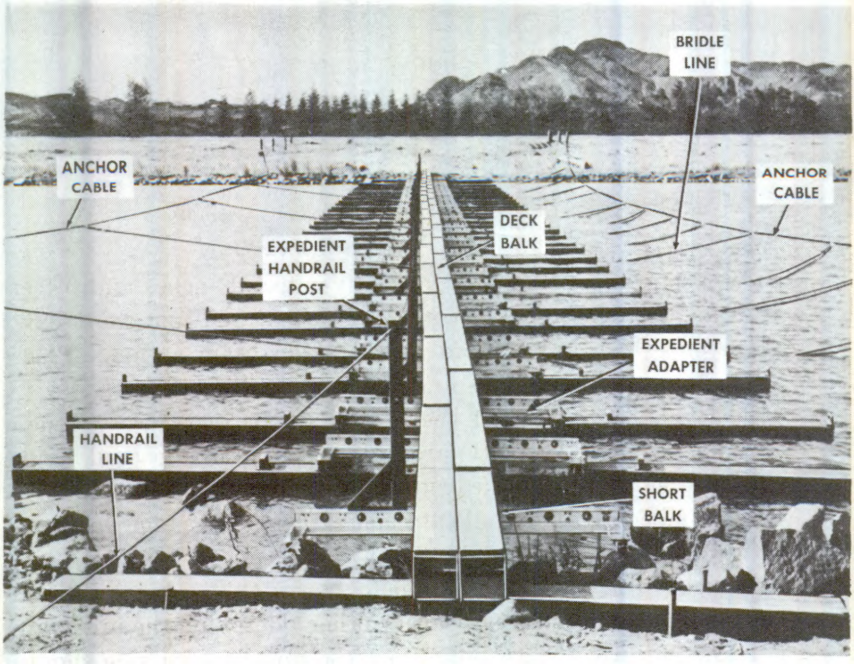

Figure 101. Expedient footbridge.

b. Assembly. Assemble the bridge in shallow water, pushing the bridge out as sections are added.

(1) Assemble the float of two normal deck balk overlapping 6 feet 8 inches and connected by an adapter (fig. 102). Floats are assembled upstream or downstream of the bridge centerline.

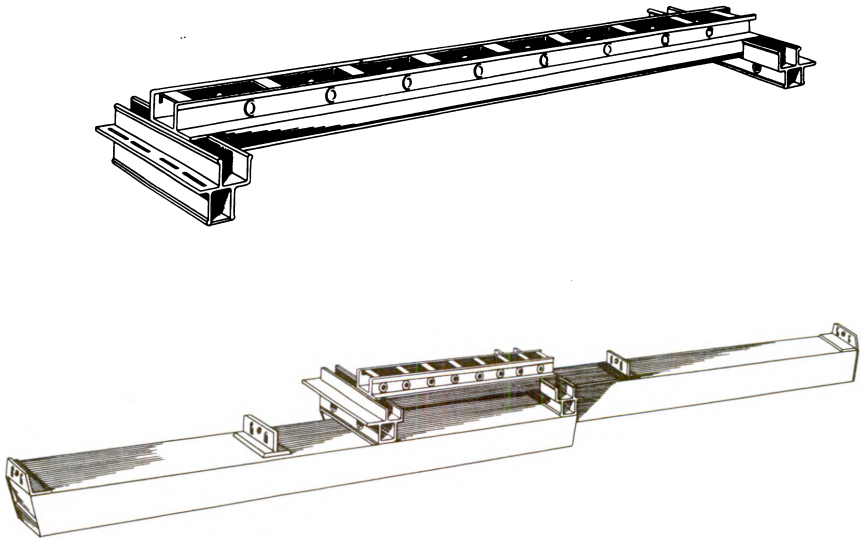

Figure 102. Expedient adapter and float assembly.

(2) Space float assemblies alternately 8 feet 4 inches and 6 feet 8 inches apart. Start with one normal and one short balk to offset joints and give a continuous-beam action. Place walkway balk on floats and pin them to this adapter.

(3) The handrail posts of the bridge set, or expedient wooden handrail posts (fig. 101) are fastened to the bridge, and handrail lines are run as the bridge is assembled.

(4) A timber abutment sill at each end of the bridge supports the end balk.

(5) Anchor the footbridge either by use of anchor cables or bed anchors. In either case, every other ponton on the upstream side and every sixth ponton on the downstream side should be anchored.

c. Capacity. This bridge will carry foot troops at 10-foot intervals in currents up to 9 feet per second. In slower currents the interval may be reduced.

d. Assembly Time. Estimated average assembly is 2 hours for 250 feet of bridge, using trained troops.

91. Jeep Bridge

a. General. The jeep bridge (fig. 103) is assembled in a manner similar to the footbridge described above. It requires one additional part: an expedient connector made of a short section of removable gunwale. The jeep bridge consists of two treadways, three balk wide, separated by a gap two balk wide.

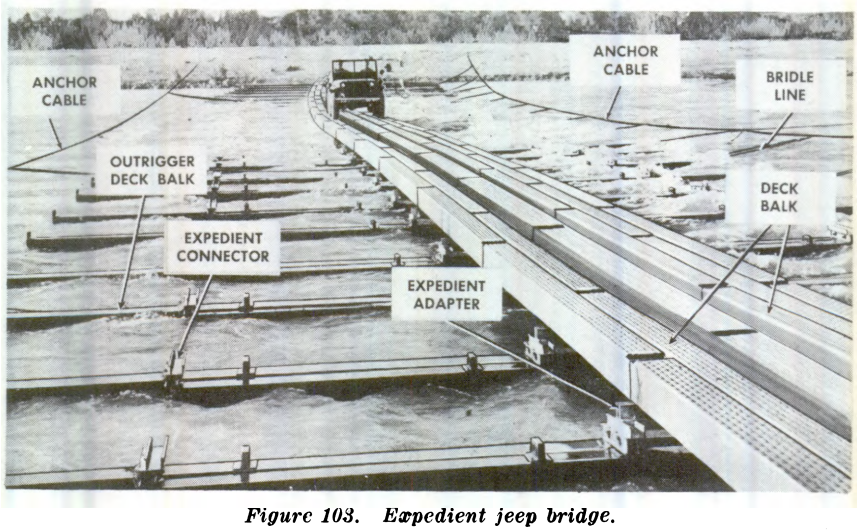

Figure 103. Expedient jeep bridge.

b. Assembly. Assemble the floats in shallow water and push the bridge out as sections are added. Use guy lines at intervals of about 100 feet to control and to help aline the bridge.

(1) The jeep bridge float is made by connecting two outrigger balk to the footbridge float (fig. 104) by means of expedient

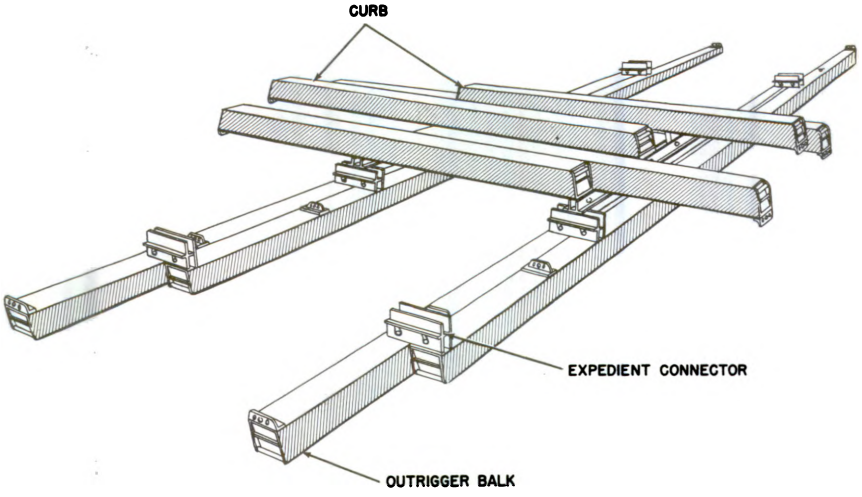

Figure 104. Float and treadway type construction.

connectors. Floats are spaced alternately 8 feet 4 inches and 6 feet 8 inches, as in the footbridge.

(2) Lay the treadway balk with the joints offset to give continuous-beam action, and pin them to the adapters. Lay the inside balk of each treadway on curb adapters for a safety curb on the bridge.

(3) A timber abutment sill is used on each shore to support the ends of the bridge. Ferry ramps, tapered balk, or fill is used for the approaches to the bridge.

(4) The bridge is anchored by any of the normal means of anchorage. Every other float on the upstream side and every sixth float on the downstream should be anchored.

c. Capacity. This bridge will carry a loaded ¼-ton truck in currents up to 8 feet per second.

d. Assembly Time. Estimated average assembly time for 250 feet of bridge is 4 hours, using trained troops.

APPENDIX I

RELATED PUBLICATIONS

FM 5–9	Elementary Bridging.
FM 5–10	Routes of Communication.
TM 5–225	Rigging and Engineer Hand Tools.
TM 5–260	Principles of Bridging.
TM 5–261K	Bridge Model Training Aid Kit Floating Bridge M4 and M4A2.
TM 5–266	Bridge Fixed or Floating, Airborne Division, 50-Ton.
TM 5–271	Light Stream-Crossing Equipage.
TM 5–277	Panel Bridge, Bailey Type, M2.
TM 55–370	Operation of Small Boats and Harbor Craft.
TB ENG 27	Repair of Pneumatic Floats.
TF 5–1414	Handling of Boats and Pontons in Swift Currents.
TF 5–1415	Operation of Rafts.
TF 5–1440	The Floating Bridge M4—Part I: End Sections.
TF 5–1441	The Floating Bridge M4—Part II: Assembly of the Bridge.
TF 5–1442	The Floating Bridge M4—Part III: Rafts.

APPENDIX II

BASIC BRIDGE SET

Bridge, Floating M4, Basic Bridge Only, Without Transportation and Erection Equipment

Nomenclature	Unit of meas	Net wt per unit (lb)	Net cubage per unit (cu ft)	Total units per basic bridge set
Adapter, curb, steel, for aluminum deck balk	ea	15. 00	0. 20	160
Adapter, saddle, steel, complete w/pins, for aluminum deck balk w/18-ton pneumatic float.	ea	260. 00	25. 60	32
Anchor, kedge, 100-lb	ea	100. 00	6. 68	56
Bag, sand, burlap, w/binder	ea	. 32	. 013	3, 000
Balk, aluminum, deck, normal, 14′ 11¾″ long.	ea	225. 00	11. 40	960
Balk, aluminum, deck, short, 8′ 3$\frac{5}{16}$″ long	ea	122. 00	6. 30	44
Balk, aluminum, deck, tapered, w/hinge plate, 6′ 8$\frac{7}{16}$″ long.	ea	110. 00	5. 10	88
Battery, dry cell, ractangular, 6-volt, 2⅝″ x 2⅝″ x 3$\frac{15}{16}$″ (Signal stock No. 3A275–200).	ea	1. 50	. 02	6
Boat, assault, M2	ea	325. 00	230. 00	2
Clamp, pusher, balk, aluminum, steel-fitted	ea	30. 00	. 20	16
Clip, wire rope, steel, galvanized:				
½-inch	ea	. 73	. 01	480
⅝-inch	ea	1. 00	. 01	150
¾-inch	ea	1. 73	. 02	100
Diving outfit, Set No. 3, light-weight diving mask.	set	125. 00	10. 96	1
Flare, road, electric, dry cell w/separate liquid to form electrolyte solution, w/ blackout hood.	ea	3. 00	. 043	100
Float, pneumatic, w/emergency kit, 18-ton, w/carrying case, M1.	ea	1,000.00	40. 00	16
Grip, cable, parallel jaws, ½ to ¾-in cable	ea	6. 25	. 09	28
Grip, cable, heavy-duty, wedge and roller type, for ⅝″ 6 x 19 stranding wire rope, w/alternate wedges for ¾″ and 1″ 6 x 19 stranding wire rope, complete w/cable bridle.	ea	32. 00	. 20	8
Gunwhale, ponton, removable, aluminum, 15′ 4⅜″ long, complete w/pins.	ea	135. 00	4. 20	152
Hammer, machinist's ball peen, type L, Class I, handled, 1-lb.	ea	1. 40	. 04	44
Holdfast, complete w/9 pickets	ea	130. 00	1. 56	32

Bridge, Floating M4, Basic Bridge Only, Without Transportation and Erection Equipment—Continued

Nomenclature	Unit of meas	Net wt per unit (lb)	Net cubage per unit (cu ft)	Total units per basic bridge set
Hook, boat, ball-point, 10-ft	ea	6.00	.13	28
Hose, fire, cotton, rubber or synthetic rubber lined, w/male and female couplings, standard iron pipe thread, single jacket, 1½-in diameter, 25 ft long.	ea	11.00	.51	4
Hose, suction, water, smooth-bore, wrapped fabric construction, synthetic rubber lined and synthetic rubber covered, w/male and female couplings, standard iron pipe thread, 1½-in diameter, 10 ft long.	ea	20.00	.53	4
Lantern, electric, portable, hand, dry-cell type, 6-volt.	ea	2.00	.25	6
Paddle, boat, single-blade, 5 ft long, set of 9 in canvas bag.	set	25.00	1.90	8
Picket, steel, 1¼" x 36"	ea	13.00	.03	80
Pioneer equipment, Set No. 5, for M4 floating bridge.	set	1,620.00	35.50	2
Plate, cover, long, aluminum, 5' 4½" long	ea	97.00	.80	40
Plate, cover, short, aluminum, 1' 6¼" long	ea	28.00	.30	20
Pole, ranging, metal tubular, 6' long, 12" red and white graduations, 2-section w/ canvas case.	ea	4.00	.06	8
Ponton, half, aluminum, M4, complete w/pin connectors.	ea	1,750.00	825.00	56
Post, approach, aluminum, 2' 2" long w/2 luminous markers.	ea	2.00	.15	140
Post, handrail, aluminum, steel-fitted, 3' 1⅛" long, w/2 luminous markers.	ea	4.00	.35	92
Preserver, life, vest type, single chamber, self-inflation, in pouch, w/two 26-gram bottles, carbon dioxide.	ea	5.00	.10	44
Pump, water, bail, ponton	ea	17.00	3.90	28
Ramp, ferry, aluminum, steel-fitted, 3' 4" long, complete w/pins.	ea	236.00	8.50	32
Repair equipment:				
Set No. 7, pneumatic float, large	set	320.00	18.00	2
Set No. 10, aluminum, M4 floating bridge.	set	315.00	17.30	2
Rigging equipment Set No. 1	set	236.00	3.20	2
Rope, sisal, 3-strand, oiled:				
½" (300' coils)	ft	.08	.002	6,000
¾" (300' coils)	ft	.19	.004	3,600
1" (300' coils)	ft	.26	.007	16,500
Rope, wire, steel, plow, improved, galvanized, fiber core, preformed regular lay, right lay, 6 x 19 stranding, ¾" rope (1000' reels).	ft	.90	.02	2,000

Bridge, Floating M4, Basic Bridge Only, Without Transportation and Erection Equipment—Continued

Nomenclature	Unit of meas	Net wt per unit (lb)	Net cubage per unit (cu ft)	Total units per basic bridge set
Rope, wire, steel, plow, mild, galvanized, fiber core, preformed regular lay, right lay, 6 x 19 stranding:				
½" (300' coils)	ft	.41	.01	4,800
⅜" (500' coils)	ft	.63	.01	2,000
Saddle, steel treadway, knockdown, 18-ton	ea	2,100.00	79.70	16
Shoe, abutment, aluminum, 15'6" long, complete w/40 pins.	ea	390.00	12.50	8
Sill, abutment, 7⅝" x 9⅝" x 15'6", 25-ton	ea	268.50	8.17	8
Snap, boat, swivel eye, galvanized No. 5	ea	.50	.003	160
Spacer, ponton, reinforcing steel	ea	18.00	.46	56
Stiffener, transverse, aluminum, 17'9" long, complete w/pins.	ea	388.00	10.80	16
Tape, cotton, general use, bleached, ¾" wide, 500' roll.	roll	1.00	.044	8
Tape, measuring, woven metallic, U. S. 50', graduated in feet, inches, and half inches, w/metal lined leather case.	ea	.70	.02	8
Traveler, bicycle	ea	30.00	1.40	4
Trestle, aluminum and steel, 50-ton complete without hoist.	ea	3,894.00	120.00	12

Note. This table is based on T/O & E's incorporating changes through 6 September 1950 and supply data current 1 January 1951, including ERDL Report 1017. Organizations should consult subsequent publications for changes in organization and supply.

APPENDIX III

TRANSPORTATION AND LOADINGS

1. Transportation and Loadings of Major or Mission Items

Vehicle	Total number of vehicles [a]	Number of basic loads	Basic loads [b]
Truck, ¾-ton, cargo, M37	1	1	Engineer section equipment.
Truck, 2½-ton, cargo	3	1	Signal equipment.
		2	Shallow-water accessories.
Truck, 2½-ton, cargo, and trailer, 1-ton, cargo.	6	6	Floats and saddles.
Truck, 2½-ton, cargo, and trailer, 2½-ton, pole type.	1	1	Crane-shovel attachments, 19-ft bridge erection boat.
Truck, 2½-ton, bolster body and bolster trailer, 2½-ton.	42	28	Pontons.
		12	Trestles.
		2	Spare components.
Truck, 4-ton, dump	8	4	Abutment equipment.
		4	Ferry equipment.
2 trucks, 4-ton, dump; 1 truck, 2½-ton cargo and 2½-ton pole trailer, 2-wheel.	3	2	Approach accessories, tools and rigging equipment.
		1	27-ft bridge erection boat.
Truck-tractor, 6-ton, and semi-trailer, 20-ton.	2	2	Bulldozers.
Crane-shovel, truck-mounted, ¾-cu-yd and trailer, 7-ton.	3	1	Crane-shovel attachments: Load No. 1.
		2	Load No. 2.
Crane-shovel, truck-mounted, ¾-cu-yd.	2	2	Crane-shovel attachments: Load No. 3.
Compressor, air, truck-mounted	2	2	Pneumatic tools.

[a] Consult latest T/O & E's for changes in issues.
[b] For detailed contents of loads, see "Truck and trailer loadings," below.

2. Truck and Trailer Loadings, M4 Bridge and Erection Equipment

ENGINEER SECTION EQUIPMENT—LOAD A

One load carried on ¾-ton cargo truck, M37

Item	Quantity	Total wt (lb)
Boat, reconnaissance, pneumatic	1	252. 00
Indicator, cable tension, heavy-duty	1	123. 00
Lamp, electric, flasher type	12	99. 00
Sign painting equipment, set No. 1	1	230. 00
Tape, measuring, steel, 100-ft	2	2. 66
Total load weight		646. 66

SIGNAL EQUIPMENT—LOAD B

One load carried on 2½-ton cargo truck

Item	Quantity	Total wt (lb)
Belt, LC–23	1	9. 00
Chest, BC–5	1	53. 00
Climbers, LC–5	1	8. 00
Converter, M–209	1	5. 50
Detector set, AN/PRS–3	3	330. 00
Flashlight, TL–122	75	67. 50
Holder, M–167	1	1. 25
Panel set, AP–50	11	220. 00
Radio set, SCR–193	1	325. 00
Radio set, AN/PRC–10	1	83. 80
Reel equipment, CE–11	4	72. 00
Reel unit, RL–31	1	52. 00
Spool, DR–8	4	32. 40
Switchboard, SB–22 ( )/PT	1	22. 00
Telephone, EE–8	6	99. 00
Tool equipment, TE–33	2	4. 40
Wire, WD–1 ( )/TT in dispenser	2	100. 00
Wire, WD–110–B on reel DR–4	5	1, 650. 00
Total load weight		3, 134. 85

SHALLOW-WATER ACCESSORIES—LOAD C

Two loads per bridge set. Each load carried on 2½-ton cargo truck

Item	Quantity	Total wt (lb)
Adapter, curb	4	60. 00
Adapter, saddle float	12	3, 120. 00
Auger, post hole, adj 8-in to 14-in	2	47. 80
Clip, wire rope, ½-in	60	43. 80
Grip, cable, ½-in to ¾-in	2	12. 50
Holdfast w/nine pickets	8	1, 040. 00
Rope, wire, ½-in	300 ft	123. 00
Tape, measuring, 50-ft	2	1. 40
Total load weight		4, 448. 50

PONTONS—LOAD D

Twenty-eight loads per bridge set. Each load carried on 2½-ton bolster truck and trailer

Item	Quantity	Total wt (lb)
Adapter, saddle float	4	1, 040. 00
Anchor, kedge, 100-lb	2	200. 00
Balk, deck, normal	22	4, 950. 00
Gunwale, ponton, removable	4	540. 00
Hammer, machinist's, 1-lb	1	1. 40
Hook, boat, 10-ft	1	6. 00
Ponton, half	2	3, 500. 00
Post, handrail	2	8. 00
Pump, water bail, ponton	2	17. 00
Rope, sisal, 1-in	500 ft	130. 00
Snap, boat, No. 5	4	2. 00
Spacer, reinforcing-ponton	2	36. 00
Total load weight		10, 430. 40

APPROACH ACCESSORIES, TOOLS AND RIGGING EQUIPMENT AND 27-FT BRIDGE ERECTION BOAT—LOAD E

Three loads per bridge set. Two loads carried on 4-ton dump trucks, one load carried on 2½-ton cargo truck towing 2½-ton pole trailer, 2-wheel

Item	Quantity	Total wt (lb)
Load on each 4-ton truck:		
Approach accessories		
Bag, sand	1, 500	450. 00
Boat, assault, M3	1	325. 00
Box, sign, 4-in x 14-in message	6	36. 00
Carpenter equipment, set No. 2	1	144. 00
Chest, bridge parts	1	60. 00
Flare, road, electric	50	150. 00
Hose, fire, 25-ft	52	22. 00
Hose, suction, 10-ft	2	40. 00
Lantern, electric	1	2. 00
Pole, ranging	4	16. 00
Post, approach	50	100. 00
Pump, centrifugal, 55-gal	1	250. 00
Repair equipment, set No. 7	1	320. 00
Repair equipment, set No. 10	1	315. 00
Tape, cotton, 500-ft roll	2	2. 00
Tape, measuring, 50-ft	1	. 70
Tools and rigging epuipment		
Auger, post hole, adj 8-in to 14-in	1	23. 90
Chest, bridge parts	1	60. 00
Clip, wire rope, ½-in	50	36. 50
Clip, wire rope, ⅝-in	50	50. 00
Grip, cable, ½-in to ¾-in	4	25. 00
Grip, cable, heavy-duty	3	96. 00
Hoist, chain, ratchet, 1½- to 3-ton	1	135. 00
Holdfast, w/nine pickets	6	780. 00
Lantern, electric	1	2. 00
Picket, steel	20	260. 00
Pioneer equipment, set No. 5	1	1, 620. 00
Rigging equipment, set No. 1	1	236. 00
Rope, sisal, ½-in	2, 100 ft	168. 00
Rope, sisal, 1-in	1, 200 ft	312. 00
Rope, wire, ½-in	900 ft	369. 00
Rope, wire, ⅝-in	1, 000 ft	630. 00
Tape, cotton, 500-ft roll	2	2. 00
Tape, measuring, 50-ft	1	. 70
Total load weight	----------	7, 038. 80
Load on 2½-ton cargo truck:		
Stern section, 27-ft bridge erection boat	1	----------
Load on 2½-ton trailer:		
Bow section, 27-ft bridge erection boat	1	----------
Total load weight	----------	6, 325. 00

ABUTMENT EQUIPMENT—LOAD F

Four loads per bridge set. Each load carried on 4-ton dump truck

Item	Quantity	Total wt (lb)
Adapter, saddle, float	2	520. 00
Balk, deck, short	10	1, 220. 00
Float, pneumatic, 18-ton	1	1, 000. 00
Grip, cable, ½-in. to ¾-in	1	6. 25
Gunwale, ponton, removable	2	270. 00
Paddle, boat (set of 9)	1	25. 00
Picket, steel	10	130. 00
Plate, cover, long	2	194. 00
Plate, cover, short	1	28. 00
Rope, sisal, ¾-in	300 ft	57. 00
Rope, wire, ½-in	300 ft	123. 00
Saddle, penumatic float	1	2, 100. 00
Shoe, abutment	1	390. 00
Sill, abutment	2	537. 00
Stiffener, transverse	2	776. 00
Total load weight		7, 376. 25

TRESTLES—LOAD G

Twelve loads per bridge set. Each load carried on 2½-ton bolster truck and trailer

Item	Quantity	Total wt (lb)
Adapter, curb	2	30. 00
Balk, deck, normal	22	4, 950. 00
Gunwale, ponton, removable	2	270. 00
Hammer, machinist's, 1-lb	1	1. 40
Hoist, chain, ratchet, 1½- to 3-ton	1	135. 00
Plate, cover, long	2	194. 00
Plate, cover, short	1	28. 00
Post, handrail	2	8. 00
Rope, sisal, ½-in	150 ft	12. 00
Trestle, 50-ton without hoist	1	3, 894. 00
Total load weight		9, 522. 40

FERRY EQUIPMENT—LOAD H

Four loads per bridge set. Each load carried on 4-ton dump truck

Item	Quantity	Total wt (lb)
Balk, deck, tapered	20	2, 200. 00
Bracket, outboard motor	1	175. 00
Chest, bridge parts	1	60. 00
Clip, wire rope, ½-in	30	21. 90
Clip, wire rope, ¾-in	100	173. 00
Grip, wire rope, ½-in	1	6. 25
Hoist, chain, ratchet, 1½- to 3-ton	1	135. 00
Motor, outboard, 22-hp	1	296. 00
Paddle, boat (set of 9)	1	25. 00
Post, approach	10	20. 00
Ramp, ferry	8	1, 888. 00
Rope, sisal, ¾-in	600 ft	114. 00
Rope, wire, ½-in	300 ft	123. 00
Rope, wire, ¾-in	2,000 ft	1, 800. 00
Traveler, bicycle	1	30. 00
Total load weight		7, 067. 15

SPARE COMPONENTS—LOAD I

Two loads per bridge set. Each load carried on 2½-ton bolster truck and trailer

Item	Quantity	Total wt (lb)
Adapter, curb	8	120. 00
Balk, deck, normal	40	9, 000. 00
Balk, deck, short	2	244. 00
Balk, deck, tapered	4	440. 00
Clip, wire rope, ½-in	70	51. 10
Clip, wire rope, ⅝-in	25	25. 00
Grip, cable, ½-in. to ¾-in	4	25. 00
Grip, cable, heavy-duty	1	32. 00
Gunwale, ponton, removable	4	540. 00
Hammer, machinist's, 1-lb	2	2. 80
Hoist, chain, ratchet, 1½- to 3-ton	1	135. 00
Holdfast, w/nine pickets	2	260. 00
Plate, cover, long	4	388. 00
Plate, cover, short	2	54. 00
Post, handrail	6	24. 00
Shoe, abutment	2	780. 00
Snap, boat, No. 5	24	12. 00
Stiffener, transverse	4	1, 552. 00
Total load weight		13, 684. 90

FLOATS AND SADDLES—LOAD J

Six loads per bridge set. Each load carried on 2½-ton cargo truck and 1-ton cargo trailer

Item	Quantity	Total wt (lb)
Load on truck:		
Saddle, steel treadway	2	4, 200
Total load weight		4, 200
Load on trailer:		
Float, pneumatic, 18-ton	2	2, 000
Total load weight		2, 000

CRANE ATTACHMENTS AND 19-FT BRIDGE ERECTION BOAT—LOAD K

One load per bridge set carried on 2½-ton cargo truck towing 2½-ton type I trailer

Item	Quantity	Total wt (lb)
Load on truck:		
Cap, drophammer, pile driver, wood pile, 3,000 lb	1	775
Hammer, pile driver, drop, 3,000 lb	1	3, 000
Total load weight		3, 775
Load on trailer:		
Bridge erection boat, 19-ft		3, 100
Bridge erection boat cradle		900
Total load weight		4, 000

CRANE ATTACHMENTS AND 27-FT BRIDGE ERECTION BOAT—LOAD L

One load per bridge set carried on 4-ton dump truck and 2½-ton cargo truck towing 2½-ton trailer

Item	Quantity	Total wt (lb)
Load on 4-ton dump truck:		
Cap, drophammer, pile driver, wood pile, 3,000 lb	2	1, 550
Hammer, pile driver, drop, 3,000 lb	2	6, 000
Total load weight		7, 550
Load on 2½-ton cargo truck:		
Stern section, 27-ft bridge erection boat	1	
Load on 2½-ton trailer:		
Bow section, 27-ft bridge erection boat	1	
Total load weight		6, 325

CRANE ATTACHMENTS—LOAD M

Three loads per bridge set. Each load carried on 7-ton 4-wheeled trailer towed by truck crane

Item	Quantity	Total wt (lb)
Attachments on crane:		
Boom, 30-ft	1	2, 300
Fairleads	1	200
Hook, block, crane-shovel, 15-ton	1	45
Total load weight		2, 545
Attachments on trailer:		
Adapter, leads, pile driver	1	90
Boom extension, middle, 5-ft	*4	1, 500
Bucket, clamshell, ¾-cu-yd	1	3, 180
Bucket, dragline, ¾-cu-yd	1	1, 750
Leads, pile driver	1	2, 500
Shovel front	1	4, 700
Tagline	1	60
Total load weight		13, 780

*1 Truck carries only two.

290471 O—54——13

CRANE ATTACHMENTS—LOAD N

Two loads per bridge set. Each load carried on crane-shovel, truck-mounted, ¾-cu-yd

Item	Quantity	Total wt (lb)
Boom, 30-ft	1	2, 300
Fairleads	1	200
Hook, block, crane-shovel, 15-ton	1	45
Total load weight		2, 545

BULLDOZER—LOAD P

Two loads per bridge set. Each load carried on 20-ton semitrailer towed by 6-ton truck tractor

Item	Quantity	Total wt (lb)
Tractor, crawler type, diesel driven, 17,100 to 22,500 drawbar pull w/bulldozer, tilting, cable-operated	1	32, 100
Binder, load, heavy-duty, ½-in chain	4	60
Total load weight		32, 160

PNEUMATIC TOOLS—LOAD R

Two loads per bridge set. Each load carried on compressor, air, truck-mounted, 105-cfm

Item	Quantity	Total wt (lb)
Drill, pneumatic portable, 1¼-in capacity	1	65
Drill, twist, $^{33}/_{64}$-in to 1-in	1	20
Drill, twist, 1$^{1}/_{32}$-in to 1¼-in	1	20
Grinder, pneumatic, rotary type	1	40
Manifold, float inflation	1	18
Pump, sump, pneumatic	1	162
Sprayer, paint, pneumatic	1	260
Tamper, backfill, pneumatic	1	39
Total load weight		624

INDEX

[AG 823 (6 Jan 54)]

BY ORDER OF THE SECRETARY OF THE ARMY:

M. B. RIDGWAY,
General, United States Army,
Chief of Staff.

OFFICIAL:

WM. E. BERGIN,
Major General, United States Army,
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