TM 5-270

WAR DEPARTMENT

TECHNICAL MANUAL

STANDARD STREAM CROSSING EQUIPMENT

TECHNICAL MANUAL

STANDARD STREAM CROSSING EQUIPMENT

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON, December 31, 1941.

TM 5–270, November 1, 1940, is changed as follows:

3. Assignment of equipment.—*a. Authority for issue.*—Assault boats are issued only to engineer troops as part of their organizational equipment. Each engineer combat battalion and squadron is issued 10 boats; each combat regiment (square division), and armored battalion, 20 boats; each combat regiment (corps), 30 boats; each light ponton company, 80 boats. The light ponton units are the chief source of supply.

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[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

9. Summary of data on assault boat.

* * * * * * *

b. Where obtained.—Organizational equipment of engineer troops—

* * * * * * *

Light ponton company	80
Army engineer depots	stock

* * * * * * *

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

CHAPTER 3

FOOTBRIDGE, MODEL 1938

* * * * * * *

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

11. Composition and assignment of equipment.—*a. Bridge unit.*—(1) A single unit of the equipment, which provides for the construction of 432 feet of footbridge, consists of the following:

Article	*Number*
* * * * * * *	
Rope, wire, ⅜-inch diameter, galvanized, 6 by 19, cast steel, 600-foot lengths (anchor cable), with reel	2
* * * * * * *	

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

12. Detailed description of equipment.—*a. Duckboard.*—(1) The duckboard, of white pine, consists of a series of transverse

*These changes supersede Training Circular No. 1, War Department, 1941.

432649°—41

slats * * * by 4½ inches in cross section. The weight of the duckboard, complete, is approximately 100 pounds. **The slats are painted with an abrasive paint to give a nonskid surface.**

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[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

17. Details of crossing operation.

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d. Construction procedure.

* * * * * * *

(4) *Float cable section.*—One man **stands in the water near the inshore end of the completed bridge. He attaches the cable tightly to the hook on the upstream end of the first float and engages the cable in the hooks on the upstream ends of the subsequent floats. Another man on shore pays out the cable to him from the reel. The reel turns about a stick mounted on suitable supports such as a pair of forked sticks driven into the ground.** Generally, the holdfast for the cable will be at some elevation above the level of the water, so that it will be necessary to omit placing the cable in the hooks of two or more floats at the ends of the bridge, in order to prevent them from being pulled out of the water when the cable is made fast and tightened. When the bridge * * * over about 300 pounds.

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

26. Bridge unit.—The principal components of one unit of the equipage are 4 trestles, 12 pontons, and the floor system transported on **6 semitrailers and 4 two-wheel trailers,** with certain spare parts and accessories. One unit of equipage provides about 250 feet of bridge of 10-ton capacity or 160 feet of 20-ton capacity. The exact length * * * components of one unit of equipage.

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

28. Ponton.—*a.* The ponton is rectangular * * * fastened with rivets. The ponton is subdivided into four compartments by three cross bulkhead frames which reach to a height of 9 inches below the gunwales. The floor of the ponton consists of wood gratings resting on the top of the bottom rib system. Cleats are located * * * gunwales of the pontons. Thirty-two of these fasteners are of a lever-actuated ratchet type. **Eight** additional fasteners, which are of a turnbuckle type, are provided as spares and are secured to the rail by moused hooks so that they can be readily moved to replace

broken or damaged fasteners. A carrying rail * * * and one pump.

* * * * * * *

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

* * * * * * *

NOTE (Fig. 21).—All four fasteners in the intervals 4–5 and 13–14 should be shown as spare balk fasteners.

FIGURE 21.—Light ponton, model 1938.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

29. Trestle.

* * * * * * *

b. The transom is a built-up beam * * * in the column above the shoe. (See fig. 22.) The complete trestle, less the chain hoists, weighs **1,050** pounds.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

* * * * * * *

NOTE (fig. 24).—In ponton balk, 4′3″ should be shown as 4′9″.

FIGURE 24.—Balk, chess, and sill.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

36. Transportation.—The basic items of a unit of ponton equipage are transported on six semitrailers each drawn by a 4-ton tractor truck (see fig. 26) and on four two-wheel trailers each drawn by a 4-ton cargo truck (see fig. 27). In addition, the unit has two light tractors, each of which is transported on a tilting trailer drawn by a 4-ton cargo truck.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

37. Semitrailers.—*a.* Each semitrailer carries as principal items 2 pontons, 20 ponton balk, and 32 chess. The balk and chess are loaded in the bed of the semitrailer. The pontons are loaded bottom side up, one on top of the other. They are securely held in place by steel cables drawn taut by reel type ratchet-operated cable tighteners. Each cable has a protecting sheath of 9-foot length of ½-inch steam hose.

***b.* The semitrailer is a pneumatic-tired, heavy duty, fifth-wheel type. It is equipped with a removable tools and accessories compartment which carries such auxiliary "bridge hardware" as anchors with cables, oarlocks, pumps, siderail clamps, etc. It is capable of being towed under favorable road conditions at a maximum speed of 60 miles per hour. It is equipped with air brakes and with hand-operated mechanical parking brakes.**

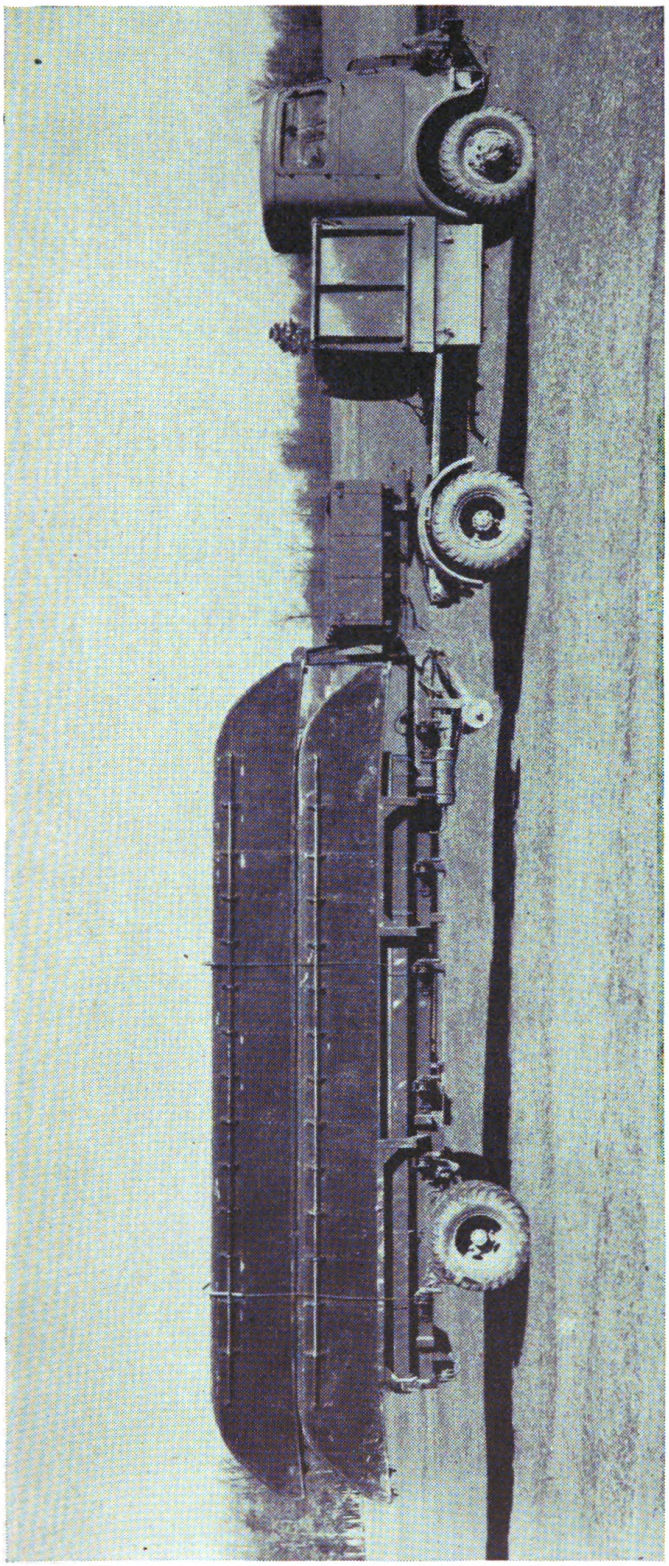

FIGURE 26.—Loaded semitrailer and 4-ton, four-wheel drive tractor truck.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

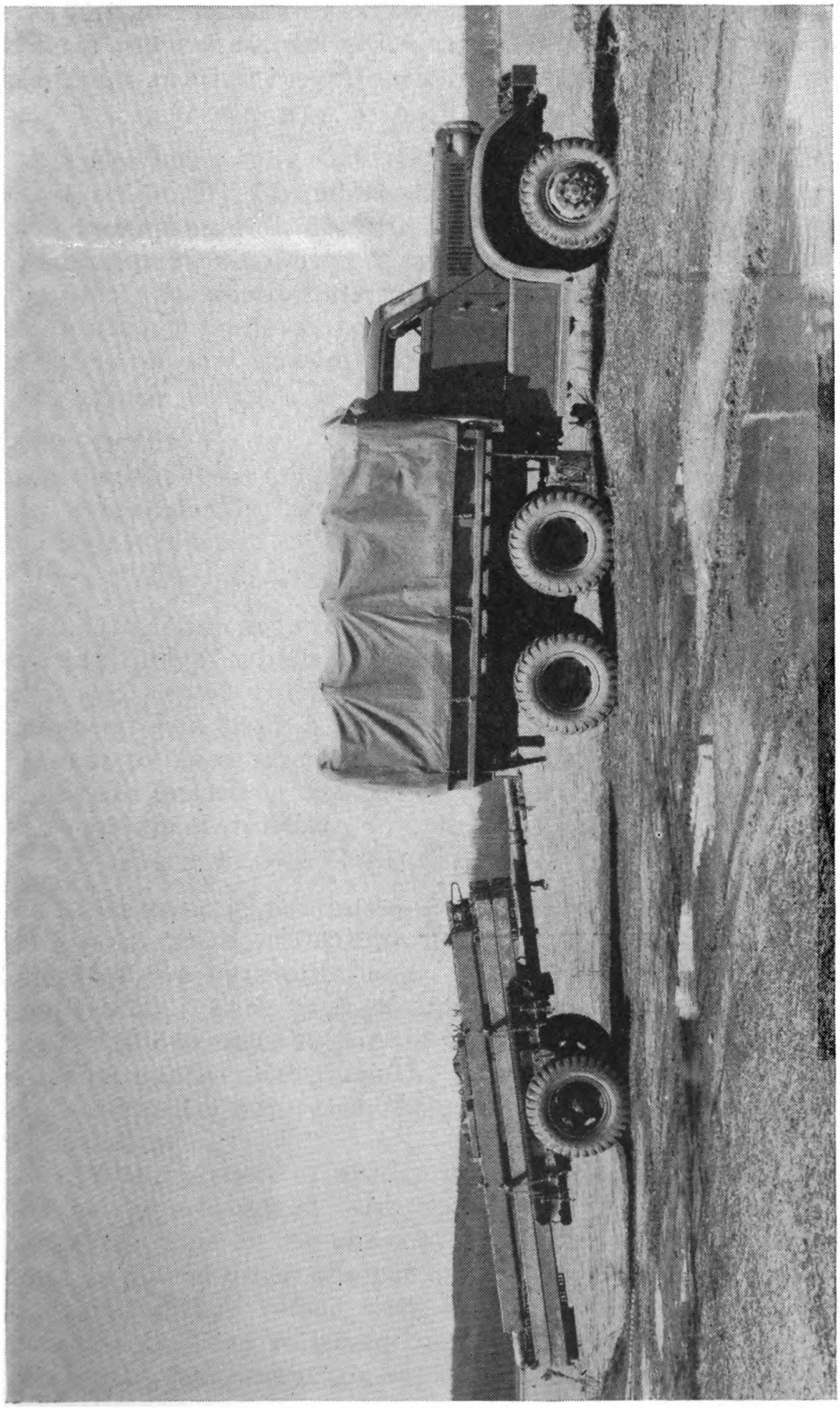

FIGURE 27.—Loaded two-wheel trailer and 4-ton, six-wheel drive cargo truck.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

c. **The semitrailer is towed by a 4-ton, four-wheel drive tractor truck equipped with a cargo body which carries ponton equipage auxiliary equipment, accessories, and spare parts.**

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

38. Trailers.—The four two-wheel trailers are similar to those originally furnished with the 10-ton ponton equipage, but strengthened in design. The loadings (principal items) are changed as follows: 2 trailers are loaded with 1 trestle complete, 24 trestle balk, and 2 sills each (see fig. 28); the remaining 2 trailers are loaded with 1 trestle, complete, 24 trestle balk, and 1 assault boat, each.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

39. Tilting trailer.—The tilting trailer has a bed which tilts to allow the light tractor to move on or off the trailer quickly and conveniently, and obviates the necessity for auxiliary loading ramps.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

40. Four-ton cargo truck.—The 4-ton, six-wheel drive cargo trucks, four of which pull the four two-wheel trailers of one unit and two of which pull two tilting trailers carrying light tractors, each have a loading bed 12 feet 3 inches long designed to accommodate the standard chess. Forty-eight chess are carried in the bed of two of the four trucks pulling the two-wheel trailers.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

41. Unloading pontons.—*a.* **Each semitrailer is equipped with a hydraulic unloading device. A hand-operated pump operates two hydraulic jacks, one at each rear corner of the semitrailer. Each jack is topped with a 2½-inch diameter roller upon which the ponton gunwales roll. The jacks have a travel sufficient to raise the pontons 10½ inches above the rests, with the gunwales of the bottom ponton resting on the two rollers.**

b. **In the process of unloading pontons, the forward end of the pontons is raised. An auxiliary roller, designed to roll along the tops of the chess stored topmost beneath the pontons, is placed under the bottom ponton. The rear end of the pontons is then raised with the hydraulic jacks. The two pontons are then rolled to the rear to allow the ground crew to rest the rear end of the bottom ponton on the ground. The**

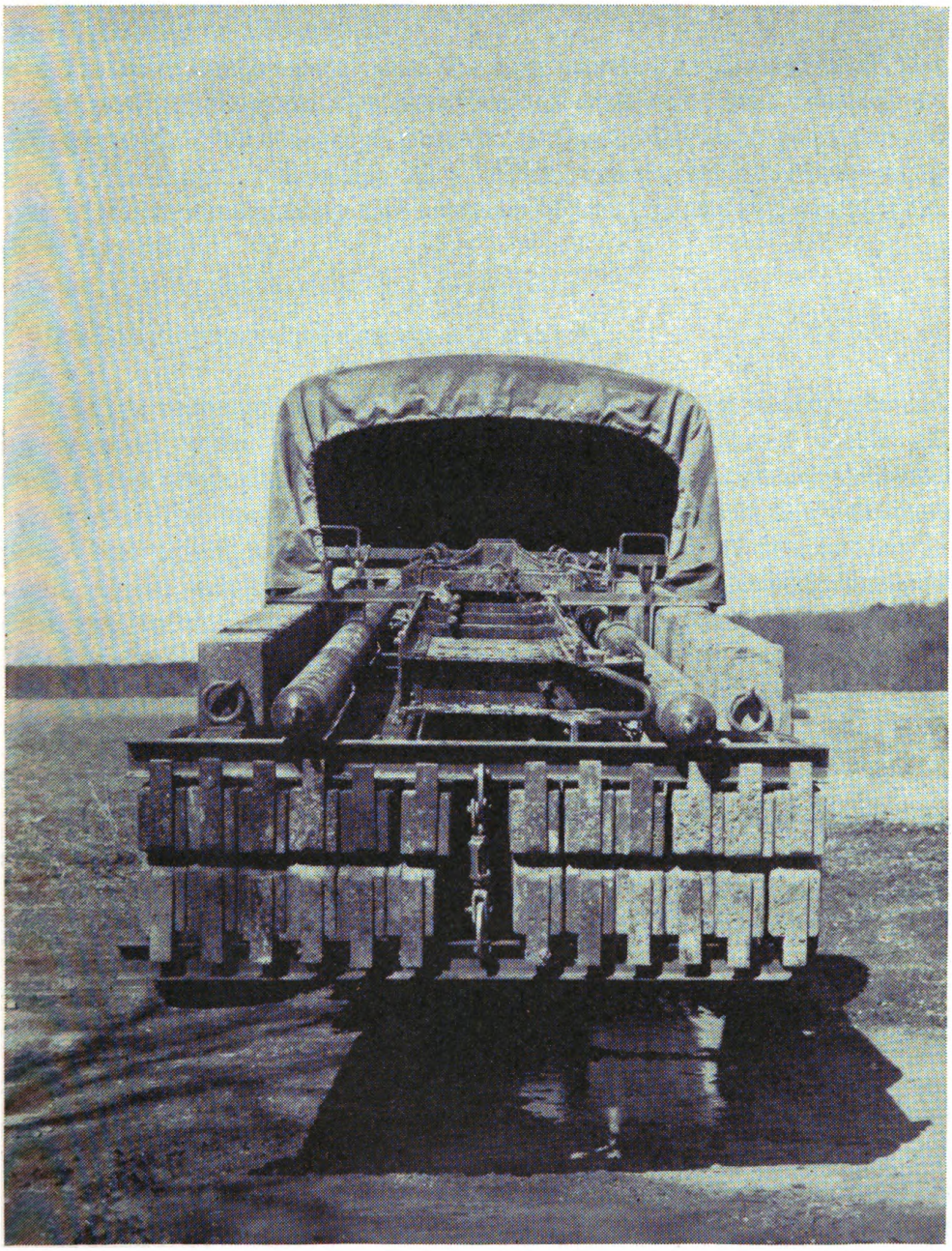

FIGURE 28.—**Loading arrangement of two-wheel trailer.**

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

ground crew then supports the front end of the two pontons until the semitrailer is pulled forward by its prime mover from under the load. The front end of the combined load is then lowered to the ground.

c. **In loading the pontons, the first ponton is placed with the front end resting on the semitrailer and rear end resting on the ground. The second ponton is then slid into position on top of the first. (See fig. 29.) The remainder of the loading operation is essentially the reverse of the unloading operation. (See fig. 30.)**

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

48. Employment of the 22-hp. motor.

* * * * * * *

e. **After removal from the water, the outboard motor should be carried with the propeller inclined downward until all water has been drained from the underwater exhaust system; otherwise the water may get into the cylinders if the exhaust ports are open, and cause hard starting even if the motor is used again without delay. If the motor is stored, serious damage to the engine will result if it is stored with either fresh or salt water in the cylinders.**

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

49. Employment of the 4.5-hp. motor.

* * * * * * *

c. **Two** assault boats **are** included in each unit of ponton equipage, and the assault boats assigned to combat units and light ponton companies also are available for use with the light motors. A small piece of * * * from 5 to 6 miles per hour in still water.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

53. School of the ponton.

* * * * * * *

c. At the command ATTENTION (executed as under individual instruction) the crew arrange themselves in the order in which they were formed on shore, the right oarsman (stroke oar) taking the after right rowlock and the others alternating, the even numbers being on the left side. The instructor then directs one or two of the crew to step ashore, remove the moorings, and prepare to push the ponton from the bank.

* * * * * * *

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

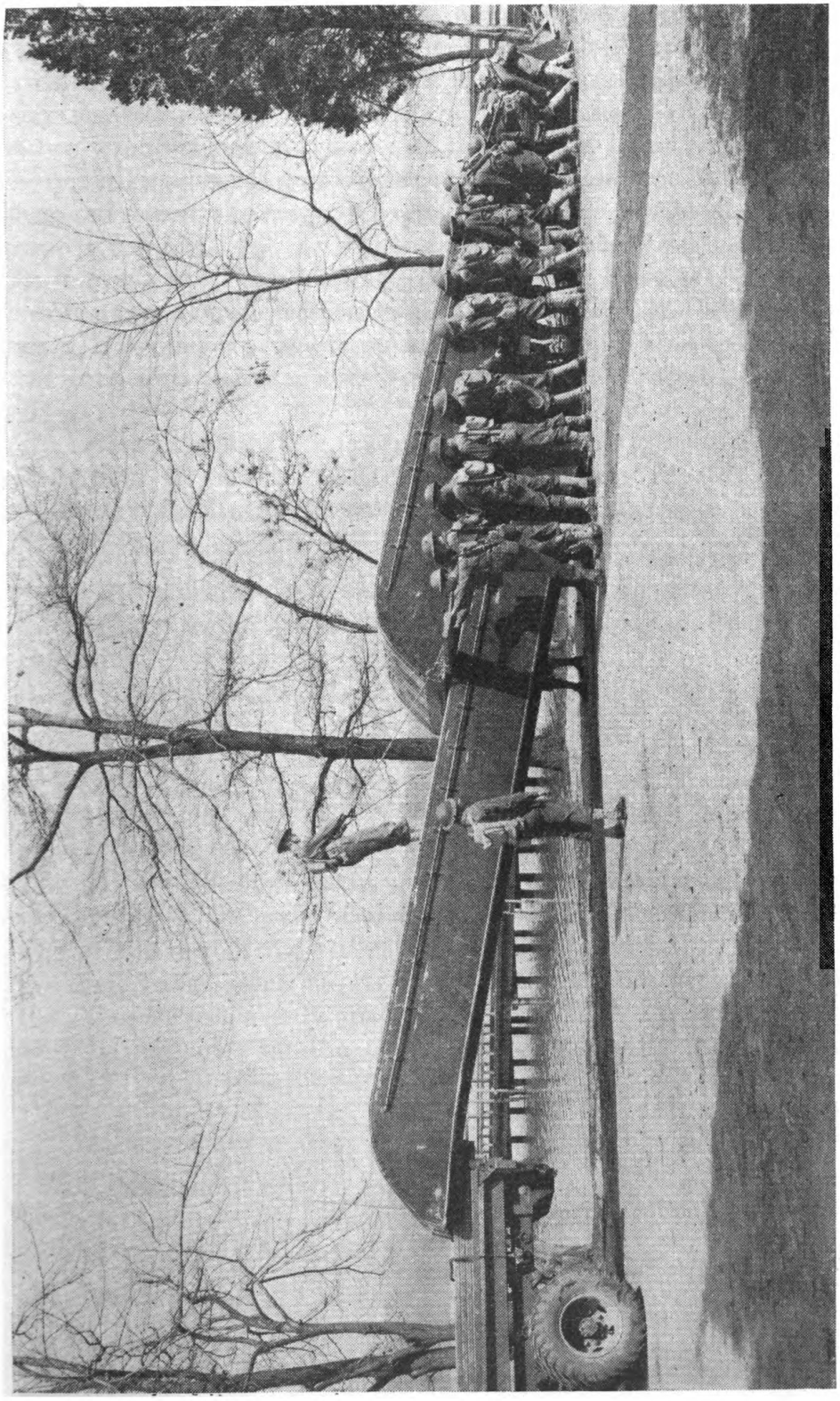

FIGURE 29.—Early stage; loading pontons on semitrailer.
[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

63. Location of semitrailers and trailers.—*a.* **Special attention should be paid during the technical reconnaissance of proposed ponton bridge sites to the feasibility of bringing semitrailers and prime movers approximately to the water's edge without necessity of clearing a trail in advance. Under especially adverse conditions the two-wheel trailers can be unhooked from the cargo trucks and pulled forward to the unloading point by a light tractor. After the trailers are unloaded, they can be used for bringing forward other loads such as pontons, ponton balk, chess, etc. It is always desirable, however, for basic prime movers to be able to bring both trailers and semitrailers forward all the way to the bridge site.**

b. **After the trailers, semitrailers, and trucks are unloaded, it is best to remove all transportation to concealed cover at least several hundred yards from the bridge site.**

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

71. Abutment.—*a. General.*—This section installs * * * by the shallow water method. This section will normally require the following:

1 abutment sill.
13 pickets.
1 chess.

* * * * * * *

b. Placing of abutment sill.—At the command CONSTRUCT THE BRIDGE the section carries its equipment to the site of the abutment. The sill is embedded in the ground, approximately horizontal, perpendicular to the axis of the bridge, with its center on the center line of the bridge and with its narrow faces vertical. Nine pickets are then driven along the river side of the sill, one near each end and the other seven evenly spaced along the sill. Two pickets usually will be sufficient on the shore side of the sill. As soon as the * * * while installing the sill.

* * * * * * *

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

72. Abutment span.

* * * * * * *

b. Assembly of trestle—shallow water method.

* * * * * * *

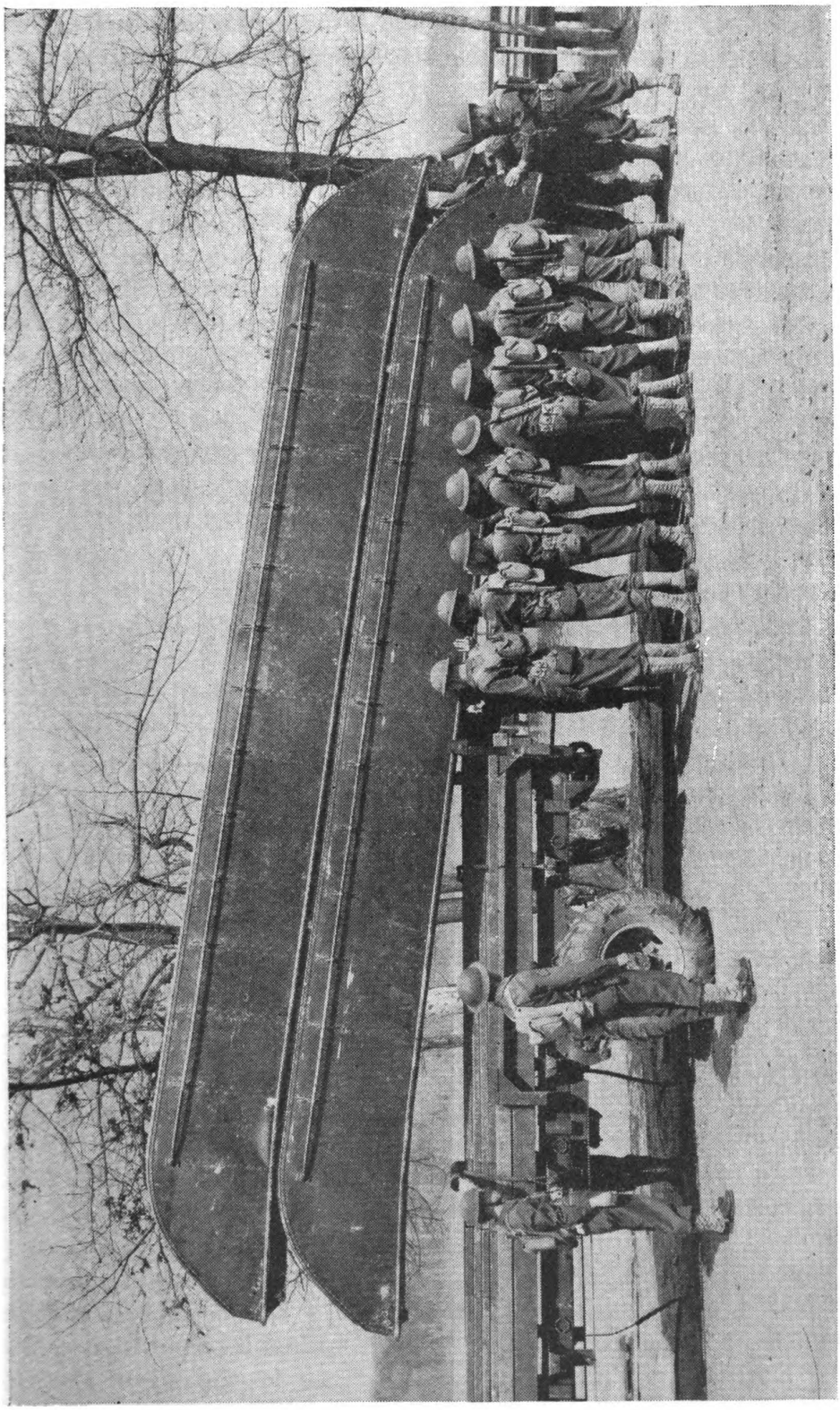

FIGURE 30.—Rolling stacked pontons onto semitrailer.
[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

(2) The trestle transom is laid on its side on top of the two trestle balk, and the trestle is assembled with the transom in this position. (See fig. 34.)

* * * * * * *

(4) The shoes are then attached to the foot of the columns. One of the hooks chained to the shoe should be secured in the eye at the bottom of the column. The other should be secured in the bottom pair of the column holes as soon as they are cleared by raising the transom to its final position. (See fig. 22.) **One-half inch steel cables** should be attached to the shoes **and** anchored to **picket** holdfasts **on shore to prevent the trestle columns from "kicking out" when subjected to heavy loads.**

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

73. Balk fastener.

* * * * * * *

c. Assembly of trestle.—To assemble the deep water trestle, * * * other balk of the raft. The trestle shoes are assembled to the columns and secured in place with the hooks chained to the shoes. **One-half inch steel cables** should be attached to shoes **and** anchored to **picket holdfasts on shore as described for the shallow water trestle.** The two 60-foot ½-inch lines used by the siderail section to maneuver the river ponton are made fast, by clove hitches at their middle points, to the column tops. The four * * * in the river ponton. (See fig. 36.)

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

75. Chess.

* * * * * * *

c. Delivery and laying of chess.—The chess layers place themselves, facing toward the near shore on the bay to be covered, one on balk Nos. 1 and 2 and the other on balk Nos. 7 and 8. They receive the chess from the carriers and place them on the balk, shoving each chess hard against the preceding chess. **Each chess has two score marks so located as to be alined with the alternate upstream and downstream edges of balk Nos. 1 and 8. Referring to paragraph 57, the score marks will be alined with the downstream edges of balk Nos. 1 and 8 of odd-numbered floating spans and with the upstream edges of balk Nos. 1 and 8 of even-numbered floating spans. Score marks will be alined on trestle balk according to the fundamentals enunciated in**

paragraph 57c. Each chess carrier delivers his chess to the chess layers and moves off the bridge keeping well to the right of the roadway. The chess of each bay * * * when the call is again made.

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

90. Increased capacity.—*a.* To double the capacity of the normal bridge, it is reinforced as follows:

* * * * * * *

(2) Each ponton span is given additional buoyancy by interposing one ponton at the center of each ponton span, the ponton being fastened to the outer ends of the chess to hold it in place. **The ponton is temporarily loaded with sufficient men (or with water) to decrease its freeboard and facilitate floating it under the existing bridge.**

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

92. Raft ferries.

* * * * * * *

b. Capacity.

* * * * * * *

(2) *Three ponton—two bay.*—This raft consists of two normal ponton spans of the bridge. It provides a platform 10½ feet by 37 feet. Its capacity is—

120 infantrymen in column of sixes closed up so as to distribute the load uniformly over the roadway of the raft.
8 animals in column of twos.

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

SECTION XVII (pars. 94-98).—A revision of this section will be made to embody changes arising from the adoption of semitrailers, truck tractors, and 4-ton cargo trucks (prime movers for two-wheel trailers and tilting trailers).

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

99. General maintenance.

* * * * * * *

h. Trailers.—(1) In general, the care and maintenance for the trailers are the same as is generally prescribed for motor vehicles. Special attention must be given to lubrication and tire inflation. The latter should be checked frequently, especially when going into service after a period of idleness. When the trailers are stored,

they should be blocked up. The clamping beams should never be used as crowbars.

* * * * * * *

(3) Rescinded.

i. Semitrailers.—**The same general rules for care and maintenance apply as for the two-wheel trailers. However, the semitrailers are designed to be backed by their prime movers.**

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

100. Repairs.

* * * * * * *

g. Major and permanent repairs to the ponton.

* * * * * * *

(4) Bent framing will present varying difficulties, depending on the magnitude of the distortion. Minor corrections have already been covered in *f* above, for which the tools supplied in the ponton repair kit are adequate. Methods of correcting more serious distortions are illustrated in figure 46. In all these cases * * * facilities of a depot.

* * * * * * *

[A. G. 062.11 (10-30-41).] (C 1, Dec. 31, 1941.)

102. List of equipage.

TABLE I.—*Light ponton equipage, model 1938* [1]

* * * * * * *

Article	Basic Quantity	Spares	Total number
* * * *	*	*	*
Cable and turnbuckle sets	20		20
* * * *	*	*	*
Lights: Bridge inspection	3		3
Spot, debris control or rescue boat	4		4
* * * *	*	*	*
Pump, water, portable	1		1
Reflectors, glass, red	78		78
* * * *	*	*	*

[1] Recent changes in basic transportation of light ponton equipage will necessitate many changes in table I. A revised table I will be issued.

TRAILER LOADS—Rescinded

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

PONTON LOAD

(Six semitrailers towed by 4-ton 4 by 4 prime movers in one unit of bridge.)

Item	Total in ponton loads	How loaded
Anchors	24	4 in each of 6 trailer cargo bodies.
Balk, ponton	120	20 in each of 6 ponton loads.
Chess	192	32 in each of 6 ponton loads on top of balk.
22-hp outboard motors in chest.	4	1 each in 4 of 6 truck cargo bodies.
Clamps, siderail	114	19 in each of 6 trailer cargo bodies.
Hangers, hinge sill	20	3 each in 4 and 4 each in 2 trailer cargo bodies.
Hooks, boat	24	4 each on 6 semitrailers.
Oars	96	16 on each of 6 semitrailers in oar storage underneath frame.
Oarlocks	120	20 in each of 6 semitrailer cargo bodies.
Pickets	50	8 in each of 5 trailer cargo bodies and 10 in one trailer cargo body.
Ponton	12	2 double-decked upside down over load in each of 6 semitrailers.
Pumps, bail	15	2 in 3 and 3 in 3 trailer cargo bodies.
Rope, manila, 1-inch	12,000 feet.	250 feet on each of 24 anchors in cargo body of semitrailer. Two 500-foot coils in each of 6 truck cargo bodies.
Stirrups, detachable, for balk.	24	8 in each of 3 trailer cargo bodies.

TRESTLE LOAD

Item	Total in trestle loads	How loaded
Adaptor, towing	4	1 each in 4 truck cargo bodies.
Balk, trestle	96	24 on each of 4 two-wheel trailers.
Boat, assault	2	1 over each of 2 trestle loads.
Bracket, stern attachment.	4	1 each in 4 truck cargo bodies.
Cable and turnbuckle sets.	20	5 in each of 4 truck cargo bodies.
Chess	96	48 in each of 2 truck cargo bodies.
Half	12	In 1 of 4 truck cargo bodies.
Columns	8	2 on each of 4 two-wheel trailers.
4½-hp. outboard motor in chest.	2	1 each in 2 of 4 truck cargo bodies.
Chain hoist in chest	4	1 each in 4 truck cargo bodies
Rope, manila, 1-inch, feet.	6,000	3 500-foot coils in each of 4 truck cargo bodies.
Rope, manila, ½-inch, feet.	2,400	1 600-foot coil in each of 4 truck cargo bodies.
Shoes	8	2 on each of 4 two-wheel trailers.
Sills	4	2 in each of 2 two-wheel trailers.
Transoms	4	1 on each of 4 two-wheel trailers.

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

CHAPTER 5 (pars. 103–110).—Rescinded. (A manual for the heavy ponton bridge, 25-ton, M1940, will be issued when available.)

[A. G. 062.11 (10–30–41).] (C 1, Dec. 31, 1941.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
E. S. ADAMS,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1941

For sale by the Superintendent of Documents, Washington, D. C.

TECHNICAL MANUAL

STANDARD STREAM CROSSING EQUIPMENT

CHANGES No. 2

WAR DEPARTMENT,
WASHINGTON, February 14, 1942.

TM 5–270, November 1, 1940, is changed as follows:

73. Balk fastener.

* * * * * * *

b. Assembly of hinge span raft.

* * * * * * *

(7) In the future, the light ponton bridge normally will be constructed with the hinge span raft reinforced. All references and illustrations pertaining thereto herein will consider a three-boat raft with the hinge sill located in the center of the middle boat. This change in construction will reduce the length of the normally constructed bridge to about 214 feet. The two spans of balk and chess which will be unused as a result of this change will be considered as spares. A suggested procedure for assembly of the reinforced hinge span raft is as follows:

(*a*) At the command CONSTRUCT THE BRIDGE, the balk fastener section, assisted by the siderail section, secures three pontons. The hinge sill, hinge sill hangers, and detachable balk stirrups are placed in the center ponton by four men of the balk fastener section. One of these pontons is held against and parallel to the shore by two men of the siderail section; the other two are held alongside the shore ponton by four men of the siderail section. Two light shore lines to the river ponton, one upstream and one downstream, are procured, made fast, and handled by the remaining two men of the siderail section. The three pontons are usually spotted near and upstream from the abutment. Four men from the balk fastener section enter each of the pontons.

(*b*) The balk fasteners in the shore ponton receive the river ends of the odd-numbered ponton balk from the balk carriers and hand them over to the balk fasteners in the river ponton who place the ends of the balk in their proper places on the river gunwale, and engage and partially tighten the fasteners. These are the only fasteners engaged at this time.

(*c*) At the command SHOVE OFF, given by the leader of the balk fastener section, the river ponton is pushed out into the stream by the balk carriers until the shore ends of the balk may be engaged at their proper places on the shore gunwale

442364°—42

of the shore ponton. The center of the center ponton is then spotted at the midpoint of the balk. (During the shoving off of the river ponton and thereafter during the construction of the raft the river ponton is kept on line and maneuvered by the siderail section by means of the temporary shore lines attached to the upstream and downstream ends of the river ponton. The shore ponton is held to the shore by hand. As soon as the upstream and downstream anchor lines are delivered by the anchor section the light shore lines are coiled and turned over to the noncommissioned officer in charge of the balk fasteners.)

(*d*) After the shore ends of the balk are engaged at their proper places and the pontons properly alined, detachable balk stirrups are placed on the balk near both gunwales of the center ponton to engage fasteners, and then all balk fasteners in all pontons are applied and tightened.

(*e*) Next the even-numbered ponton balk are received from the balk carriers, placed, and fastened in their proper places. Additional detachable balk stirrups are placed on each even-numbered balk near the gunwales of the center ponton and the hinge sill is placed inside the center ponton approximately at the midpoint of the balk. Hangers are made fast to all balk as the raft is floated to bridge site. If the raft is to be employed in the erection of a deep water trestle, three additional balk will be required. One is placed on top of and perpendicular to the other balk near the center of the center ponton. Two ponton balk, one between balk Nos. 1 and 2, the other between balk Nos. 7 and 8, are extended shoreward about 5 feet and the river ends fastened at the shore gunwale of the river ponton. (After the transom of the trestle is raised clear of the hinge span raft, the three extra ponton balk are removed and used as siderails on the bridge.)

* * * * * * *

[A. G. 062.11 (12–15–41).] (C 2, Feb. 14, 1942.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1942

TECHNICAL MANUAL

STANDARD STREAM CROSSING EQUIPMENT

CHANGES No. 3

WAR DEPARTMENT,
WASHINGTON, December 18, 1942.

TM 5–270, November 1, 1940, is changed as follows:

34½. (Added.) **Trestle bracing.**—Trestle bracing is designed to increase the stability of the trestle spans of the 10-ton ponton bridge. Trestle bracing consists essentially of bracing struts, 22-foot sections of 2½-inch standard pipe, which are clamped to the columns of the trestle with special clamps. On semistable foundations, it is desirable to connect adjacent trestles with single diagonal bracing with one end of the strut clamped near the top of the shoreward trestle column and the other end clamped near the water level on the next riverward trestle column. On unstable foundations, it is desirable to make an integral unit of each trestle and its bracing. Two struts are utilized on each column. A strut shoe, which is so shaped that it may be screwed into soft earth, is attached to the end of each strut. The two struts are screwed into the stream bottom to secure a firm bearing. They are so arranged that, as viewed from above, they are approximately at right angles to each other and at a 45° angle with the axis of the bridge.

[A. G. 062.11 (12–8–42).] (C 3, Dec. 18, 1942.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

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TECHNICAL MANUAL
No. 5–270

WAR DEPARTMENT,
WASHINGTON, *November 1, 1940.*

STANDARD STREAM CROSSING EQUIPMENT

Prepared under direction of the Chief of Engineers

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CHAPTER 1

GENERAL

	Paragraph
General	1

1. General.—*a.* This technical manual is designed to supply all necessary factual data on the various standard types of stream-crossing equipment, and to outline construction procedure. Tactical considerations, except as directly affecting the technique of putting the equipment into use, are not developed.

b. The detailed instructions given for the organization of working parties and for the actual assembly and erection of equipment should be modified when necessary to conform to unusual conditions.

c. The material dealing with the portable bridges of H–10 and H–20 capacity has been prepared without benefit of more than limited experience, since these two types of equipment have not yet been subjected to rigorous service tests. Changes will be published with respect to these and other equipment developed as appear desirable. In the meantime minor departures and modifications in procedure devolved in the manual should be reported to the Chief of Engineers for consideration.

266173°—40——1

CHAPTER 2

ASSAULT BOAT

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2. General purpose and use of equipment.—*a. Transport of the covering force.*—The assault boat is designed to carry the troops and weapons of the initial combat waves across an unfordable river line which is being attacked. The construction of even the simplest type of bridge cannot ordinarily be started until security has been gained from direct observed hostile small arms fire. Therefore, in the first phase of an opposed river crossing the leading assault elements, which are to establish the bridgehead, must be landed on the enemy bank in some manner other than by bridges. Small separate floating units of high maneuverability, which may be easily and noiselessly propelled, have been demonstrated as the most effective means of transporting these foremost waves of the covering force. The assault boat, possessing these characteristics, as well as meeting other criteria of suitability, has been adopted as an article of standard engineer equipment.

b. Advantages of the standard assault boat.—The small, light assault boat of moderate capacity is adapted to the first stages of a forced crossing under a variety of conditions. That degree of surprise which is so essential to the always hazardous operation of first crossing a stream defended by an alert enemy may be much better obtained by the use of assault boats than by that of rafts, locally procured boats, footbridges, or pontons used as ferries. Groups of assault boats can be brought to the river bank, launched and loaded, in darkness and in silence, with much less likelihood of apprising the enemy of the operation under way than can either footbridges or pontons. Assault boats permit crossing on a wide front, and so do not canalize the advance as do footbridges. Pontons also permit dispersion during the crossing, but they are much more difficult to transport to the river and maneuver in the water than assault boats. Moreover, the use of pontons as ferries is liable to result in serious

damage or loss, thus adversely affecting the later construction of bridges.

c. Use of assault boats in conjunction with other crossing equipment.—The use of assault boats for carrying the leading waves across does not preclude the employment of footbridges, or pontons and

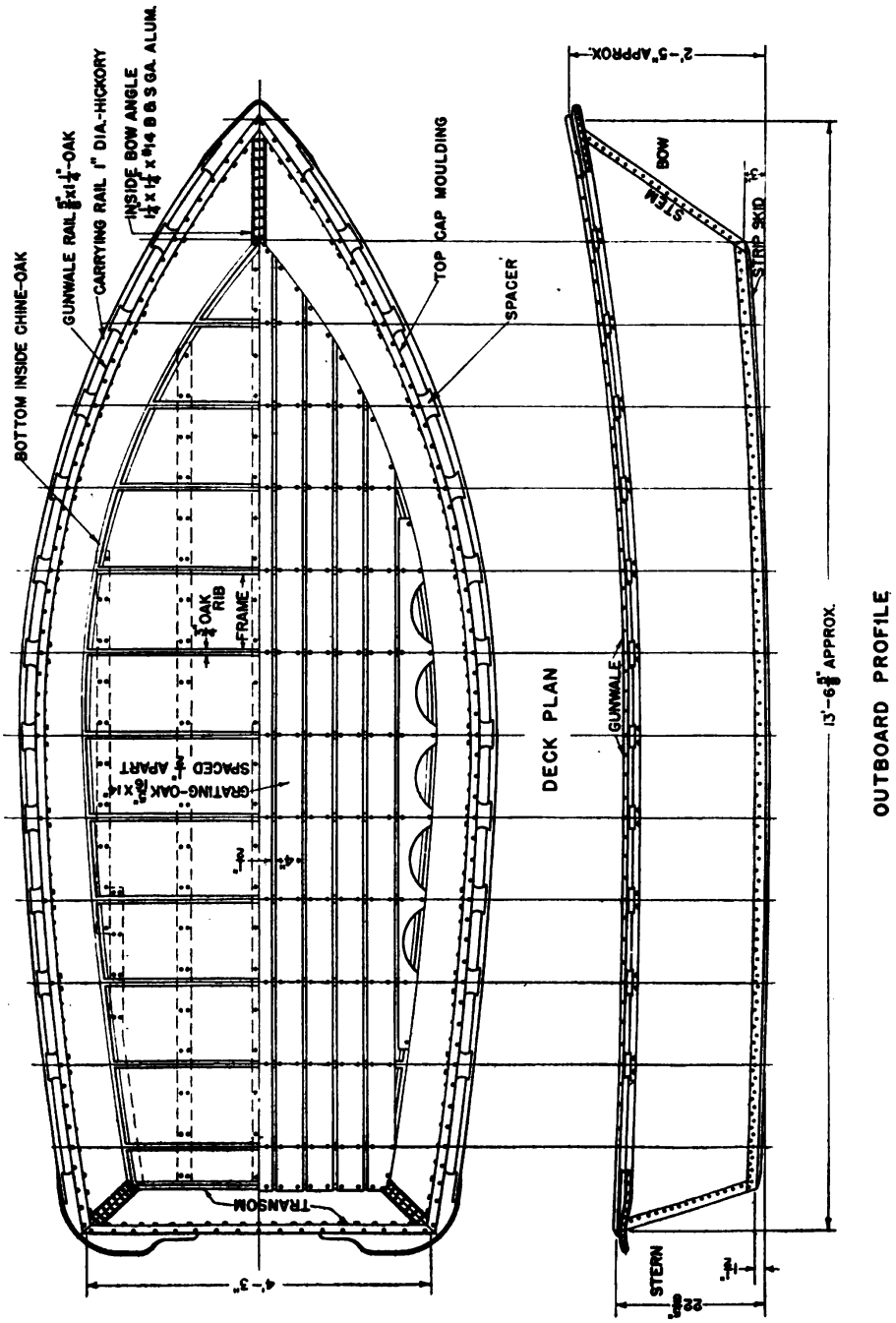


FIGURE 1.—The assault boat.

ponton rafts for ferrying, but makes it possible to delay utilization of these other more vulnerable means of greater capacity until the first echelon has secured the enemy bank and thus assured some protection for their construction and use. Assault boats are normally continued in operation, supplementing the other forms of equipment subsequently brought into use, until adequate facilities for the crossing (usually ponton or fixed bridges) have been completely established.

3. Assignment of equipment.—*a. Authority for issue.*—Assault boats are issued only to engineer troops as part of their organizational equipment. Each engineer combat battalion and squadron is issued 10 boats; each combat regiment (square division), and armored battalion, 20 boats; each combat regiment (corps), 30 boats; each light ponton company, 120 boats. The light ponton units are the chief source of supply.

b. Basis of allotment.—Assault boats are issued to the engineer organizations using them on the basis of normal needs, and additional boats to meet a particular need will be made available by higher headquarters. For a discussion of the capacity of the boat, see paragraph 4*b*.

4. Detailed description of equipment.—*a. General design features.*—The assault boat is of conventional skiff type, with flat bottom, straight stern, flat transom, and moderate overhang at bow and stern.

The maximum straight line profile length is about 13 feet 6 inches from the top of the stem to the top of the transom, and the minimum depth amidships is 1 foot 8 inches. The weight of the hull is just under 200 pounds. The frames (used on the bottom only) and gunwales are of oak. The planking and bottom are of an improved type, resin-bonded fir plywood, which is unaffected by moisture. The gunwale cap is of maple, and a hickory carrying rail extends along the outside of the gunwale and around the corners of the transom. The transom may be reinforced by means of a removable patch to provide for the attachment of an outboard motor, as shown in figure 3. The corner edges of stem, chine, and transom ends, are bound on the outside with aluminum angle-strips riveted to the frames and sides. The inside of the bottom is covered by a flooring of oak slats attached to the frames, while strip skids, also of oak, run fore and aft along the outside of the bottom for protection during loading and transport. Each boat is equipped with seven canoe paddles. The boats are painted the standard shade of olive drab.

FIGURE 2.—Interior view of assault boat. (The carrying rail does not extend across the transom in the newer model.)

b. Capacity.—(1) With about 5 inches of freeboard amidships, the net displacement of the boat is approximately 3,000 pounds. With men fully equipped, it will safely carry any of the following loads:

(*a*) Eleven men.

(*b*) Ten men, one caliber .30 machine gun with tripod, and 13 boxes of ammunition.

(*c*) Ten men, one caliber .50 machine gun with tripod, and 4 boxes of ammunition.

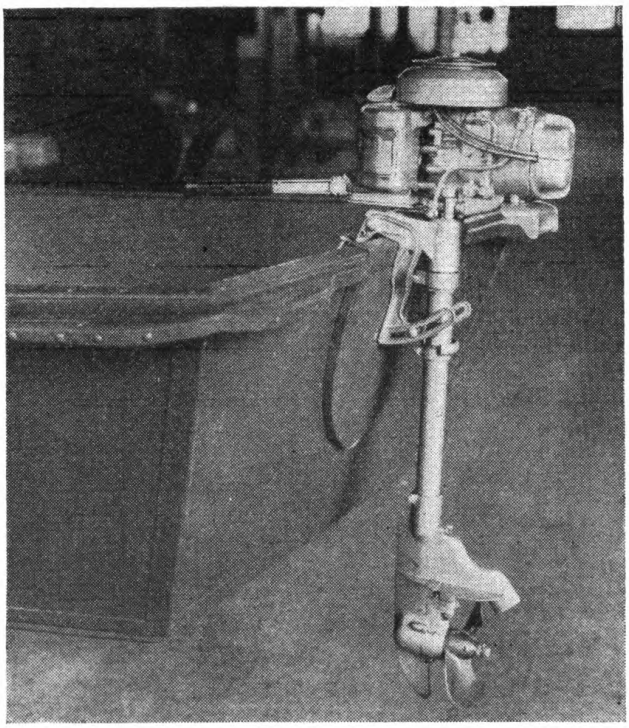


FIGURE 3.—4.5-hp. outboard motor attached to transom of assault boat.

(*d*) Nine men, one 37-mm gun (model 1916) on its mount, and 4 boxes of ammunition. The 37-mm antitank gun on pneumatic tires *cannot* be carried.

(*e*) Nine men, one 81-mm mortar, and 50 rounds of ammunition.

(*f*) Nine men and the equipment of the advanced echelon of the infantry battalion communication section.

(2) Inclusion of the usual two-man engineer crew reduces these capacity figures by two men so far as the Infantry is concerned.

5. Care and storage of equipment.—*a. Careful handling necessary.*—(1) Since it is designed to be as light as possible, the assault

boat is somewhat less rugged than the heavier types of small boats in ordinary use; it is, however, quite stanchly framed, and the plywood bottom and sides are of considerable strength. Thus the boat meets service requirements, but should still be handled with care—especially in peacetime training operations when no element of emergency exists.

(2) Water should be removed from the interior by pumping or bailing, or, if the boat has been beached, by gentle and gradual careening so as to spill the water over one gunwale. The boat should not be carried when containing water.

b. Repairs.—Major repairs to the bottom or sides can readily be made with plywood applied to the outside of the hull. In practice, the following method has been found very satisfactory for effecting permanent repair:

Enlarge the hole to an opening of regular shape, square, or rectangular.

Cut out a piece of weldwood to fit tightly in the enlarged opening.

Cut out two aluminum patches (ponton repair kit) of the minimum size necessary to cover the enlarged opening and and to provide space for nailing.

Fit weldwood in opening, place aluminum patches, one on outside, one on inside, and nail in place.

Small patches may be made of sheet metal, preferably copper, laid in a coating of white lead and fastened with shingle nails clinched on the inside. Broken frames should be replaced. Bullet holes may be plugged temporarily with wads of cloth or paper, pegs, adhesive tape, or putty.

c. Maintenance.—Ordinary issue olive drab paint is satisfactory for these boats, since they are in the water for short periods only. The boat has so few seams, and these are so well protected by metal strips and the sealing material in which they are laid, that recaulking should rarely be necessary. However, when it does appear advisable, a standard marine caulking compound should be used. Caulking cotton should never be used on a small, light boat. It should be unnecessary to soak the boat before use.

d. Storage.—When not in use the boats should be kept under cover, protected from sun and weather. Before being placed in storage for a protracted period the boats should be dried out, cleaned, inspected, and then repaired and painted if necessary. If storage space is limited, boats may be nested in small stacks after the bottom of the lowermost boat of each pile has been carefully chocked up in such

a way as both to allow the circulation of air and to support the hull properly.

6. Transportation of equipment.—The all around overhang of the boats permits nesting them to facilitate their transport. Ten nested boats are the standard load for both the 1½-ton infantry cargo truck and the 1½-ton engineer dump truck. Normally, the standard load should not be exceeded, but in an emergency as many as fourteen boats may be carried by the dump truck. However, the nested stack of more than 10 boats becomes top heavy and unstable, and damage to the lower boats of the load becomes possible because

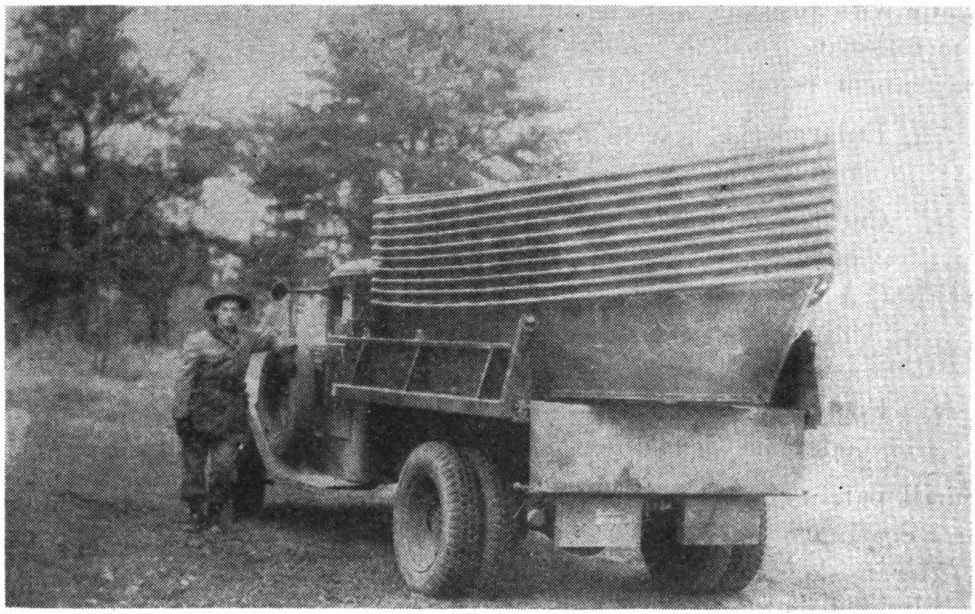


FIGURE 4.—Engineer 1½-ton dump truck with normal load of ten assault boats.

of the considerable superposed weight. Consequently, when it is necessary to carry an assault boat load of greater than the standard size, the pile must be properly secured and the truck driven with care. On trucks with narrow bodies and high sides, it may be necessary to chock up the load in order that the gunwales of the bottom boat will not rest on the sides and thereby support the whole load.

7. Details of crossing operation.—*a. Final assembly areas.*—(1) "Final assembly areas" are designated in the orders for a stream crossing operation. At these assembly points the assault boats are placed in readiness for the final carry by hand to the launching area at the riverbank, and here the engineer crews are assigned to

individual boats and await the arrival of the infantry troops of the covering or bridgehead force in their movement forward from bivouac areas. (See fig. 6.)

(2) The assault boats are brought to the final assembly areas by truck when the terrain, the road net, and the requirements of secrecy permit. Engineer troops unload the boats and distribute them along the foot routes to the river so that they may be readily picked up by the carrying parties. Each boat is carried by the infantrymen who will cross in that boat, accompanied by the two-man engineer crew.

(3) The principal desirable characteristics of the final assembly areas, which should be sought in the reconnaissance preliminary to the drafting of the orders for the crossing, are—

(*a*) Accessibility to the trucks (or carrying parties) bringing up the assault boats.

(*b*) Concealment from hostile ground and aerial observation.

(*c*) Nearness to, or connection with, numerous easily followed foot routes to the river.

(*d*) Proximity to the actual crossing fronts.

(*e*) Distribution parallel to the front to allow both for crossing the river along the entire front and for proceeding directly and without delay to the embarkation points.

(*f*) Defilade or other protection from such enemy rifle and artillery fire as is to be anticipated even though secrecy may be preserved.

b. Engineer boat crews.—The two engineer soldiers, habitually assigned to each assault boat as crew, supervise the final approach to the river, the launching and loading of the boats, and all movement on the water. The engineer personnel is charged with the proper handling and movement of the boats, from the time the carrying party of original passengers goes forward from the final assembly area until the boats are withdrawn from use upon the establishment of other crossing means.

c. Movement from the final assembly area to the river.—(1) The passengers of the first assault wave carry the boat from the final assembly area to the water under the direction of the engineer crew. The senior crew member who is in charge of the movement follows close behind the boat, accompanied by the man in command of the infantry detail. The second engineer soldier acts as guide at the head of the group, near the bow of the boat.

(2) The following general rules should be observed during the forward movement:

(*a*) Not more than 10 men should attempt to carry the boat at any one time, and not less than 4 should be used for even a short carry.

(*b*) From the time of its departure from the assembly area until the moment when the far river bank is reached, the forward movement of each assault boat should be generally uninterrupted. Momentary halts may be made en route to permit the changing of hand holds and to avoid aerial detection through movement when flares are dropped, but such stops should be few and brief. A short pause must be made at the near edge of the water for the loading of passengers and weapons.

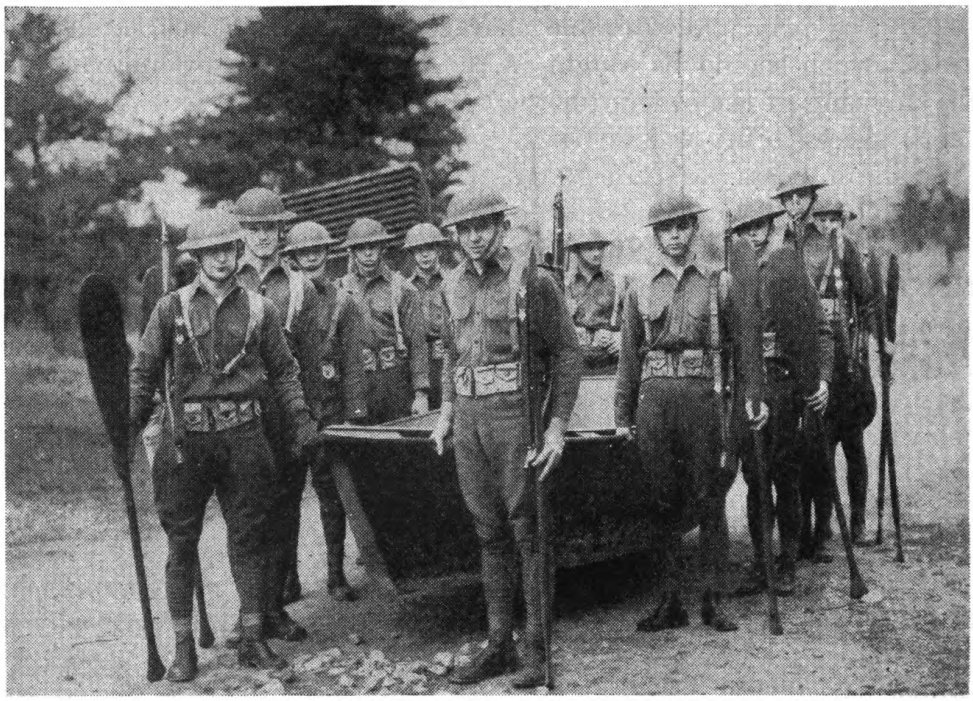


FIGURE 5.—Assault boat in carrying position.

(*c*) The movement should be the most direct practicable route to the crossing front; movements along the near bank, or in the water, and parallel to the shore are dangerous and should be avoided.

(*d*) All suitable routes forward from the assembly area should be used; dispersion is essential, for the bunching of columns on a few of the more easily traversed routes may be disastrous; route markings and guides are indispensable.

(*e*) Movement should commence from the various assembly areas at such times as will insure that all boats of the first wave will be launched at approximately the same moment, without delay at the edge of the river.

(*f*) The sounds of objects striking the sides or bottoms of the light, hollow hull resound loudly, and therefore great care must

be exercised if silence is to be preserved. Nothing whatever should be placed in the boat during the hand carry. Rifles should be slung on the shoulders away from the boat and the butts not allowed to come into contact therewith. At the most convenient carrying height the clearance between the bottom of the boat and the ground is not great (see fig. 5), and hence every precaution must be taken to avoid striking stumps, rocks, and other obstructions with the boat, and to prevent the bottom from being dropped or dragged on the ground.

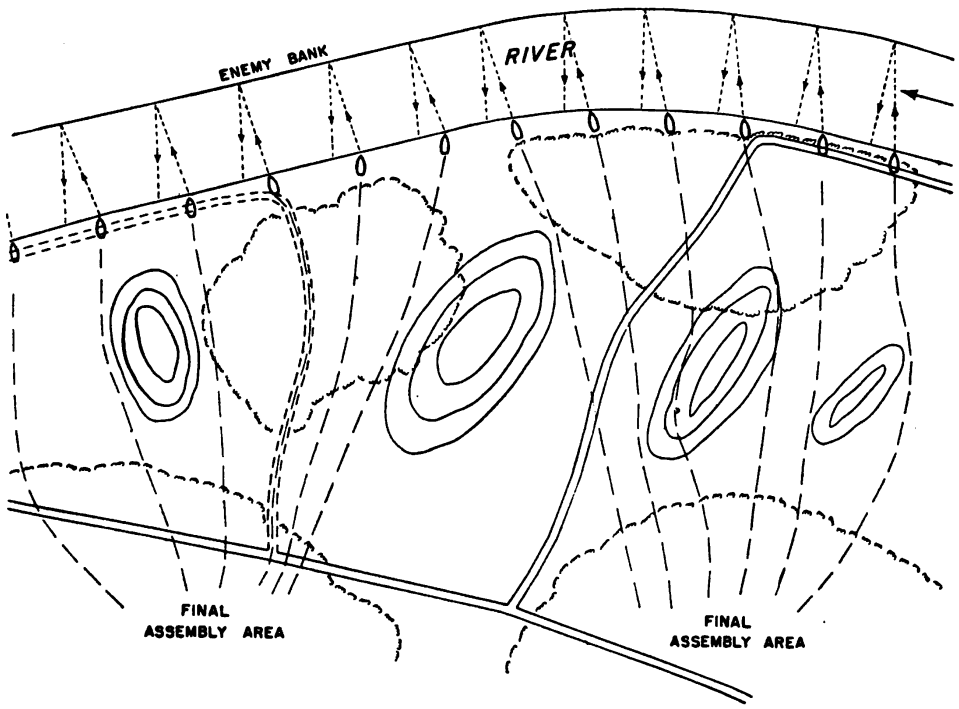


FIGURE 6.—Diagrammatic sketch illustrating typical movement of assault boats from final assembly areas to crossing front, and first round trip after being launched. (Not to scale.)

d. Launching and loading.—(1) Immediately upon arrival at the river bank, and without change in the carrying formation, the boat is carried bow first into the water until a depth sufficient to float the fully loaded boat is reached. Ammunition, machine guns, and any similar weapons or equipment are first quietly placed in the boat. Then, and not until then, the passengers move aboard, keeping the boat in balance and avoiding the noise which will certainly be caused by striking any part of the boat with heavy footgear, weapons, or paddles. In shallow water, care must be exercised to prevent grounding the boat, which, with its attendant noise and delay, is

particularly dangerous at this time. One engineer soldier stations himself with paddle at the bow; the other, who commands the boat, ascertains that the boat is in balance and that paddlers are properly distributed before climbing aboard himself at the stern and then giving the low command to shove off.

(2) Paddlers, with rifles slung, should kneel on the one knee nearer the side of the boat, three paddlers to each side. Other passengers should crouch low in the interior of the boat, holding their rifles upright against the floor.

FIGURE 7.—Assault boat with total load of ten men and equipment.

(3) Occasionally, when the water is deep close to the bank, the boat must be soundlessly lowered or slid from the bank to the water. The boat is then held parallel to the bank at bow and stern by the engineer crew, and loaded directly from the bank. Rope lashings attached to bow and stern will assist in this.

e. Crossing water.—(1) Each boat starts across as soon as loaded and proceeds as rapidly as possible, and by the most direct route, to the opposite bank. No attempt should be made to maintain formation of any kind while on the water, although intervals between boats should be preserved to a certain extent. Neither should any effort be made to paddle somewhat upstream in order to counteract drift,

unless the relative positions of landing and embarkation points and the nature of the current have led to prior and explicit orders to such effect. Under conditions of complete darkness, or of heavy fog or smoke, the proper direction of the boat may be most readily maintained by use of the luminous compass.

(2) Paddlers should hold their paddles away from the carrying rail along the gunwales to avoid the sounds of scraping or striking the hull. Splashing should also be avoided. Passengers should not move about. Firing from the boat should never be attempted and should be expressly prohibited before departure from assembly areas. All men should be prepared to unsling packs and belts and swim to shore in the event of capsizing.

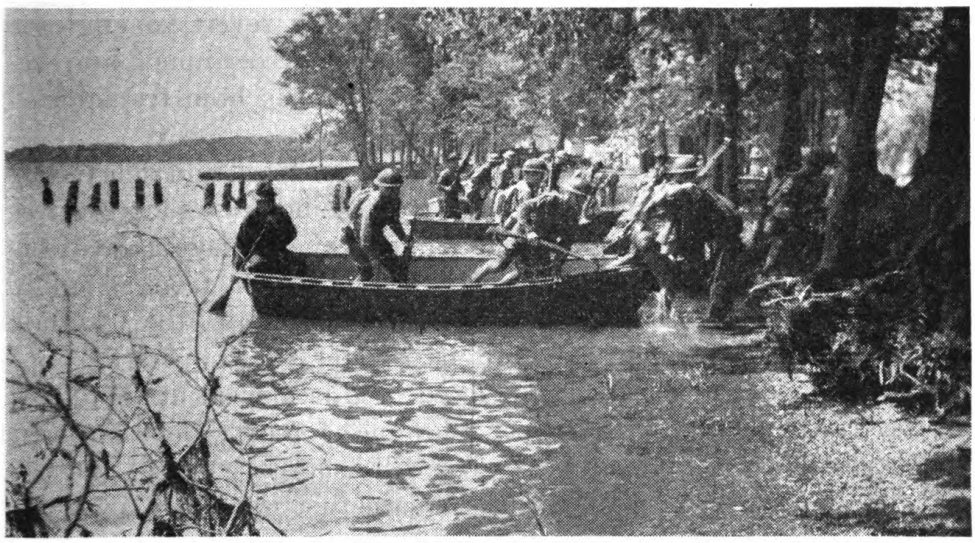


FIGURE 8.—Infantrymen disembarking from assault boats.

f. Disembarkation and return of boats.—(1) Upon arrival at the far shore silence should be maintained, unless the enemy has discovered the crossing and opened fire. The boat should not be beached except upon a mud bottom if noise is to be avoided. Paddles are laid on the floor of the boat and passengers step into the water or directly ashore, quickly and quietly. Any cargo is unloaded. Control of the infantrymen then passes to their combat leaders.

(2) The engineer crew then promptly paddles back for a second load.

(3) It is generally impracticable to return boats at night or during limited visibility, and under fire, to the point from which they started, especially if the current is at all swift. Therefore, unless an effort to keep boats from drifting downstream has been

definitely ordered and can be successfully made, all boats will arrive on the near shore at the end of the round trip a certain distance below the point of departure. Hence, the initial crossing front should be so located that waves after the first may cross at points progressively farther downstream and still accord with the plan of maneuver for the attack. The amount of drift during each round trip may be estimated in advance.

(4) Succeeding waves should follow the first from the assembly areas at such times as will insure their arrival at the bank just prior to the return of the boats. The locations of the returning boats should be anticipated and approached directly so that movement along the river bank will be unnecessary.

(5) The engineer troops and assault boat equipment attached to an infantry unit for a river crossing normally revert to engineer control when the entire infantry unit (less the personnel and vehicles which will cross later by other means) has been transported to the far bank.

8. Time required for crossing.—If not confused and delayed by hostile small arms fire, an assault boat wave should cross each 200 feet width of ordinary river in about five minutes where the total width is not over 1,000 feet. The time taken for the movement from assembly areas to the crossing front will vary with the terrain, the distance, and the tactical situation, and will be greater for the first groups which must carry the boats. The speed of this movement should be carefully estimated, making proper allowance for the delays imposed by darkness (during which the crossing will usually be made) and the need for preserving silence, in order that the first wave may arrive at the far bank at the moment intended.

9. Summary of data on assault boat.—*a. Purpose.*—To ferry the assault echelon in a river crossing.

b. Where obtained.—Organizational equipment of engineer troops—

Combat battalion or squadron	10
Combat regiment (square division) or armored battalion	20
Combat regiment (corps)	30
Light ponton company	120
Army engineer depots	stock

c. Number carried per 1½-ton truck.

10 to 14 boats.

d. Normal load afloat.

Engineer crew	2
Soldiers with arms and equipment	9
	11

(For alternate loads see par. 4*b*.)

e. Characteristics of boat.

Weight	200 pounds
Length	13 feet 6 inches
Beam	5 feet
Depth	1 foot 8 inches

CHAPTER 3

FOOTBRIDGE, MODEL 1935

	Paragraph
General purpose and use of bridge	10
Composition and assignment of equipment	11
Detailed description of equipment	12
Care and storage of equipment	13
Transportation of equipment	14
Site requirements	15
General methods of construction	16
Details of crossing operation	17
Time required for construction of bridge	18
Night construction	19
Discipline of troops using bridge	20
Dismantling bridge	21
Reinforced bridge	22
Ferrying	23

10. General purpose and use of bridge.—*a.* The footbridge is a standard means for effecting the rapid passage of foot troops across a stream.

b. If the river crossing is opposed, the first phase of the offensive operation is the seizing of one or more bridgeheads. This involves the crossing of bridgehead troops by assault boats (see chapter 2) which

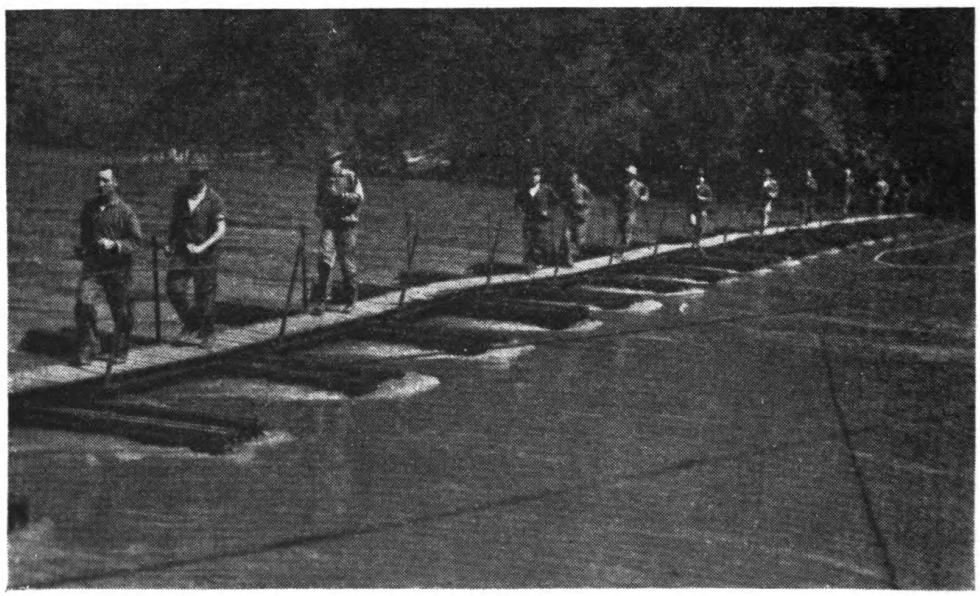


FIGURE 9.—Column crossing on footbridge.

are not only suited to surprise action but constitute the least vulnerable means of crossing in case the operation is discovered. When the initial covering face has secured a foothold sufficient to prevent the direct fire of hostile automatic weapons on bridge sites, the construction and use of a number of footbridges will permit a more rapid and better controlled passage of foot troops.

When the bridgehead has been extended sufficiently to prevent terrestially observed fire on the sites, the construction of light ponton bridges is begun by which artillery, other arms, and trains are crossed.

11. Composition and assignment of equipment.—*a. Bridge unit.*—(1) A single unit of the equipment, which provides for the construction of 432 feet of footbridge, consists of the following:

Article	*Number*
Clip, wire rope, ¼-inch	12
Clip, wire rope, ⅜-inch	12
Duckboard, 12-foot	36
Float, 10-foot	72
Hook, boat, ball point, 10-foot handle	2
Picket, steel, 2 by 36 inches	32
Post, handrail, metal	72
Rope, manila, ½-inch diameter, 30-foot lengths, with ⅝-inch harness snap on both ends (bridle lines)	36
Rope, manila, ½-inch diameter, 500-foot lengths (handrail lines)	2
Rope, manila, ½-inch diameter, 750-foot lengths (guy lines)	2
Rope, wire, ¼-inch diameter, galvanized, 6 by 19, cast steel, 600-foot lengths (float cable), with reel	2
Rope, wire, ⅜-inch diameter, galvanized, 6 by 19, cast steel, 600-foot lengths (float cable), with reel	2

(2) Each single sectional unit (or bay) of the footbridge comprises one duckboard, two floats, and two handrail posts. There are 36 such bay sections in the complete unit of the bridge.

b. Issue.—One unit of the bridge is issued to each engineer combat regiment (corps). Three units are assigned to each light ponton company.

12. Detailed description of equipment.—*a. Duckboard.*—(1) The duckboard, of white pine, consists of a series of transverse slats, 22 inches long, mounted on two longitudinal stringers, 12 feet long. The slats are of 1- by 7-inch material, and the stringers are 1⅝

by 4½ inches in cross section. The weight of the duckboard, complete, is approximately 100 pounds.

(2) Spacer blocks are attached to the under side of the stringers for securing the floats in proper position when the bridge is assembled. The duckboards, and hence sections of the bridge, are attached to each other by means of fastenings at the ends of the stringers. There is one male and one female fastening at each end of each duckboard. Insertion of the lug of the male fastening between the two spring leaves of the female fastening, until the lug is gripped and held by the supporting shoulders, effects the connection. The fastenings may be uncoupled by means of the fitting at the top of the handrail post,

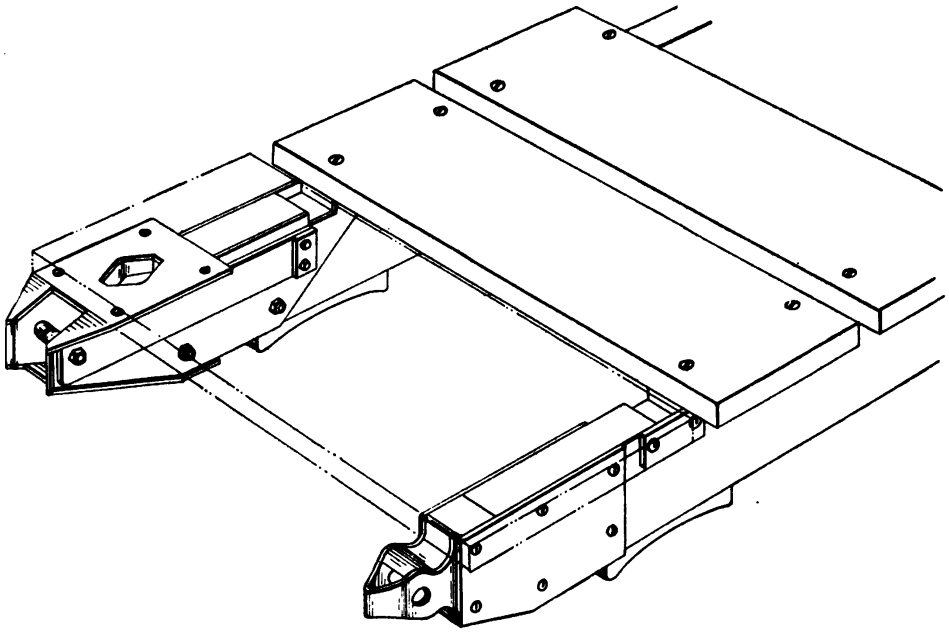


FIGURE 10.—Duckboard connectors.

which, when inserted in the hole in the duckboard slat or crosspiece directly behind each female fastening, may be rotated until the leaves of the female fastener are pried open sufficiently to release the mail lug (see fig. 12).

b. Float.—(1) The float is a white-pine crate, 10 feet long and 10 by 13½ inches in cross-section. The crate contains layers of expanded rubber, the displacement of which affords buoyancy to the unit. The float weighs about 100 pounds and will support about 400 pounds.

(2) Spacer blocks for the alinement of the duckboard stringers are attached to the top of the float crate. Folding carrying handles, to assist in hand carry and launching, are provided at each end of

the float. As the bridge is formed, the duckboards are secured to the floats by means of spring fasteners which are attached to the top of the floats and have hinged shanks that may be hooked over each duckboard stringer. The floats are provided with hooks at each end in which the float cable may be placed.

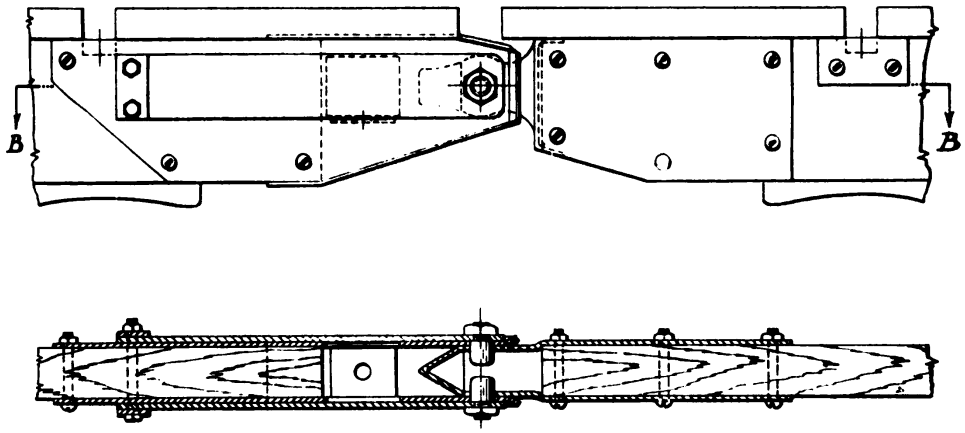


FIGURE 11.—Duckboard connector, latched.

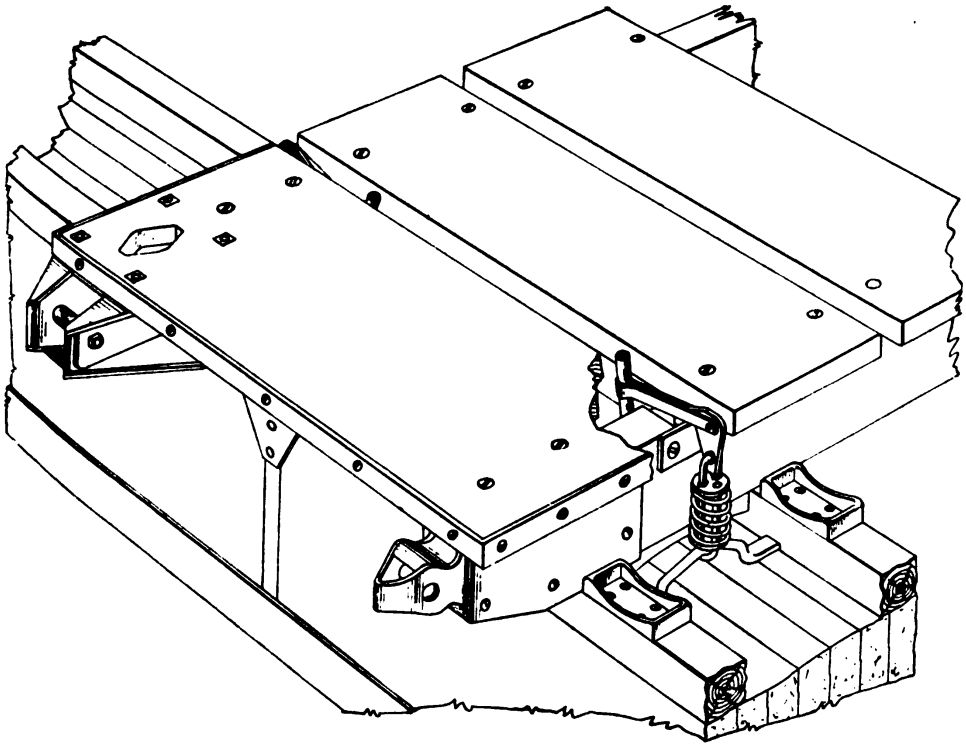


FIGURE 12.—Float fastener attached to duckboard.

c. Handrail post.—The aluminum handrail post has at the top a bronze fitting which serves both as a receiver for the handrail line and as a tool for disengaging the duckboard fasteners. The post is attached to the duckboard stringer just inside the floats of each bay by means of a slot in the bottom of the post. Two posts per bay are used, one at each alternate corner of the duckboard.

d. Cables and lines.—The anchor cable and bridle lines, as well as the guy lines for attachment directly to the ends of the bridge, serve the purpose of alining and guiding the bridge during construction

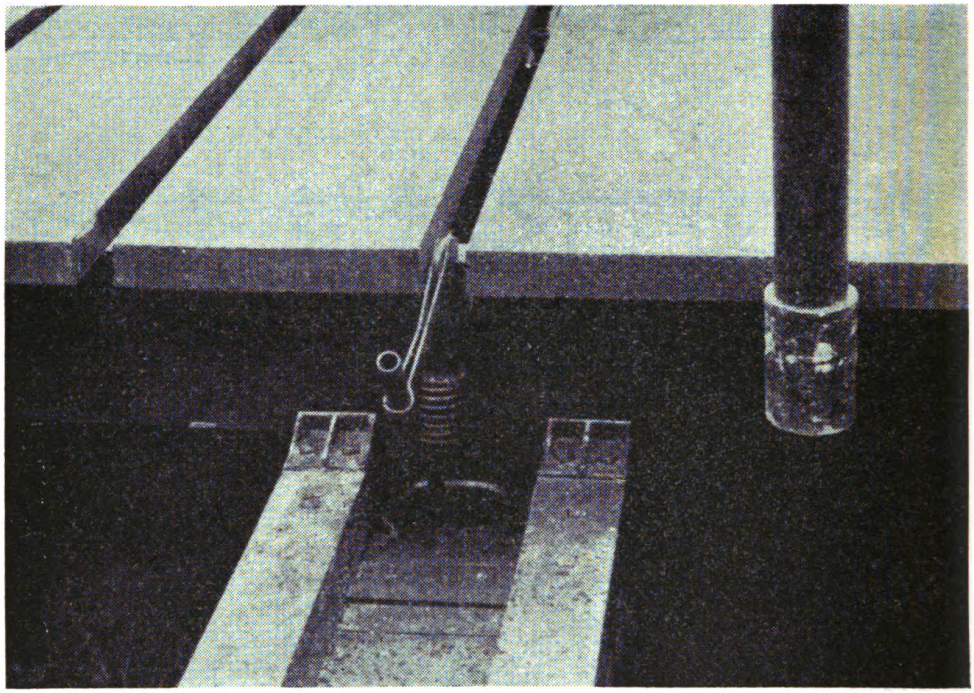


FIGURE 13.—Duckboard fastened to float. (Note handrail post attached to duckboard stringer.)

and of holding it in position while in use. The float cable prevents submergence of the upstream ends of the floats under the action of swift currents. The pickets listed in paragraph 11 are for use as holdfasts. The methods of anchoring and guying the bridge vary with the current and the length of the bridge, as indicated in paragraph 16*d*(2).

13. Care and storage of equipment.—*a. General.*—All parts of the equipment should be carefully inspected at appropriate intervals, and always before being stored away for an extended period. Any broken or damaged parts should be repaired or replaced, and all parts cleaned, painted, and greased as required. A well-ventilated shed or building should be used for storing the equipment. Floats

and duckboards should be kept from contact with the ground and piled so as to permit ventilation through the stacks. Standard olive drab paint is suitable for painting the parts of the equipment requiring such treatment.

b. Duckboards.—(1) Abuse of the duckboard fasteners and the wooden parts should be carefully avoided in disassembling the bridge. There is much less danger of damage in the dismantling operation if each bay is removed from the bridge while it is still afloat. In disconnecting bays from the remainder of the bridge, the lug on the end of the handrail post should be used only as a key to separate the spring leaves by turning the post about its axis through an angle of 90°. When there is any difficulty, separation should be accomplished by jiggling and working the parts rather than by any attempt to force them. Efforts to pry the bridge apart with the handrail posts will almost certainly result in damage to both the floorboards and the handrail posts.

(2) The duckboard connector of the earlier type, model 1935, of which a few are still in service, is the part of the duckboard most often requiring adjustment or repair. The spring steel leaves of the female fasteners should be approximately parallel when connection has been made, and will be so if the leaves, when not connected, incline toward each other in such a way that there is positive contact between them at their outer ends only. These leaves may, however, after much use, become bent so that they are parallel or diverge before insertion of the male lug; in either such condition they will not make a secure and satisfactory connection. Leaves not in correct alinement may be restored to proper condition by placing the duckboard on the ground, driving a drift pin into the ground against the end of the stringer and between the two leaves, and then tying a line to one spring leaf and pulling so as to secure a permanent set in the right direction and amount. The other leaf may then be set up to the other in the same manner.

c. Floats.—The expanded rubber which is the principal buoyant material of the floats is subject to damage by exposure to excessive heat. Accordingly, the floats should not be stored indoors next to radiators or steam pipes, nor outdoors in the sun during periods of very high temperature except when covered. When exposed outdoor storage is necessary care should be taken to avoid a heat absorbing background such as a black bituminous or tar road. The surfaces of the expanded rubber boards become brittle in time. Tears or abrasions of the surface will tend to accelerate such deterioration of the material, although they will have no effect upon its

buoyancy. In fact, the material may be punctured by bullets or other missiles without appreciable reduction in buoyancy. Dragging the floats over the ground or permitting collision with sharp projections will damage the framing of the floats as well as the expanded rubber boards, and should be avoided. During assembly of the bridge the bays should be carried out into water in which they will float freely, and in dismantling they should be picked up while still afloat. To prevent damage, the fasteners for connecting the floats to the duckboards should be secured by the spring clips provided for the purpose except when actually in use. These fasteners should be kept clean and should be washed, dried, and oiled before the floats are placed in storage.

d. Handrail posts.—The handrail posts are not designed for us as crowbars and they must not be used as such. (See par. 13*b*(1).)

e. Rope.—Rope should be kept dry and clean and should be carefully washed, dried, and coiled before storing. The harness snaps on the anchor lines should also be cleaned, dried, and oiled before storing.

f. Cables.—Particular care should be taken to avoid kinking the cables. When securing the ends of the cable to holdfasts, a suitable loop should be formed and secured with the cable clips provided. Knots should not be used in fastening either end, and the formation of loops except near an end of the cable should be avoided. The cable may be secured to a holdfast at the far shore most quickly and with the least possibility of damage to the cable by attaching to the side of the cable reel a harness snap which, when engaged in the running end of the cable, prevents further turning of the reel. After snapping the cable to the reel, the reel may be carried around the holdfast three or four times below the standing end of the cable, and finally both the running end and the reel itself thrown over the cable. The cable should be washed, dried, and thoroughly oiled before storing.

14. Transportation of equipment.—The standard load for a 1½-ton truck is 108 feet of bridge, a quarter of the 432-foot unit. Thus, four such trucks are required to transport a single complete unit. The standard load may be somewhat exceeded in emergency, and of course greater lengths of bridge may be carried in trucks of greater capacity.

15. Site requirements.—*a. Technical.*—The technical requirements of a footbridge site are as follows:

(1) Proximity to a road, path, or other definite line of approach to the near shore that will facilitate carrying of the equipment to the site, as well as the approach of infantry troops to the bridge.

(2) A small cleared area on the near shore, either flat or with a uniform gentle slope close to the edge of the water, large enough in area for the assembly of the bays and the convenient piling of the bridge parts.

(3) Water close to the near shore not more than waist deep, but still of sufficient depth to float the bridge and so facilitate the connection of assembled bays to the completed portion of the bridge.

(4) Absence of high banks, especially on the near shore, and of other features that will impede the construction of the bridge and passage of troops.

(5) The presence of a few sturdy trees or other usable anchorages near the bank, to which anchor and float cables and guy lines may be attached, without having to prepare holdfasts. Such natural anchorages are especially helpful on the far bank, for the anchor and float cables; and on the near bank, for the guy lines.

b. Tactical.—From a tactical standpoint it is desirable that the footbridge site be—

(1) At or near crossing points most suitable to the scheme of maneuver.

(2) Near a road, path, fence line, or similar feature roughly paralleling the far shore which will facilitate reorganization, control, and direction of troops after their crossing and engagement.

(3) Defiladed from hostile artillery observation posts, or other rearward observation posts.

(4) Cover and concealment in close vicinity for troops immediately ready to cross.

c. Selection of the site.—Footbridge sites, and the best approach routes thereto, are selected after careful reconnaissance and with regard to both technically and tactically desirable features. Data as to the width and current of the stream, which are afforded by the reconnaissance, form the basis of the decision to use anchor and float cables, or simply guy lines.

16. General methods of construction.—*a. Normal method (construction by bays).*—Ordinarily the most rapid, effective, and practicable method of construction is by successive bays. By this method, single bays are successively assembled and connected to the near shore end of the completed portion of the bridge, which is then pushed farther out into the water a distance equal to the length of the added bay. During construction the completed portion of the bridge is held in place and alined by guy lines or an anchor cable, as circumstances may require.

b. Construction by sections.—The bridge may be constructed in a manner generally similar, except that sections of two or more bays (rather than the single bay of the normal method) are assembled and attached to the end of the completed portion of the bridge. Construction by sections requires more working room, more men, more skill, and better organization and training, than does the normal method. Such construction is, however, more rapid than that by single bays.

c. Land assembly of entire bridge.—Under particularly favorable conditions of current, site, and approach, the bridge may be assembled on land, carried forward by hand, and launched in a single unit as an assault bridge. The bridge has scarcely any lateral and little vertical flexibility, however, and this method becomes impracticable when steep banks characterize the site, or when brush, trees, or rough ground adjoin it. Neither is the method practicable over swift or wide streams. Assembly on land will ordinarily be limited to the speedy and surprise erection of the bridge across a narrow and sluggish waterway, and will even then be subject to favorable site conditions.

d. Use of cables.—(1) When the stream is wide or the current swift, the anchor cable is necessary both for constructing the bridge and for holding it in position after it has been built. This cable is connected to the bridge by bridle lines. Under conditions requiring the use of the anchor cable, the float cable also is required, except for the one exception given in the table in (2) below. The float cable is placed in the hooks on the ends of the floats provided for the purpose, and prevents the upstream ends of the floats from submerging and finally overturning the bridge when the bridge is long and the current swift. Under less severe conditions only the guy lines from the bridge to the bank are required, to aline the bridge during construction and to secure it once it has been completed.

(2) The proper use of the various cable and guy line aids, according to bridge length and current velocity, is outlined in the following table. The current velocities given are those prevailing in the main channel of the stream. (The data included refer to the footbridge only, not the reinforced bridge, see par. 22.)

Current	Maximum practicable bridge length with anchor cable	Anchor cable required for bridge length over	Bridle lines, anchor cable to bridge	Float cable required for bridge length over	Guy lines required both sides bridge to bank, when anchor cable is not used
Miles per hour	*Feet*	*Feet*	*Bays*	*Feet*	
None	1,000	500	Every 10	None	Required only over 100 feet, 100 feet–300 feet at far end. 300 feet–500 feet at end and center.
1	700	300	Every 6	300	Less than 100 feet at end. 100 feet–300 feet at end and each 6 bays.
2	500	200	Every 4	200	At end and every 4 bays.
3	350	100	Every 2	100	At end and every 2 bays.
4	200	Any length	Every bay	Any length	Anchor cable required.

17. Details of crossing operation.—*a. Movement to the bridge site.*—(1) The footbridge equipment is brought forward in trucks to some previously selected point which affords as much defilade as possible from both hostile observation and fire. This unloading and assembly point should be near enough to the stream to make long and exhausting hand carries unnecessary, yet far enough away to reduce as much as practicable the likelihood of discovery by the enemy.

(2) It is at this point, where the equipment has been unloaded, that the engineer construction party usually awaits the arrival of the infantry detachment designated first to cross the bridge and to furnish carrying parties for transporting the equipment farther forward to the vicinity of the bridge site. Issue of the equipment to these carrying parties is supervised by the engineer troops. It is important that the issuing and carrying operations be carefully planned and executed, so as to proceed systematically and without noise, confusion, or delay. The equipment may be unloaded from the trucks some time in advance of the arrival of the Infantry, in which event it should be laid out in convenient order; or it may be left in the trucks until the moment of issue. If the latter method is followed, measures should be taken positively to insure that the various parts of the equipment will have arrived by the scheduled time of issue. Equipment should arrive at the shore assembly point in the order: cables, ropes, accessories, tools, duckboards, floats, and handrail parts. Carrying parties should be loaded and dispatched in accordance with such an order of arrival.

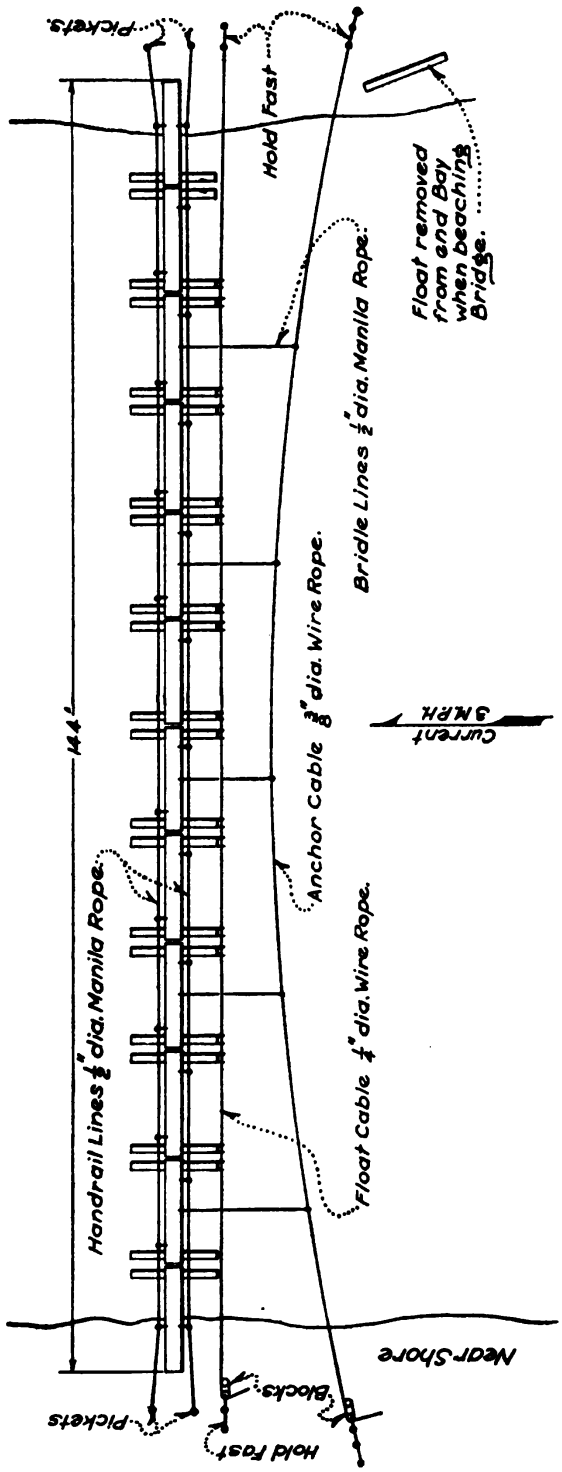


FIGURE 14.—Assembled footbridge using anchor cable, bridle lines, and float cable.

(3) The training of troops for footbridge construction must include practice in the unloading of equipment and its issue to carrying parties. During maneuvers or actual operations this work should be rehearsed in advance, in areas secure from hostile observation, by the engineer and infantry troops concerned.

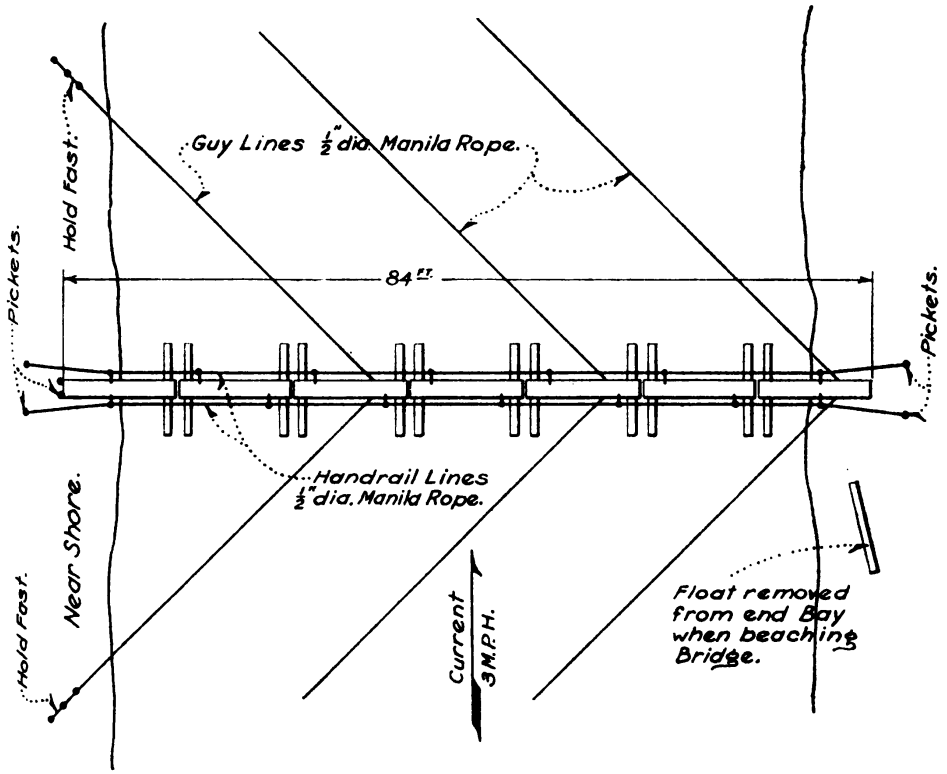


FIGURE 15.—Assembled footbridge using guy lines only.

(4) Loads should be distributed for carry by hand approximately as follows:

Duckboard	2 men
Float	2 men
Steel pickets	4 per man
Handrail posts	6 per man
Bridle lines, 30-foot length	15–20 per man
Handrail lines, 500-foot length	1 man
Guy lines, 750-foot length	2 men
Float cable, 600-foot length	2 men
Anchor cable, 600-foot length	4 men

About 256 men will be required to carry, without relief, a single complete unit of the bridge.

(5) For carries in excess of about 300 yards, provision for periodic rests or relief should be made. The floats will prove the most difficult

loads, and float carriers will find it necesary to stop and change hands frequently.

b. Arrival at the bridge site.—(1) As the hand transported loads arrive at the point on the shore where the bridge is to be constructed, the equipment should be arranged and piled in convenient order. Floats should be placed on one side, duckboards on the other; handrail parts half on one side and half on the other; and the remainder of the equipment as circumstances may require. Often, space at the shore assembly point will be insufficient to permit such arrangement of the parts of the bridge, and pieces will have to be brought forward by separate engineer carrying parties, in the order and at the moment needed in the process of bridge assembly, from some point slightly to the rear.

(2) Construction of the bridge may be started as soon as the first loads of material reach the site.

c. Organization of the construction parties.—(1) The construction of the bridge should be under the direct general supervision of an officer, or an expressly designated noncommissioned officer.

(2) (*a*) In still water short lengths of the footbridge may be constructed by 1 officer or noncommissioned officer and 10 men, or in current by 1 officer or noncommissioned officer and 16 men. These figures are, however, absolute minima. With bridge parts piled conveniently near the site, the footbridge may be most expeditiously constructed by the use of working parties organized as outlined in the following table:

Section	Noncommissioned officers	Men
Anchor cable: [1]		
Near shore		[2] 4
Far shore	1	6
Bridle lines [1]	1	1 per line
Float cable [1]		4
Guy lines [1]	1	2 per line
Shore assembly	1	8
Assembly carrying	1	[2] 4
River assembly	1	6
Handrail lines		3
Material carrying	([3])	([3])

[1] When utilized.

[2] When the near shore men have completed their duties with the anchor cable detail, they report to the assembly carrying detail as relief when required. Additional crews of 4 men should be attached to the assembly carrying detail when the amount of material to be handled and the distance from the shore assembly point to the water make such an increase in strength desirable.

[3] As required for carrying from the unloading point to the shore assembly point.

(*b*) As an example, a bridge built in a 2-mile current, about 300 feet long, requiring the use of anchor and float cables with 6 bridle lines, requires 1 officer or noncommissioned officer in general charge, 5 noncommissioned officers, and 41 men for the various sections; and a 200-foot bridge, in a 1-mile current, built with 6 guy lines (3 on each side) requires 1 officer or noncommissioned officer in general charge, 4 noncommissioned officers, and 33 men.

(*c*) When construction is caried out in the form of a drill, the sections are formed in line in double rank, with an interval between sections, and with the noncommissioned officers in front of their respective sections. Individual duties are assigned to the men within the parties by each section leader, and at the command for constructing the bridge the sections proceed to their various tasks.

d. Construction procedure.—(1) *Officer in charge.*—The officer or noncommissioned officer in charge of construction has the working parties formed; issues instructions as to the use of anchor and float cables or guy lines; designates or has marked the points at which the upstream ends of the floats are to enter the water at the near bank and join the far bank; and, as soon as the section leaders have instructed the members of their parties, gives the command to begin the construction. Thereafter, he exercises general supervision over all parts of the work.

(2) *Anchor cable section.*—The anchor cable section carries forward to a point upstream from the bridge and as close as practicable to the point where the near shore anchor cable connection is to be made the following articles: an assault boat or other suitable boat, paddles or oars, the anchor cable on its reel, a stick on which the reel may turn, blocks and tackle, pickets, lashing, sledges, and other needed accessories. The four men of the near shore part of the section remain ashore to hold the end of the anchor cable while it is being unreeled from the boat, to rig the block and tackle for tightening the anchor cable, to prepare a holdfast when a suitable one does not already exist, and to secure the cable to the holdfast by the block and tackle. The noncommissioned officer in charge of the section informs the bridle line section of the approximate number and length of bridle lines required. The noncommissioned officer and the far shore detail of six men then load the cable and the needed accessories in the boat and push off. Two men hold the reel in the center of the boat and allow the cable to unreel as the boat crosses the stream. The noncommissioned officer steers and the remaining men paddle or row. Upon reaching the far shore, the boat is unloaded and the noncommissioned officer designates the holdfast, if one exists, or

directs the preparation of one. The anchor cable then is made fast. If the number and length of bridle lines required could not be previously determined and given, the noncommissioned officer sends this information to the bridle line section on the near shore by voice, signals, or by messenger in the boat. The near shore detail picks up the slack in the cable with the block and tackle, and makes fast. It is not necessary, and is even undesirable, to attempt to put too much initial tension on the anchor cable. The more sag the anchor line has within limits, the more effective it becomes in resisting the pull of the bridge. Meanwhile, the far shore detail finds or

FIGURE 16.—Anchor cable being carried across river in assault boat.

prepares a holdfast for the float cable, and makes it fast when it arrives at the far shore (see (3) below). When the men of the far shore detail have made fast the float cable, they stand by on the far shore to assist in landing the bridge. The noncommissioned officer with them notes when only two more bays are required to complete the bridge and transmits this information to the near shore by voice, signals, or by sending a messenger back over the completed portion of the bridge.

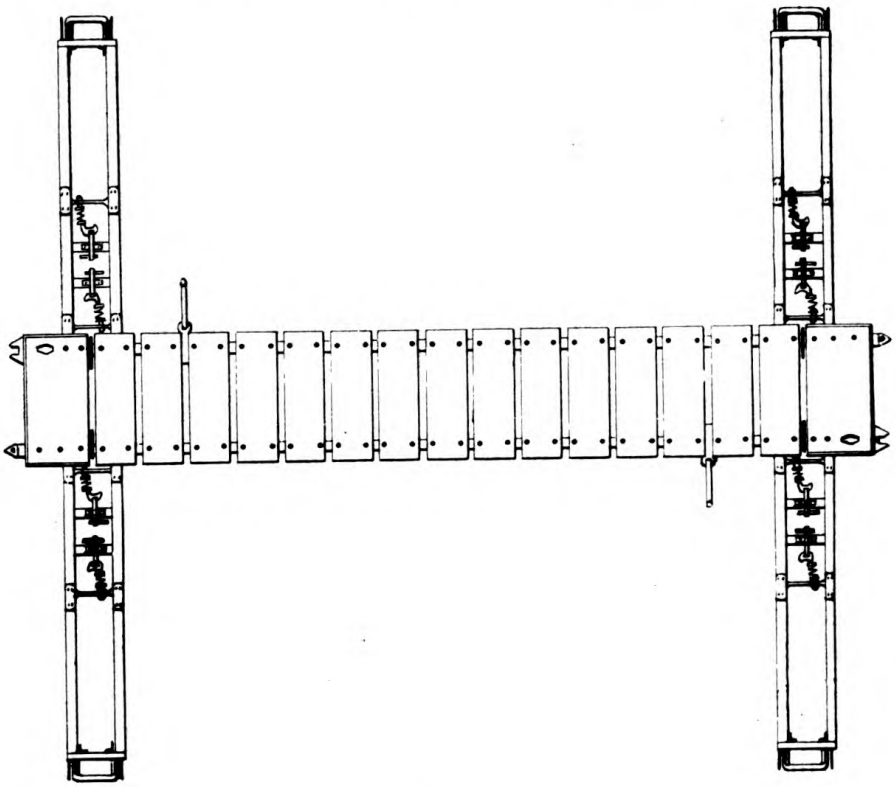
(3) *Bridle line section.*—As soon as the noncommissioned officer in charge of the section receives information from the noncommissioned officer of the anchor cable section as to the number of bridle lines and their lengths, he directs the preparation by the section of the proper lines, and their attachment to the anchor cable by the harness snaps. He then distributes the section on the bridge at the

correct intervals, and directs the alinement of the bridge. He places the first man of the section, with his line, on the riverward end of the completed portion of the bridge, and the remainder, with their lines, on the bridge at proper intervals as it is completed. As the completed portion of the bridge is pushed across the river, the men maintain its position and alinement by pulling in or slacking off the bridle lines. As soon as the bridge meets the far shore its alinement is checked by the noncommissioned officer, and then made fast by securing the bridle lines to the duckboards. In a swiftly flowing stream, the correct performance by this section of its duties is both difficult and of great importance.

(4) *Float cable section.*—One man of this section rides the riverward end of the completed section of the bridge and pays out the cable. Another man stands in the water, near the inshore end of the completed bridge, and places the cable in the hooks on the upstream ends of the floats. Generally, the holdfast for the cable will be at some elevation above the level of the water, so that it will be necessary to omit placing the cable in the hooks of two or more floats at the ends of the bridge, in order to prevent them from being pulled out of the water when the cable is made fast and tightened. When the bridge reaches the far shore, the anchor cable section makes fast the far end of the float cable, and the float cable section makes fast on the near shore and applies the necessary tension with block and tackle. This tension need not be over about 300 pounds.

(5) *Guy lines section.*—The noncommissioned officer in charge of the guy lines section indicates the number of lines to be used, where they are to be attached to the bridge, and the holdfasts to be used or prepared on the near shore. The lines are made fast to the duckboards on each side where required as the completed portion of the bridge goes out into the river, the first two lines being made fast to the riverward end of the bridge. The men take position at the designated holdfasts, and pay out the line as the bridge goes out, snubbing around the holdfasts when necessary. Under the direction of the noncommissioned officer, these men maintain the desired position and alinement of the bridge. The men upstream and downstream from the bridge maintain alinement by paying out and taking in line, as required. Two men are assigned to each line. When it is necessary to prepare holdfasts, this is done by the men whose lines have not yet been attached to the bridge. Holdfasts are so selected or placed and the men stationed at such distances along the bank on both sides of the bridge, as will cause the guy lines to

form a sufficiently large angle with the line of the bridge to permit positive control. Occasionally it may be advisable to attach some guy lines to the far shore and use them to assist in pulling the bridge across the stream and into place. When the bridge is completed, the lines are brought to the proper tension and made fast.



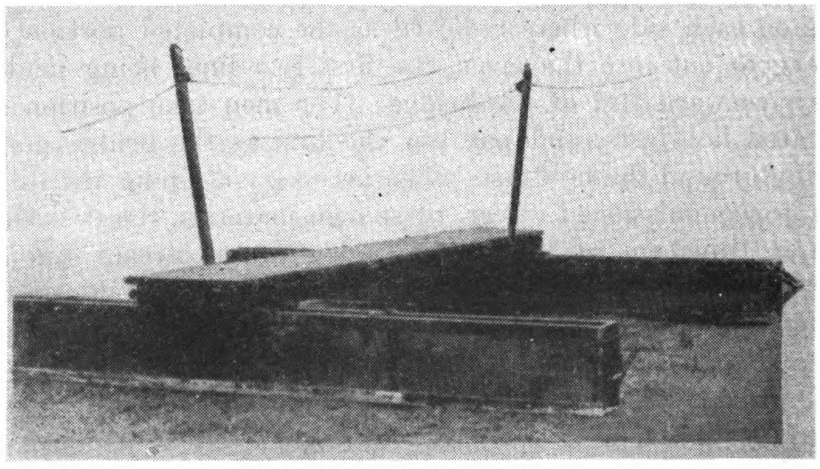


FIGURE 17.—Assembled bay.

(6) *Shore assembly section.*—The separate bays of the bridge may be most efficiently assembled by the use of a template. Such a template may be made by outlining with drift pins or stakes driven into the ground one side and one end of each of the two floats of one assembled bay. Four men, two to each float, procure the floats from the nearby pile or the carrying parties, and place the floats on the ground in the templates; two men bring up the duckboards and place them on the floats; and two additional men attach the handrail posts to the duckboard. The men placing the floats connect them to the duckboards by the fasteners as soon as the duckboard is in position. The assembled bay is then immediately removed by the assembly carrying section. The noncommissioned officer in charge of the section directs the work.

(7) *Assembly carrying section.*—The assembly carrying section is responsible that the bays are removed from the shore assembly point the moment completed, and promptly carried and turned over to the river assembly section. The assembled bays are carried far enough into the water to insure that they will float freely before being put down and turned over to the river assembly section. The section may be reinforced by the four near shore men of the anchor cable section as a relief when the latter have completed their original duties. When circumstances require, additional parties of four men each may be assigned to the assembly carrying section.

(8) *River assembly section.*—Since the assembled bays are most rapidly and efficiently joined to the completed portion of the bridge in the water, this should be the habitual method of assembly unless the water immediately adjacent to the near shore is too deep. The noncommissioned officer in charge of the section takes position on his knees, facing the shore, on the inshore end of the completed portion of the bridge and guides the incoming completed bays so as to effect their quick and proper connection by the duckboard fasteners, using his weight on the two parts to secure proper engagement of the fasteners. After the assembly carrying section places each bay in the water where it will float, it is taken over by four men of the river assembly section, who move it in the water at the direction of the noncommissioned officer in order to make connection. The connection is best effected by engaging one pair of connectors at a time, with the new bay held out of line of the completed portion until the first pair of connectors on one side has been fitted. The same four men then push the bridge away from the shore to make room for the next bay. The remaining two men of the section take post at the inshore float of the completed portion of the bridge, moving

this float at the direction of the noncommissioned officer, and assisting in joining each newly assembled bay to the bridge.

(9) *Handrail line section.*—One man of the handrail line section makes the lines fast to the river end of the first duckboard, and then takes post on the bridge near its inshore end and threads the handrail lines through the handrail posts on each side as the bridge is pushed out. Two men remain on the near shore, one upstream and one downstream from the bridge, to pay out the handrail lines and make them fast to the last inshore duckboard when the bridge is completed.

(10) *Material carrying sections.*—Material carrying sections are provided as may be necessary. The circumstances requiring the use of such sections may vary so widely that no definite organization or

FIGURE 18.—River assembly section at work.

procedure can be prescribed. However, it is of the utmost importance that they are so organized and supervised by officers and noncommissioned officers that the parts of the equipment will arrive at the shore assembly point in the proper order (see par. 17*a* (2)). At night, particular care must be taken for the proper guiding of these carrying parties so that none will go astray. White tracing tape may be useful for such a purpose.

18. Time required for construction of bridge.—*a. Factors affecting rate.*—In addition to the tactical effect of the enemy, the rate of construction is influenced by the width and stage of the stream, the velocity of the current, site conditions such as the nature of the banks and the working space, the weather, visibility, and the condition and training of the troops.

b. Optimum rate.—Fresh and well-trained men have completed 350 feet of bridge in a 3-mile current in as little as 8½ minutes in daylight, and in 18 minutes at night without the use of any lights. Under similar daylight conditions, a shore assembly detail has assembled a complete bay on land in 8 seconds. While this may serve as a rough criterion, training of engineer troops in the technique of erection should not be considered complete until erection of the bridge has been accomplished at an unfamilar site under unfavorable conditions.

c. Adverse conditions.—Under ordinary service conditions rates of progress will be much less because of unfamiliarity with the site, the confusion, hazards, and delays imposed by battle, and the fatigue and imperfect state of training of the troops. Assuming a fairly good bridge site and shore assembly area, troops somewhat fatigued but with some experience and training with the equipment, and with other conditions neither exceptionally good nor exceptionally poor, the figures given in the following table afford a basis for time estimates. These figures must be increased or decreased as conditions vary from those assumed. During peacetime training, the rates given should be doubled by troops who have attained proficiency in construction of the bridge.

Velocity of current (miles per hour)	Rate in bays per minute	
	Day	Night
Less than 2	2	1
2 to 3	1½	¾
Over 3	1	½

19. Night construction.—*a. Limitations of equipment.*—The equipment is not adapted to use as an assault bridge, that is, one which is quickly thrown over a stream without the knowledge of the enemy and before a friendly covering force has been crossed to secure a bridgehead. Except under very favorable conditions, the footbridge cannot be assembled in rear of the river and then carried forward and quickly launched as a unit. Because of the nature of the equipment, assembly at the river bank is certain to create noise which will be audible for some distance.

b. Operations at night.—During actual operations, it will so often be necessary to construct the bridge under cover of darkness that this may prove an almost habitual procedure. In general, construc-

tion procedure at night is identical with that in daylight. However, successful and rapid construction at night is even more dependent upon careful planning, close control, and adequate training. Prior practice and rehearsal should always be given when practicable, preferably at night over water.

c. *Difficulties imposed by darkness.*—No particular difficulty is involved in the assembly of individual bays and incorporating them into the bridge during darkness, although the process is somewhat slower. The chief difficulty arises in the proper placing and handling of the cables and lines, and in the directing of the bridge to the proper point on the far shore. These difficulties will vary widely with the width of stream and force of current, and with the degree of darkness; they may be minimized by careful prior reconnaissance and by careful planning and organization. Suitable arrangements for signals and intercommunication during the process of construction should be made.

d. Special measures desirable in night construction.—Except when the stream is very narrow, or when there is moonlight, the anchor cable should be used at night, because, even though it might not otherwise be necessary, the direction and alinement of the bridge can be much more readily maintained by this means. A single flashlight covered with blue cloth can be used on the far bank to indicate the point of landing for the anchor cable, and then the point of landing of the bridge, with virtually no likelihood of detection by the enemy. Possibly, the use of other shielded flashlights may be permissible for signalling or for controlling the handling or placing of cables and lines. The use of flashlights to aid in the assembly of the bridge itself should never be necessary. If available, luminous markers or paints, white tracing tape, or white pieces of cloth are useful in outlining certain essential features such as the assembly template and the avenues of approach.

e. Maintenance of secrecy.—Although actual construction will ordinarily be started only after the need for secrecy has passed, communication for any distance by word of mouth may be expected to be unreliable because of the sounds of battle in the vicinity. Moreover, light signals may not be permissible except to a very limited and restricted extent, because even though the necessity for avoiding noise may no longer exist, it will seldom be desirable to disclose the exact location of the bridge to aerial and ground observers by the promiscuous use of lights around the construction.

20. Discipline of troops using bridge.—*a. Control of columns.*—The bridge will carry either men and their equipment or small

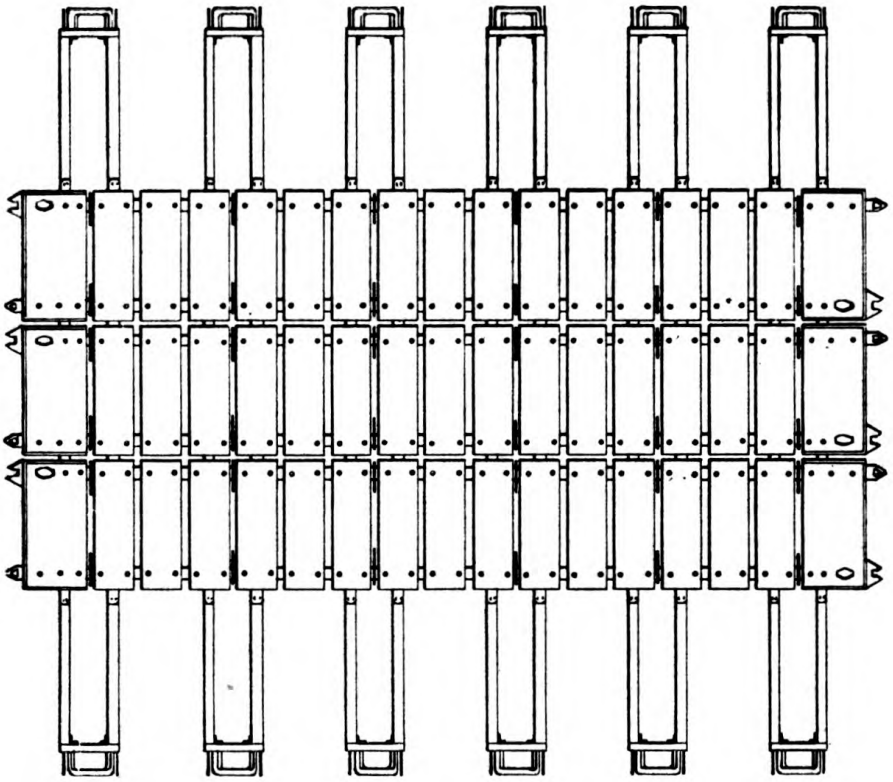
groups of men carrying infantry accompanying weapons. The men, or these groups, should cross at double time, maintaining intervals of about two paces. Such separation is required to provide sufficient running room and to avoid concentration of loads on the bridge. Crossing troops should be particularly warned against closing up or bunching in a stream of considerable current, as it is possible to cause the bridge to overturn by overloading. The bridge will cross 100 men per minute in daylight for bridge lengths of from 100 to 300 feet, with the men at double time, but 75 men per minute is a safer estimate for campaign conditions. These figures should be about halved for crossing during a dark night. The rate of crossing is limited more by the boldness of the crossing troops than by the capacity of the bridge itself.

b. Bridge guards.—The officer in charge of construction of the bridge supervises the entry of troops upon the bridge, and stations one of his noncommissioned officers, or officers, at the far end of the bridge, to aid in expediting the clearing of the troops from that end. When the bridge is to remain in place for some time after it is completed, a suitable bridge guard should be mounted in order to adjust cables and lines, to maintain the bridge in proper condition, and to govern its use by the crossing troops. The priority of traffic on the bridge in both directions is governed by the orders of the local or higher commander. In the absence of such orders, traffic is regulated by the engineer officer or soldiers in charge of the bridge.

21. Dismantling bridge.—Working sections in the same number and size as are used for erecting the bridge are required for dismantling. In general, the dismantling procedure is the reverse of that of construction. An exception is that the float cable, which is simply a safety measure to prevent overturning of the loaded bridge, should be taken in at once to permit ready dismantling.

22. Reinforced bridge.—*a. Assembly of bays.*—The reinforced bridge differs from the footbridge in that each bay consists of three duckboards, laid parallel and abutting along their sides, and six floats. Four handrail posts per bay, one near each outside duckboard corner, are used instead of two. Thus one unit of the equipment will provide 144 feet of bridge.

b. Bridge lengths and use of cables.—Although it would be practicable to construct this bridge under favorable conditions in lengths of 300 or 400 feet, it is unlikely that it will be built in lengths exceeding 200 feet, because of the quantity of material required. Although the bridge offers greater resistance to the current than the footbridge, it is much more rigid and stable laterally. Because of



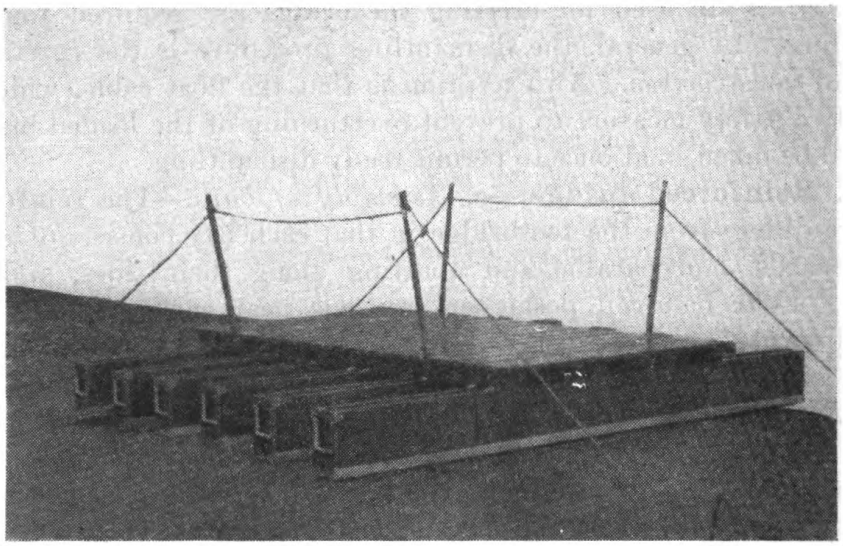


FIGURE 19.—Assembled bay of reinforced bridge.

this lateral rigidity, the float cable is not usually required. The reinforced bridge is much more difficult to push out across the stream and to hold in place because of its greater resistance to the current and the anchor cable will always be used, except for very short bridges in still water.

c. Methods of construction.—The general methods of construction, as well as the detailed preparatory measures and the construction procedure, for this bridge are virtually identical with those for the footbridge. The dismantling procedure is also the same. The float cable and guy line details will be required only in the rare instances when the use of these features is applicable. Anchor cable, bridle line, handrail line, and river assembly details of the same size and with the same duties as for the footbridge are required. Two or more shore assembly details will be required, each to consist of 1 noncommissioned officer and 10 men. In constructing the footbridge, one shore assembly detail is sufficient because it can assemble the bays rapidly enough to keep up with the speed of their connection to the completed portion of the bridge by the river assembly detail. This speed cannot be attained by one shore assembly detail for the reinforced bridge. Since 2 more men are as many as can be added to this detail without having the men get in each other's way, additional details must be formed. Each assembly carrying detail must be increased to 1 noncommissioned officer and 12 men, and the material carrying details must be correspondingly strengthened. With at least two shore assembly details working, the reinforced bridge can be constructed in about twice the time that would be required under the same circumstances for a footbridge of the same length.

d. Capacity.—The reinforced bridge will carry—

(1) Infantry accompanying weapons on carts with mules nose to tail of carts, or carts drawn by hand.

(2) Foot troops in column of three at a walk at the rate of 100 men per minute.

(3) Foot troops in column of two at a run, at the rate of 150 men per minute.

(4) Solo motorcycles or motorcycles with side cars.

e. Limitations in employment.—The reinforced bridge will seldom be used. Provision for it was made originally in order to provide a bridge suitable for crossing the animal drawn carts that were formerly standard for transporting infantry accompanying weapons. Since these carts have become obsolete, one of the main reasons for the reinforced bridge has been removed. Moreover, past experience showed that it was seldom necessary to cross the infantry accom-

panying weapons on animal-drawn carts, and that often it was disadvantageous because of the ensuing congestion at both ends of the bridge, and particularly at the far end. Occasionally the reinforced bridge may be useful for crossing infantry accompanying weapons on the hand drawn wheeled mounts, which are still provided to aid in the transport of these weapons when their motor transportation cannot be used. The most probable use of this bridge, however, will be to provide a footbridge of greater capacity over narrow streams.

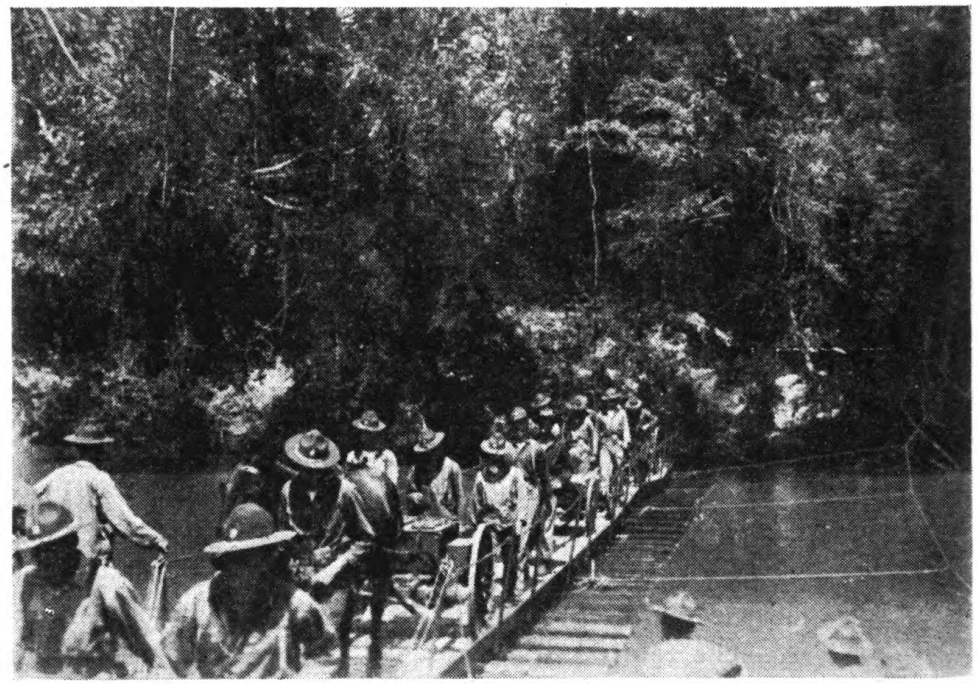


FIGURE 20.—Reinforced bridge in use.

23. Ferrying.—The parts or sections of the footbridge are less suitable as aids to swimming men than are small logs or other types of partially supporting floats. The floats and duckboards are unwieldy and offer such resistance to the current and to forward motion that they impede rather than assist the swimmer. Rafts of one bay are virtually useless as ferries because of their limited capacity and the extreme difficulty of controlling or propelling them—even in still water. Rafts made of one bay of reinforced bridge, or of two bays with the floats dovetailed and lashed together, may be of some utility in ferrying operations, but even such units are poorly adapted to the purpose. These rafts must be guided and moved by means of cables or ropes, since without these aids they are unmanageable.

CHAPTER 4

LIGHT PONTON EQUIPAGE, MODEL 1938

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SECTION I

PURPOSE, COMPOSITION, AND ASSIGNMENT OF EQUIPAGE

	Paragraph
Purpose	24
General features of design	25
Bridge unit	26
Issue	27

24. Purpose.—The normal use of this equipage is to provide for the rapid bridging of streams for the crossing of all the elements of Infantry, Cavalry, armored or similar divisions, and the lighter vehicles of higher echelons. The bridge may be reinforced to a capa-

city of approximately 20 tons, which is sufficient to pass all the loads of the Army except the Air Corps fuel truck.

25. General features of design.—The bridge consists of a floating floor system supported by pontons and connected to shore abutments by one or more trestle spans. The floating part is connected to the trestles by means of spans hinged both to the shore pontons and to the riverward trestles.

26. Bridge unit.—The principal components of one unit of the equipage are 4 trestles, 12 pontons, and the floor system transported on 33 two-wheel trailers, with certain spare parts and accessories. One unit of equipage provides about 250 feet of bridge of 10-ton capacity or 160 feet of 20-ton capacity. The exact length of the bridge can be adjusted by varying the location of the hinge in either of the short boat bays. See table I (par. 102) for complete list of the components of one unit of equipage.

27. Issue.—Three units of equipage are assigned to each light ponton company; these companies will be assigned to tactical organizations by GHQ as the situation demands.

SECTION II

DETAILED DESCRIPTION OF EQUIPMENT

	Paragraph
Ponton	28
Trestle	29
Ponton and trestle spans	30
Balk	31
Chess	32
Sills	33
Siderail clamps	34
Ponton repair kit	35
Trailers	36
Ponton load	37
Deck load	38
Abutment load	39
Trestle load	40
Unloading	41

28. Ponton.—*a.* The ponton is rectangular in cross section between the rakes of the two scow type ends, either of which may serve as bow or stern. It is 28 feet long, 5 feet 6 inches wide, and 3 feet deep (see fig 21). It is built of aluminum alloy sheets and shapes fastened with rivets. The ponton is subdivided into four compartments by three cross bulkhead frames which reach to a height of 9 inches below the gunwales. A storage compartment for accessories

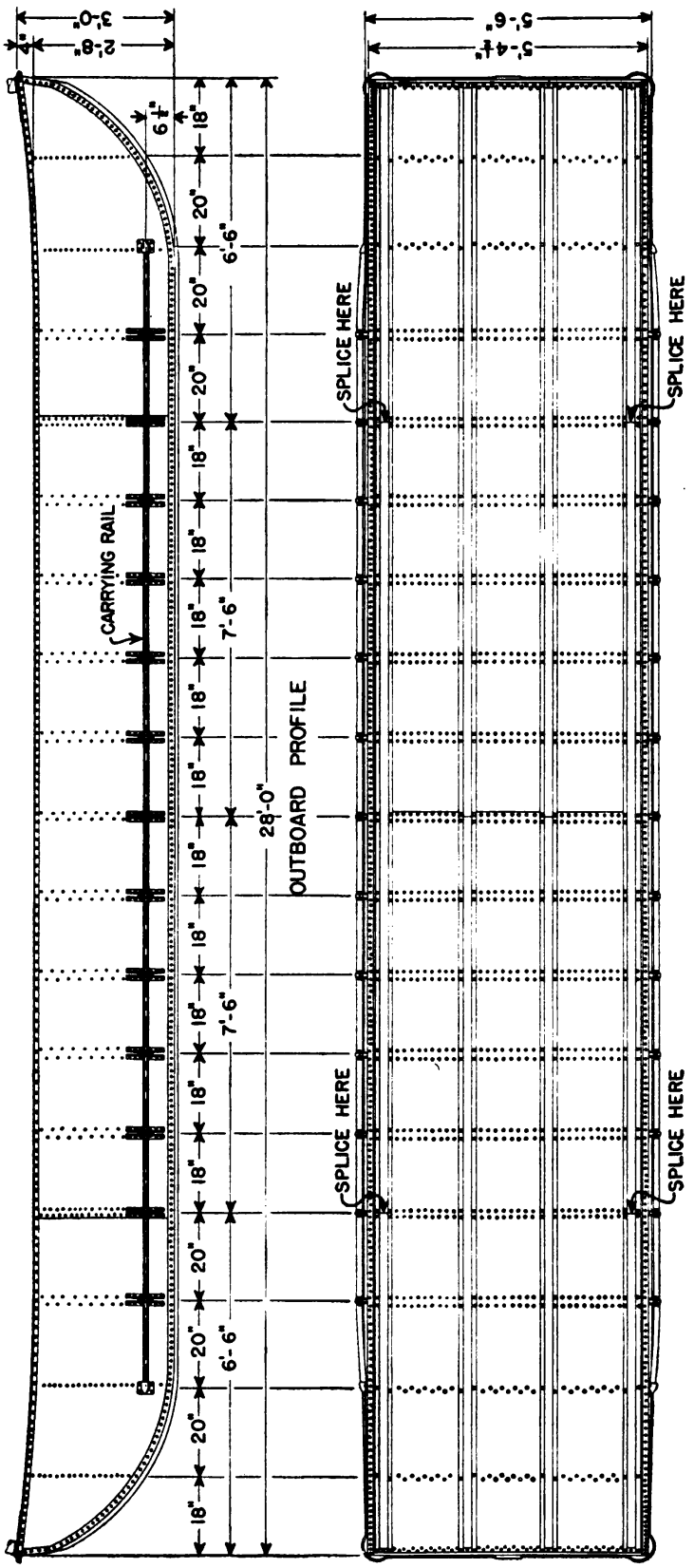


FIGURE 21.—Light pon'on, model 1938.

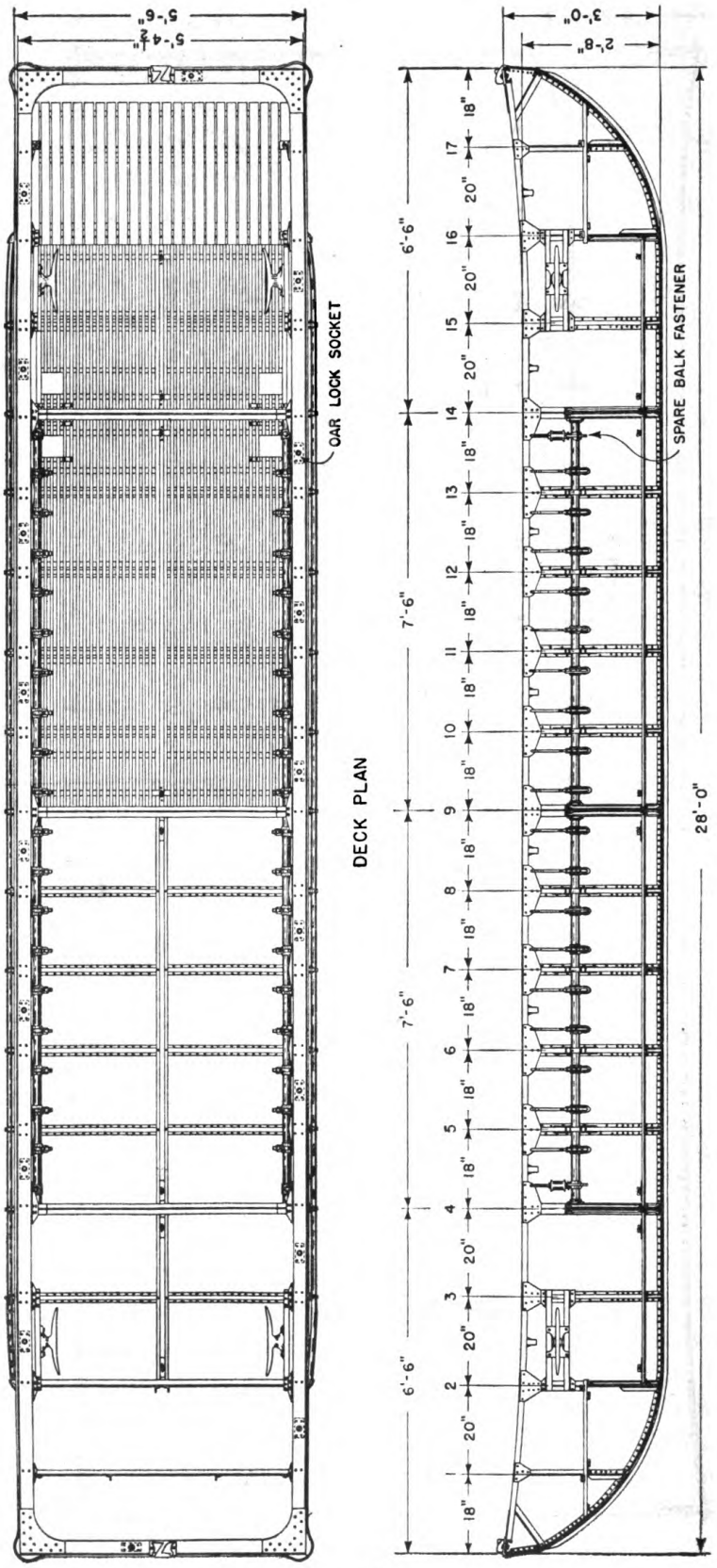


FIGURE 21.—Light ponton, model 1938.

is located at each end of the ponton. The floor of the ponton consists of wood gratings resting on the top of the bottom rib system. Cleats are located in both ends for the securing of anchor and other lines. Receptacles for oarlocks are placed in the gunwales to permit the operation of six pulling oars and a steering oar at either end. A rail runs lengthwise along each side of the ponton to which are attached the mechanical fasteners used for clamping the balk to the gunwales of the pontons. Thirty-two of these fasteners are of a lever-actuated ratchet type. Four additional fasteners, which are of a turnbuckle type, are provided as spares and are secured to the rail by moused hooks so that they can be readily moved to replace broken or damaged fasteners. A carrying rail is secured along the outside of each side of the ponton, and the bottom of the ponton is protected by aluminum skids. In use, each ponton normally is equipped with one anchor, one anchor cable, two boat hooks, eight oars, eight oarlocks, and one pump.

b. The ponton weighs 1,450 pounds and has a total displacement of 23,000 pounds. The following table gives the ponton's displacements for various drafts and freeboards:

Draft	Displacement	Freeboard amidships
Inches	*Pounds*	*Inches*
8	4, 000	24
14	8, 200	18
20	12, 700	12
26	17, 500	6
32	23, 000	0

29. Trestle.—*a.* The trestle is designed to carry the maximum allowable load of the floating part. The trestle parts are the transom, columns, shoes, and chain hoists.

b. The transom is a built-up beam of aluminum alloy, to the top of which a tube is atached. On this tube the end fittings of the trestle balk rest. (See fig. 22.) Cleats which are used in fastening the trestle balk securely to the transom are provided near the bottom of the transom. The transom is 13 feet 10 inches long by 9 inches wide by 15 inches deep. The two columns are aluminum alloy tubes 4½ inches in diameter, in which a vertical row of holes is provided, the holes being 3½ inches apart on centers. Two pin holes are provided in each column well of the transom. One of these holes passes through the column well parallel and one perpendicular to the center line of

the bridge. They are spaced at 1¾ inches vertically. A pin is attached to each end of the transom by a chain. Each end of the transom is held in place on the column by passing one of these pins through one of the two holes in the column well and a hole in the trestle column. Three and a half inch adjustments in height can be made without changing holes in the transom. If, for any reason, 1¾-inch adjustments are deemed desirable, it is possible to make them by rotating the column through an angle of 90° with a windlass stick

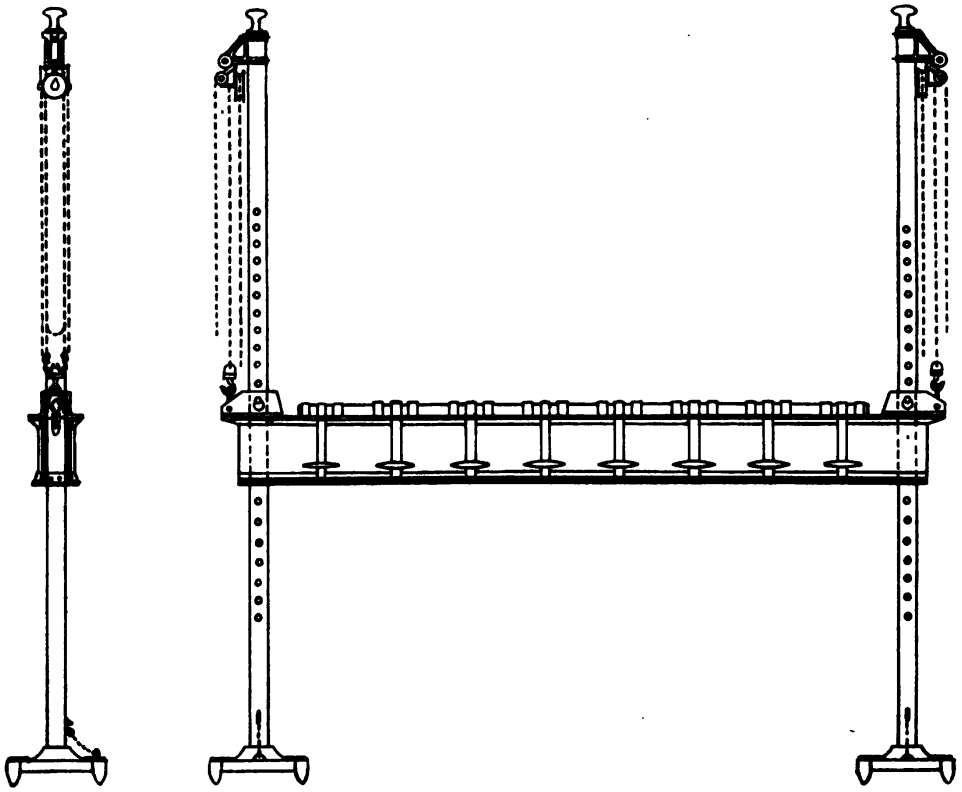


FIGURE 22.—Assembled trestle.

and using the other hole in the transom. Two 1-ton chain hoists are provided with each trestle for adjusting the height of the transom. The hoists are attached to swiveled hangers at the top of the trestle columns and the lifting hooks engage in stirrups integrally attached to the transom. A spool is placed on the top of the trestle column for the attachment of guy lines. The shoes are aluminum alloy with steel and bronze fittings and are 24 inches square. A shoe is attached to the bottom of each trestle column by a ball and socket joint and is secured by a hook on the end of a chain which is attached to the shoe and engaged in an eye on the hemispherical end of the column.

To prevent loss of the shoe if this hook comes out, another hook, also secured to the shoe by a chain, is engaged in the first pair of holes in the column above the shoe. (See fig. 22.) The complete trestle, less the chain hoists, weighs 700 pounds.

30. Ponton and trestle spans.—Floating spans are 15½ feet, and trestle and hinge spans are 15 feet in length. Fixed spans are from abutment sill to trestle or from trestle to trestle. The hinge span is measured from the riverward trestle to the hinge sill. The hinge span laps over the balk of the first floating span by about 6 feet, depending on the exact location of the hinge sill in the floating bay nearest the shore, which must be a full balk's length from the river-

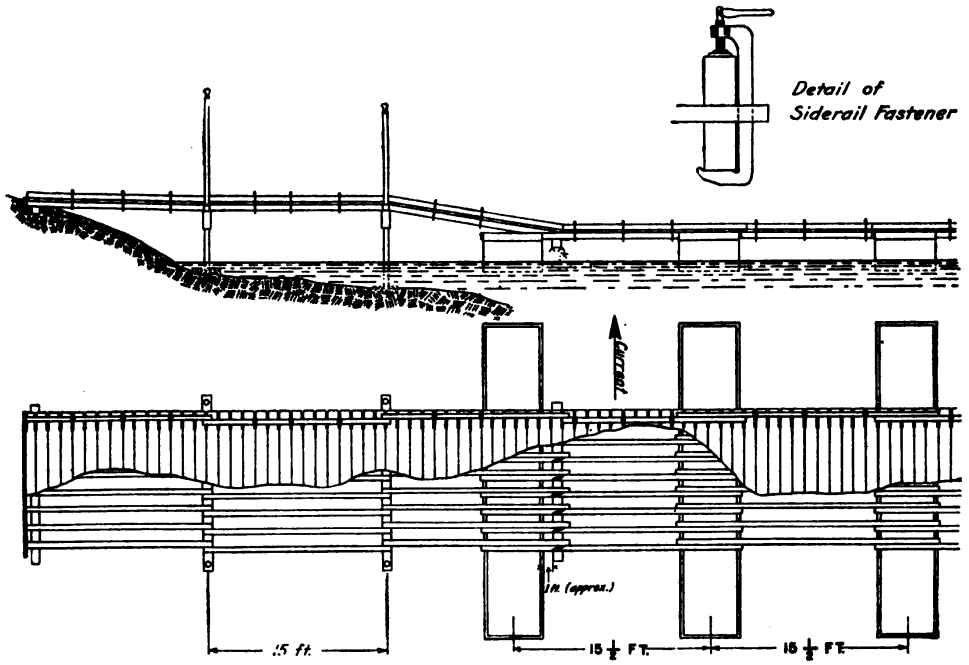


FIGURE 23.—Elevation and plan of typical shore connection, using two trestle spans.

ward trestle. (See fig. 23.) The deck of fixed and hinge spans is supported by trestle balk. The ponton balk span two adjacent pontons in the floating spans. In other words, the ponton balk of adjacent bays lap each other at each ponton by the width of a ponton, each balk being securely fastened down on four gunwales. (See fig. 23.) This arrangement gives continuous beam action in the floating portion of the bridge. A considerable portion of a load concentrated at the center of one ponton will be transmitted to adjacent pontons and a small portion to the two next adjacent pontons. Trestle balk are used as siderails in the fixed spans, hinge spans, and first floating span at each end of the bridge, and ponton balk in the

other floating spans. The siderails lap over at each ponton as do the balk, and hold the chess in place with clamps that secure them to the outside balk over which they are laid. The clear roadway width of the bridge is 10 feet 6 inches.

31. Balk.—*a.* Both ponton and trestle balk are 4 inches by 6 inches in cross section, net dimensions. The balk are made of high-grade Douglas fir. The ponton balk weighs approximately 140 pounds, and the trestle balk approximately 100 pounds. Eight balk are used in each span as stringers, and two as siderails, in the normal bridge.

b. The trestle balk is 15 feet 4⅜ inches in length, with a metal strap secured over each end of the balk and forming a semicircular fitting on the underside of the end. This fitting engages the tube on the top of the trestle transom. Nine inches from the latter fitting is a U-shaped eye of metal, which is secured to the underside of the balk and used in fastening the balk down on the trestle transom. The two fittings so located provide a space to receive either an abutment or hinge sill. (See fig. 24.)

c. The ponton balk is 21 feet 5 inches in length. Each end is bound with a steel collar, on the underside of which is fitted a clip which acts as a gage stop over the outside edge of the ponton gunwale, enabling the pontons to be readily assembled into bays. (See fig. 24.) Behind these fittings are metal straps around the balk, ending in an eye, in which the hooks of the balk fasteners in the ponton engage. The gunwale of the ponton fits between the two end fittings.

32. Chess.—The chess are made of high grade Douglas fir and are 12 feet by 11⅞ inches by 2⅛ inches, net dimensions. At each end for a distance of 18 inches the width is reduced to 10⅜ inches to provide space for the placing of the siderail clamps. (See fig. 24.) Rivets pass through the ends of the chess and the outer ends of the wide sections to prevent splitting. A chess weighs approximately 75 pounds.

33. Sills.—The sills are made of high grade Douglas fir and are 13 feet by 7¾ inches by 5¾ inches, net dimensions, metal-bound and equipped with rings at their ends. (See fig. 24.) A sill weighs approximately 135 pounds.

34. Siderail clamps.—*a.* The siderails are secured by a screw type fastener, weighing about 10 pounds, which engages under the outside balk and above the siderail, clamping the chess in place between them. (See fig. 23.)

b. The rope siderail lashing utilized with the M1869 ponton equipage can be used as a substitute fastening in the absence of the

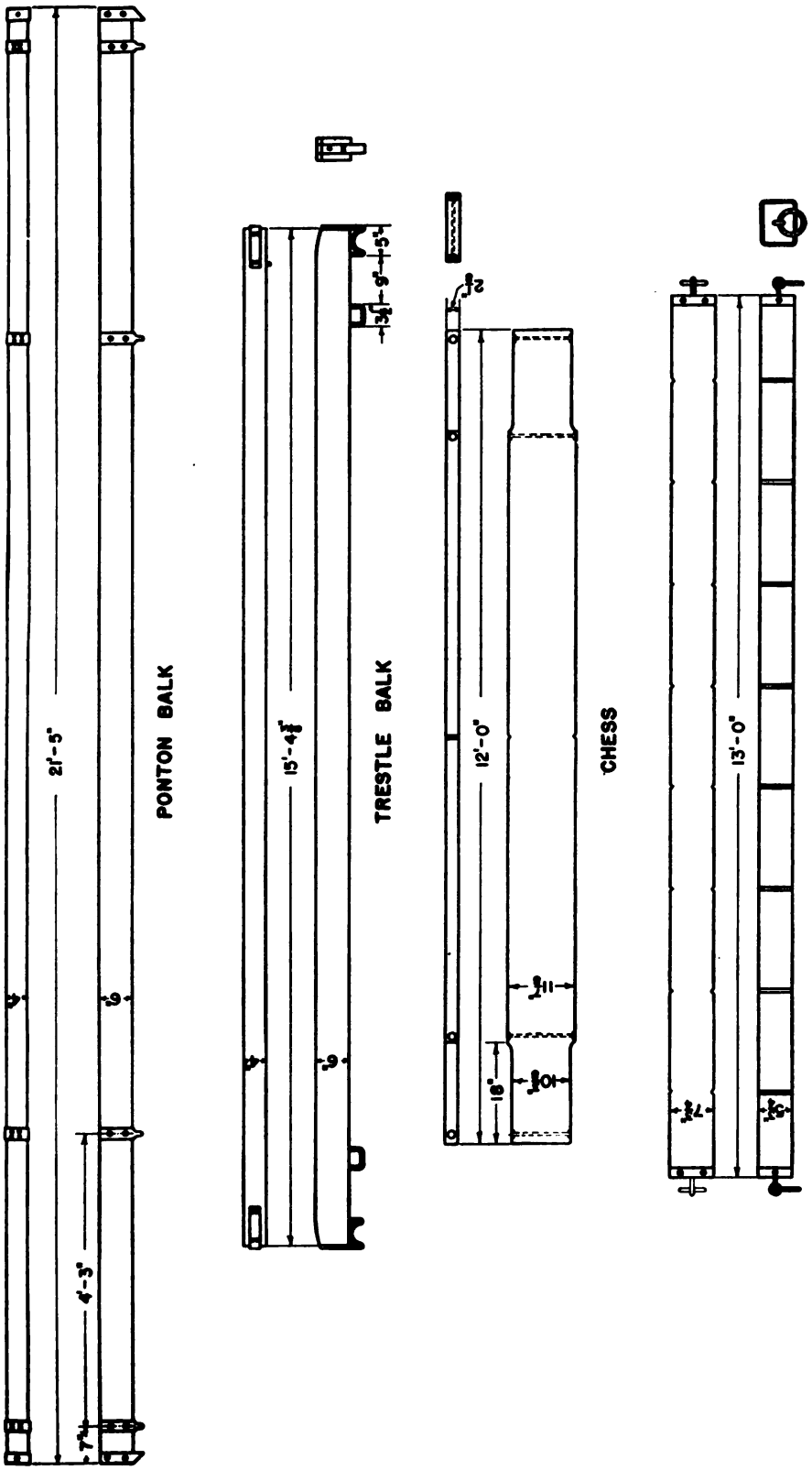


FIGURE 24.—Balk, chess, and sill.

mechanical fasteners. It is made by passing a lashing, twice if doubled and three times if single, around the balk and siderail, tying it loosely in a half bowknot, and then twisting it tightly with a rack stick. (See fig. 25.)

35. Ponton repair kit.—This kit includes special tools, material, and fittings for the repair of the pontons and the trestle transom. The contents of this kit are listed on the inside of the lid of the chest and in table I (par. 102).

36. Trailers.—*a.* The major items of the equipment are transported on two-wheel trailers. There are four types of trailer loads on a single type of two-wheel trailer, as follows:

(1) The ponton load of one ponton, one anchor, one anchor cable, two boathooks, eight oars, and one pump.

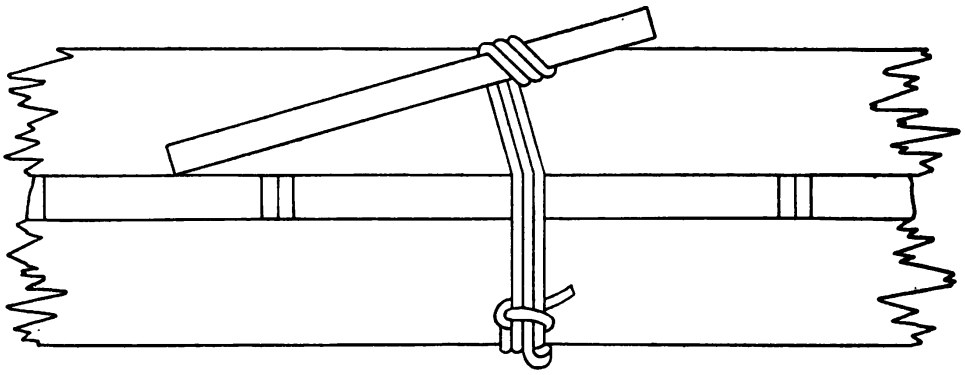


FIGURE 25.—Rope siderail lashing (used only in absence of mechanical fasteners).

(2) The deck load of the 10 ponton balk and 16 chess required for 1 floating span.

(3) Abutment load of the 10 trestle balk and 16 chess required for 1 fixed span with either 2 sills or 2 coils of 1-inch rope in addition.

(4) Trestle load of two trestles.

b. The trailer has a rectangular shaped open chassis of steel members; a straight, tubular axle; pneumatic heavy duty tires 7.00 by 20; disk steel wheels and hubs of commercial truck type; and springs of commercial truck type. (See fig. 26.) Auxiliary lashing rings are welded to the four corners of the chassis to assist in manhandling the trailer and in lowering it down steep grades. These rings also can be used for improvised lashings to secure the loads should the mechanical load fastening devices be lost or broken.

c. The drawbar is a tubular telescopic type, permitting three adjustments of its length required for the several loadings. The drawbar is held at the proper adjustment by a pin, and is further

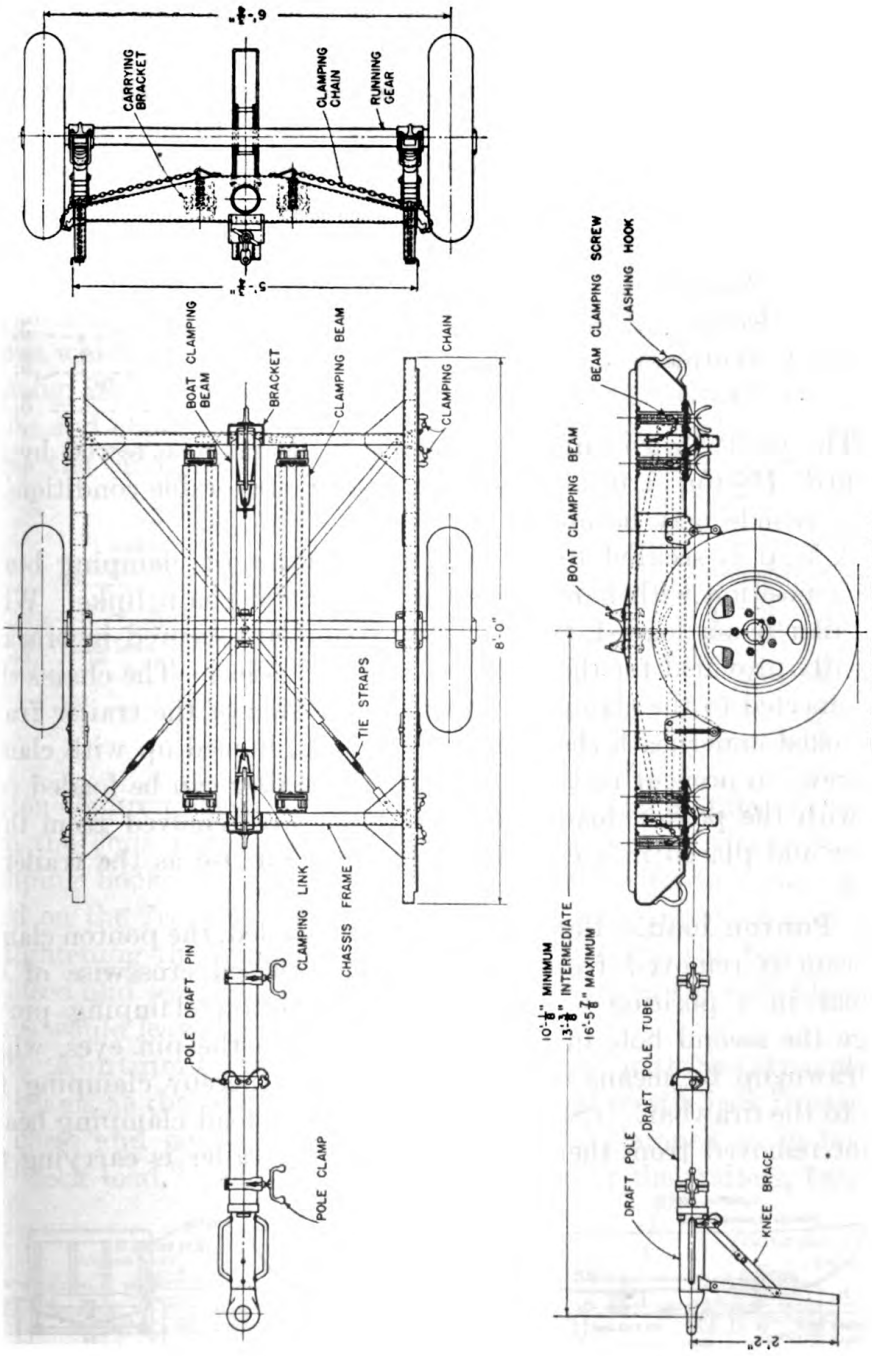


FIGURE 26.—Two-wheel trailer, light ponton equipage, model 1938.

secured by two clamps. A rest is provided for the drawbar so that the vehicle may be supported in a horizontal position when unhooked from the prime mover. This rest has a knee brace, which can be folded with the rest beneath the drawbar and there secured by means of a pin.

d. The trailer is not provided with brakes and when parked on anything except a level surface the wheels should be chocked.

e. The empty trailer weighs 1,500 pounds, and the loaded weights are approximately as follows:

Load:	*Pounds*
Ponton	3,330
Deck	3,850
Abutment	3,720
Trestle	3,550

f. The trailer with any of the above loads may be towed by the standard 1½-ton truck. However, under favorable conditions a lighter vehicle may be used.

g. A load is secured to the trailer by means of clamping beams held in position with hand operated screws and chain links. When the trailer is not loaded, the clamping beams are secured in brackets especially provided for that purpose. (See fig. 26.) The chains that are connected to the clamping screws on the side of the trailer frame are hooked underneath the trailer and then tightened up with clamping screws to prevent rattling. Before the trailer can be loaded (except with the ponton load), all these items are removed from their keepers and placed in a convenient location for use as the trailer is loaded.

37. Ponton load.—Before the ponton is loaded, the ponton clamping beam is removed from its keeper and placed crosswise of the drawbar in a position that will allow the beam clamping pin to engage the second hole in the drawbar through the pin eyes, which are drawn up by means of the thrust screw, thereby clamping the beam to the drawbar. (See fig. 27.) The four load clamping beams are not removed from their keepers when the trailer is carrying the

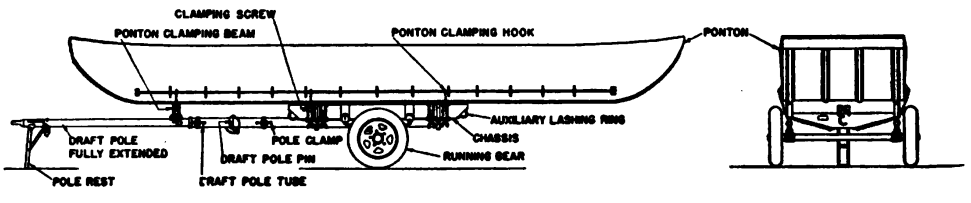


FIGURE 27.—Ponton load.

ponton. The ponton is carried upright and loaded symmetrically on the trailer, held down at four points by hooks engaged over the carrying rails of the ponton and clamped to the side members of the trailer by means of the clamping screws. The ponton is also clamped to the drawbar. This is accomplished by means of the previously placed ponton clamping beam, on which the bottom of the ponton rests. The two hooks on the end of the beam are placed over the carrying rail of the ponton and then the ponton is clamped securely to the beam by tightening the wing nuts of the hooks.

38. Deck load.—The chess are first loaded flat, in four stacks of four chess each. These are clamped to the trailer by means of two of the clamping beams and the chains from the two outside clamping screws which are hooked in the beam clevices and securely tightened. (See fig. 28.) The balk are then placed on top of the chess clamping beams and clamped down by the same method as used for the chess. After the clamping beams over the balk have been tightened, the

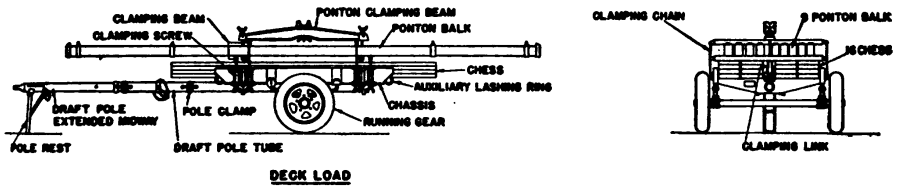


FIGURE 28.—Deck load.

ponton clamping beam is placed lengthwise in the middle of the load with the ends resting on the clamping beams over the balk. The clamping hooks are engaged in the eyes of the folding stirrups located on the front and rear bolsters. The beam is secured in place by tightening the wing nuts of the hooks. Unless the ponton beam is placed and secured as indicated, the deflection in the balk clamping beams would leave the inside balk loose.

39. Abutment load.—This load is secured with the same clamping beams as the "deck load." The chess and trestle balk, instead of the chess and ponton balk, are arranged and clamped as in loading the "deck load." Then, in addition, on two of the trailers, two sills

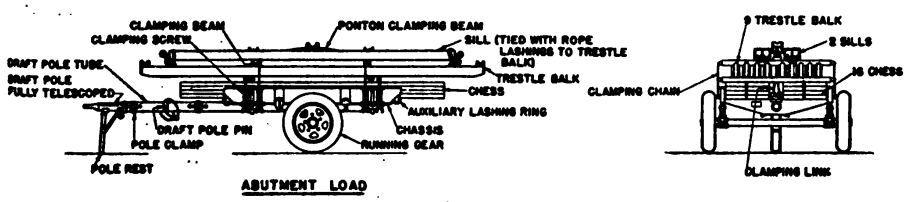


FIGURE 29.—Abutment load.

are loaded symmetrically, one on either side of the ponton clamping beam, and secured by lashing the rings in the ends of the sills to the eyes of the trestle balk. On a third trailer an assault boat is lashed. (See fig. 29.)

40. Trestle load.—Two trestle transoms are loaded on the trailer. (See fig. 30.) They are placed on their sides, one each on either side of the bracket that supports the ponton clamping beam when the trailer is empty. Two clamping beams are placed across the transom and secured to the trailer. The outside or short chain clamping screws are used to clamp this load. The four trestle columns are placed on the two clamping beams holding the transoms and are held down with the two remaining clamping beams. The latter clamping beams are secured with the chains of the inside clamping screws. The ponton

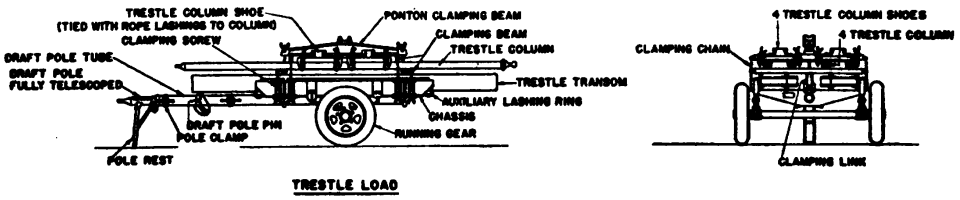


FIGURE 30.—Trestle load.

clamping beam is secured in the same manner as with the deck loads. The four trestle shoes are placed on the trestle columns, two on either side of the ponton clamping beam, and lashed to the columns.

41. Unloading.—*a.* In general, unloading trailers is the reverse of the operation of loading. As soon as the trailer is unloaded, all clamping beams, including the ponton clamping beam, must be carefully replaced on the trailer and secured as described in paragraph 36*g* (see fig. 26). It is especially important that the ponton clamping beam is removed from the drawbar of the trailer after the ponton is unloaded.

b. In the general case, the ponton should be unloaded on dry land. From eight to ten men are stationed on each side of the ponton. At the command LAY HOLD, all take hold of the carrying rail on the side of the ponton. At the command RAISE, they raise the ponton clear of the trailer, and at the command FORWARD MARCH, they carry it in the direction away from the drawbar. If the truck is still attached to the trailer, it may pull the trailer out from under the ponton as soon as the ponton is raised clear. When the approach to the river or the river's edge is rocky, the ponton should be carried into water which is sufficiently deep to float it throughout its length.

c. Under certain conditions the ponton can be most rapidly and conveniently unloaded either by tilting the trailer and letting the

ponton slide forward into the water in case of a steep bank, or by moving the trailer into the river until the water is deep enough to float the ponton clear in case of a shelving shore with a gravel bottom. The ponton should not be slid off the trailer into the water when there is any likelihood that the ponton may be damaged by striking rocks along the bank or shore or slightly submerged along the water's edge.

SECTION III

OUTBOARD MOTORS

	Paragraphs
Issue	42
22-hp. motor	43
Attachment bracket	44
Towing adapter	45
4.5-hp. motor	46
Care and maintenance of motors	47
Employment of the 22-hp. motor	48
Employment of the 4.5-hp. motor	49
Surprise	50

42. Issue.—Included in the organizational equipment of each unit of ponton, equipage are the following:

4 22-hp. outboard motors,
4 attachment brackets,
4 towing adapters,
2 4.5-hp. outboard motors.

43. 22-hp. motor.—The 22-hp. motor weighs approximately 110 pounds and has an over-all length of about 52 inches and an over-all width of about 18 inches. It carries a three-blade propeller with a diameter of 12 inches and a pitch of about 8 inches. It is a non-reversing, twin-cylinder, rope-starting motor, rated at 22 hp. at 4,000 r. p. m. An instruction book for the operation and care of the motor is furnished with each motor and describes in detail the parts of the motor. The spare parts and accessories furnished with each motor are listed in table I (par. 102).

44. Attachment bracket.—An attachment bracket is furnished for each 22-hp. motor. It is fastened to the stern of the ponton, clamping over the top of the ponton and hooking over two lugs on the skids. Movable metal arms carry a board to which the motor is attached. See figure 31 for details. The board is raised or lowered by a lever so that the propeller may be kept submerged at the proper depth regardless of the draft of the ponton.

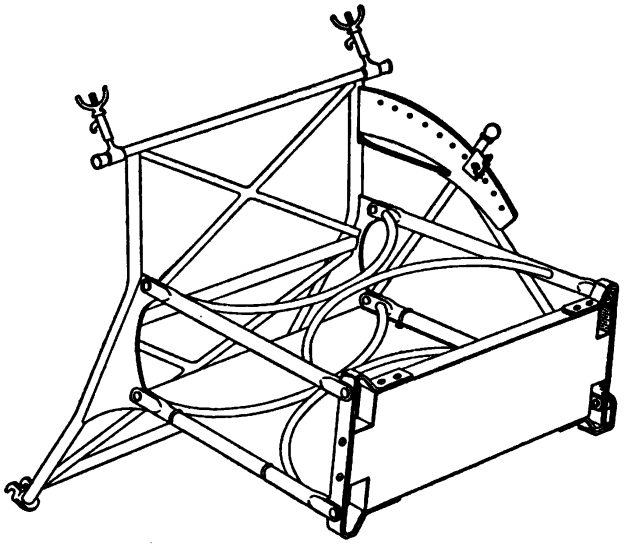


FIGURE 31.—Attachment bracket for 22-hp. motor.

45. Towing adapter.—The towing adapter is a device for facilitating the attachment of a power ponton to a raft in bridging or ferrying operations. It is fastened to the bow of the power ponton and to the stern of one or two of the pontons in the raft. The adapter compensates for changes in draft due to raft loading and increases the lever arm of the steering component of the propeller thrust, thus assuring better control. However, in many cases, attachment of an outboard motor directly to one of the pontons forming the raft will furnish sufficient power and control so that a separate power ponton and adapter will not be required.

46. 4.5-hp. motor.—The small motor of about 4.5 horsepower, for use with light boats such as the assault boat, weighs about 45 pounds and has an over-all length of about 46 inches and an over-all width of about 18 inches. It has a two-blade propeller with a diameter of 8 inches and a pitch of about 7½ inches. It should operate at about 4,000 r. p. m. It is a twin-cylinder, rope-starting motor which is reversible by full pivoting. Complete information on operating the motor is included in the instruction book. The spare parts and accessories furnished with each motor are listed in table I (par. 102).

47. Care and maintenance of the motors.—Successful and dependable operation of outboard motors is assured provided the directions contained in the manufacturer's instruction book are faithfully and precisely followed, and the motors are operated only by men trained in their use. Otherwise the operation of outboard

motors will be unreliable and unsatisfactory. The following points are worthy of especial emphasis:

a. Special boxes are provided for transportation of motors by truck and always must be used. Motors must not be dropped on the ground whether in their boxes or not. Motors should be covered when not in use.

b. The instructions of the manufacturer regarding spark plugs and the mixture of oil and gasoline are especially important and must be followed exactly.

c. Dirty or wet spark plugs are the most frequent cause of failure of an outboard motor to start or to operate properly. The motor operator always should carry at least one extra set of clean, dry spark plugs in his pocket so as to be prepared to make immediate substitutions when necessary.

d. Motor operators should be prohibited from disassembling the motor other than removal and replacement of spark plugs and removal and replacement of fuel line screens. Other repairs are shop jobs to be performed under the supervision of a skilled mechanic.

48. Employment of the 22-hp. motor.—*a.* This motor is for use with the ponton equipage in bridging and ferrying operations. Attached to a single ponton it has many uses, such as ferrying troops, anchor work, moving pontons to their places in the bridge, patrolling, taking a line or detail to the far shore and similar work. In currents of three miles per hour or more, the efficiency of bridging and ferrying operations is greatly increased by the use of outboard motors.

b. In propelling rafts the outboards are necessary. For a two-ponton raft the motor may be attached to one ponton of the raft. For larger rafts the motor should be attached to the stern of a separate ponton, which is used as a power ponton, fastened to the rear of the center of the raft by the towing adapter. To hold the power ponton parallel to the pontons of the raft, lines should be run from the sides of the raft to the stern of the power ponton. (See fig. 32.) Training and practice are necessary for efficiency in the use of motors in ponton work.

c. Motors can be used only in streams of sufficient depth to prevent damage to the propeller. The propeller should be raised and cleaned of weeds as often as necessary. Driftwood may damage the propeller if care is not exercised.

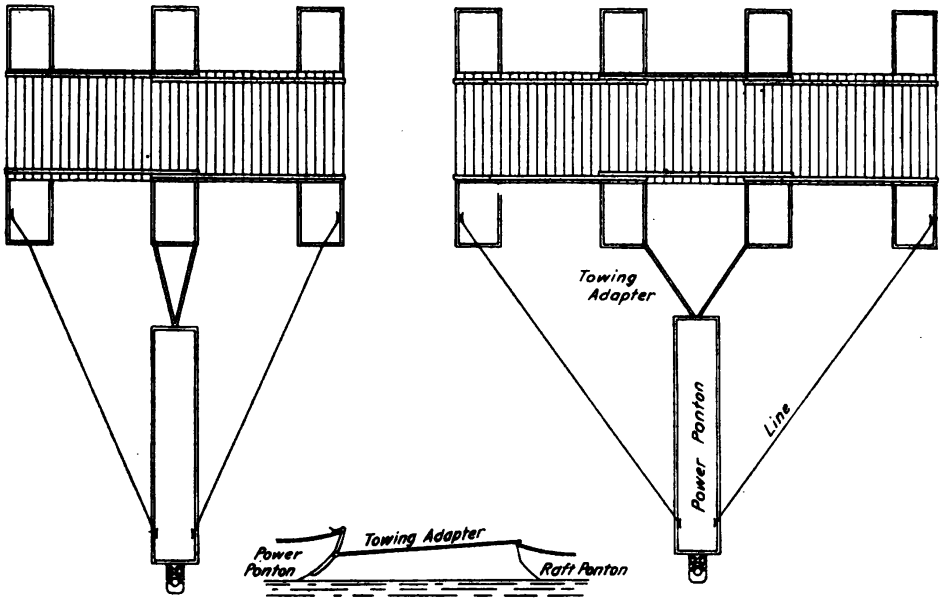


FIGURE 32.—Propelling lay-out for outboard motors used with ponton raft.

d. Approximate stillwater speeds of individual pontons and rafts propelled by the 22-hp. motor are as follows:

	Speed (*m. p. h.*)	
	Light	Fully loaded
Individual ponton	7	5
2-ponton—1-bay raft	4½	3½
3-ponton—2-bay raft	4	3
4-ponton—3-bay raft	3½	2½

49. Employment of the 4.5-hp. motor.—*a.* This motor is for use with assault boats or other small boats when light boats are needed in connection with bridging or ferrying operations. Some of the uses for light boats in river crossing operations are—

(1) For reconnaissance by water.
(2) For taking a line or a small party to the far shore.
(3) As a rescue or safety boat.
(4) As a patrol boat.
(5) As a messenger boat.

b. In many instances it will be difficult or impossible to move a ponton to locations where water transportation may be needed for reconnaissance, patrolling, or inspections. Also all the pontons may be

needed for the bridges. In such cases light motor boats will be of particular value. The weight of an assault boat is about 200 pounds.

c. One assault boat is included in each unit of ponton equipage, and the assault boats assigned to combat units and light ponton companies also are available for use with the light motors. A small piece of wood ½-inch thick with two small bent metal strips for hanging it over the top edge of the stern is furnished for each motor to serve as a filler plate so that the bracket may grip the stern properly. The assault boat equipped with the light outboard can make from 5 to 6 miles per hour in still water.

50. Surprise.—Since surprise is usually sought in ferrying the initial waves of Infantry, outboard motors should not be used with assault boats in such operations.

SECTION IV

ROWING DRILL

	Paragraph
General	51
Individual instruction	52
School of the ponton	53

51. General.—A well-instructed engineer soldier must be a good oarsman. The following exercises should be thoroughly taught and frequently practiced to train troops to maneuver a ponton expertly.

52. Individual instruction.—*a.* Individual instruction in the use of the oars, paddles, and boat hooks should be carefully supervised by the commissioned officers of the company to see that every part of the drill is properly taught.

b. The instructor (usually a noncommissioned officer) embarks his detachment, consisting of 6 oarsmen, and pushes out into deep water where he casts anchor. The ponton is provided with 7 oars, 2 boat-hooks, and 1 anchor and cable. The instructor, placing himself in the stern, details each oarsman in turn to practice with the oar, the others paying close attention to the drill.

c. At the command ATTENTION, the oarsman inserts the rowlock in the socket, and then facing aft places himself in the middle of the ponton abreast of his rowlock, assuming a standing position and trimming boat.

d. At the command UP OARS, he grasps his oar and raises it briskly to the vertical in front of the center of his body, the handle resting on the bottom of the boat and the blade parallel to the keel. The hand next to his rowlock grasps the oar at the height of the chest, elbow and wrist horizontal; the other steadies it at a point 12 inches lower.

e. At the command LET FALL, he side-steps 18 inches with the foot opposite the rowlock, and allows his oar to fall outward so that the blade strikes the water while the shaft is held clear of the gunwale. He then places the shaft in the rowlock, 3½ feet from the end of the grip, with the blade horizontal. He next slips one hand to the grip and places the other on the oar 8 inches from it, the backs of both hands being up and the wrists lowered, and moves the foot next to the rowlock 18 inches to the rear. Only 3½ feet of the oar should be in the ponton.

f. At the command GIVE WAY, given when the oar is at the final position indicated for LET FALL (or at HOLD WATER, in which case the oar is at once brought to this position), he raises his wrists and extends his arms, throwing the weight of the body well forward, drops the blade vertically into the water, throws his weight strongly backward upon the oar, disengages it from the water, and resumes his first position. These motions are repeated with regularity, taking care to make a long sweep, to keep the oar near the water, and to feather it by depressing the wrists after every emersion until the command WAY ENOUGH or OARS is given. The instructor will take care that the oar is moved by the weight of the body and not by the force of the arms.

g. At the command WAY ENOUGH, given when the oar is in the water, the oarsman takes one stroke, raises his oar to a vertical position, and lays it gently in the ponton, the blade toward the bow.

h. At the command OARS, given when the oar is in the water, he takes one stroke if rowing, and resumes the final position indicated for LET FALL. If at the position HOLD WATER, the stroke is omitted.

i. At the command HOLD WATER, given when the car is in the final position indicated for LET FALL, the oarsman raises the grip so as to engage the blade in the water, and holds the oar firmly at right angles to the ponton, blade vertical. The object is to check the headway when in motion.

j. At the command STERN ALL, given when the oar is at HOLD WATER, or at the final position indicated for LET FALL, he reverses the operation of rowing as described under GIVE WAY, and by pushing vigorously against the oar when immersed, gives the ponton a motion astern. The operation ceases at the commands WAY ENOUGH or OARS, which are executed as described above.

k. The command UNSHIP is given when the oar is in the final position indicated for LET FALL, and is executed by removing the oar from the rowlock and letting it trail alongside, held by the hand next the gunwale. This position is used whenever it is necessary to prevent fouling the oars suddenly. At the command SHIP the oar is restored to its former position.

l. The command BOAT OARS may be given when the oar is in the final position indicated for LET FALL or at UP OARS. The oarsman raises his oar to the vertical, if not already there, lays it quietly on the bulkheads of the ponton, blade toward the bow, and takes the position of ATTENTION.

53. School of the ponton.—*a.* The object of this school is the instruction of the oarsmen in the management of the single ponton. It is not to be taught until all of the crew are thoroughly familiar with the use of the oar as described under individual instruction. The exercise will be conducted under the close supervision of a commissioned officer. The right and left of a boat are the right and left sides when facing the bow.

b. To embark, the instructor provides his detachment with seven oars and two boat hooks, forms it in single rank, with the best oarsmen on the right, commands LEFT FACE, and marches it into the ponton. Oars and boat hooks are carried on the shoulder, blades or hooks well up. The oars are deposited in the bottom of the ponton, six with the blades toward the bow and the seventh reversed. The boat hooks are placed outside the oars, prongs toward the bow. The cable is coiled in the bow, with the lower end made fast to a bow mooring cleat and the other attached to the anchor by an anchor knot. The anchor is placed with its flukes over the bow with the shank and stock resting on the accessory storage compartment.

c. At the command ATTENTION (executed as under individual instruction) the crew arrange themselves in the order in which they were formed on shore, the right oarsman (stroke oar) taking the after right rowlock and the others alternating, the even numbers being on the left side and abreast of the odd numbers. The instructor then directs one or two of the crew to step ashore, remove the moorings, and prepare to push the ponton from the bank.

d. At the command UP OARS (executed as under individual instruction) the instructor takes the reversed oar himself and, drawing it aft horizontally, puts the blade over the stern.

e. At the command SHOVE OFF the men on shore, aided by the instructor, and, if necessary, by others of the crew with their oars, disengage the ponton from the bank and jump in. All the oarsmen then assume the position of UP OARS, and the instructor places his oar in the stern rowlock in readiness to direct the course of the boat.

f. The command LET FALL (executed as under individual instruction) is then given.

g. The crew is next drilled to execute in unison the following movements as prescribed under individual instruction, the after right oarsman (stroke oar) giving the cadence: GIVE WAY; WAY ENOUGH; UP OARS; LET FALL; OARS; HOLD WATER; STERN ALL; UNSHIP; SHIP; BOAT OARS; REST. In order to secure the simultaneous and prompt execution of these movements the preparatory commands similar to the following may be used: STAND BY TO GIVE WAY; STAND BY TO LAY ON OARS; STAND BY TO STERN ALL. These exercises will be continued until the entire crew can execute them properly.

h. When the crew is well drilled in the foregoing simple exercises, the following more complicated movements will be taught:

(1) To turn the ponton rapidly, the oars being at the final position indicated for LET FALL, the instructor commands GIVE WAY RIGHT (or LEFT); BACK LEFT (or RIGHT). Pulling and backing oars keep stroke with the after oar of their own side. To cease turning the instructor commands GIVE WAY, at which the backing oars take the direct stroke. Assisting with his own oar, the instructor can turn the ponton with great rapidity and in a very small space by this method.

(2) To cast anchor the ponton is first headed to the current and its way checked. At the command PREPARE TO CAST ANCHOR, the right and left bow oarsmen boat their oars; the former unships the bow rowlock (if in the socket) and sees that the cable is clear, while the latter grasps the stock with both hands near the shank, and stands ready to cast it overboard. At the command CAST ANCHOR he tips it into the water and assists the right bow oarsman in paying out the cable. When the ponton has dropped astern (or been backed) about five times the depth of the water, they take a single turn around one of the bow cleats and hold strongly upon the cable to make the flukes take hold of the bottom. When this is accomplished, they gradually pay out about as much more rope, and then secure the cable to one of the bow cleats. The instructor then commands BOAT OARS.

(3) To weigh anchor, the crew being at ATTENTION, the instructor commands: 1. PREPARE TO WEIGH ANCHOR; 2. UP OARS; 3. LET FALL. At the first comand the left bow oarsman loosens the cable from the cleat and, aided by the right bow oarsman, passes it over the middle of the bow; they then stand ready to haul in. The remaining oarsmen obey the second and third commands as given. The instructor then commands GIVE WAY and causes the ponton to be moved slowly toward the anchor, the bow oarsman taking in the slack of the cable and neatly coiling it away in the bow. While the cable becomes vertical, the way of the ponton is checked, and the two men, pulling vigorously,

raise the anchor to the bow, where it is held by the right bow oarsman, while the left bow oarsman grasps the stock with both hands, and, aided by the other bow oarsman, lifts it to its position already described. Weeds should be removed by hand and the anchor cleaned by dipping. They then resume their oars and take the stroke.

(4) To debark on approaching the landing place, the ponton being headed in the proper direction, the instructor commands IN BOWS. At this command the bow oarsman takes one stroke, and, boating his oar as directed under individual instruction, takes a boat hook and stands ready to assist in the landing. When sufficient way has been gained, the instructor commands WAY ENOUGH, and the stroke oarsman takes the remaining boat hook to assist in the landing. The instructor with the steering oar then brings the ponton to the bank in the most convenient manner, causes the rowlocks to be unshipped and the ponton to be properly secured, and lands his men in a way similar to that prescribed for embarking them.

SECTION V

CONSTRUCTION METHODS AND GENERAL CONSIDERATIONS

	Paragraph
General	54
Trestles	55
Anchors	56
Upstream and downstream balk	57

54. General.—*a.* Ponton bridges of various types may be constructed by three general methods, as follows:

(1) By successive pontons, which means that the floating portion of the bridge is built progressively adding one ponton after another.

(2) By parts, which means that parts consisting of three bays, or a greater odd number of bays are assembled along the shore or in some tributary stream under cover and floated to their places in the bridge, together with the material required for effecting the connection with the last part placed.

(3) By rafts, which means that rafts of one or more bays of the bridge are assembled along the shore or in some tributary stream under cover, floated to their places in the bridge and connected together by securing the end pontons of adjacent rafts together, side by side, using a false balk or some other means to keep the adjacent pontons forming the connection at the same level.

b. Of these methods, only the first two, construction by successive pontons and by parts, are applicable to the light ponton equipage, model 1938. The method of construction by rafts offers little, if any,

advantage over the method of construction by parts, and a bridge so constructed will be capable of supporting only the lightest loads because the continuous beam action of the balk is interrupted at the junction of the rafts. This continuous beam action is required to support the loads for which the bridge is designed.

c. The method of construction by parts will be particularly applicable if a tributary stream, which provides concealment and defilade, is available in friendly territory. In such a situation it might be possible to construct all of the floating parts of the bridge during the earlier phases of the river crossing operation and float them into place very quickly after the construction of the ponton bridge is authorized. Except under the most favorable conditions some form of power boat must be available for maneuvering the parts into their final position. An outboard motor on a separate ponton can handle a 6-ponton 5-bay part in streams whose current does not exceed 3 miles per hour. Under no circumstances should the method of construction by parts be attempted unless the troops are thoroughly familiar with the prescribed drill for the normal method of construction by successive pontons.

55. Trestles.—*a.* Occasionally the water near the abutment sill will be deep enough to prevent contact between the bottom of the first ponton and the river bed when the bridge is heavily loaded. However, it will usually be necessary to use one or more trestles to reach water which will furnish the necessary draft for the pontons. The easiest way to place a trestle is to float it into position on a raft which later becomes the first floating bay of bridge. When several trestles are needed for the shore connection, the river trestle will be placed by this method. When the water is too shallow to float the trestle into position or too shallow to allow free action for the first boat after a trestle is placed by this method, it must be assembled on the shore as near to its final position as possible and manhandled into its final position. Hereafter in this manual the flotation method will be referred to as the *deep water method* and the manhandling method will be referred to as the *shallow water method.*

b. Bridge site conditions will govern the erection method. For example, three trestles may be required, the first in shallow water, the second in water deep enough to float the hinge span raft but not so deep as to prevent the use of the shallow water method, and the third in deep water. In this case it is preferable to erect the first two trestles simultaneously by the shallow water method, adding an additional construction party for erection of the second trestle. No attempt should be made to launch more than one trestle from the hinge span raft.

56. Anchors.—*a.* The normal method of securing the bridge against current and wind action is by anchors with 1-inch rope anchor lines. The spacing of the anchors on the line of upstream anchors will vary according to the velocity of the current. The downstream line of anchors is necessary to provide cables for the manipulation of pontons, maintain the alinement of the bridge during construction, and prevent pontons from weaving in the current. The downstream anchors are usually spaced at intervals of 62 feet or at every fourth ponton. These anchors also provide security against the action of high winds.

b. In tidal estuaries where the current may flow in both directions, the anchors should be spaced on each side of the bridge as required by the maximum currents which are to be expected.

c. The distance of the lines of anchor from the center line of the bridge will vary depending upon the maximum depth of water to be encountered on the lines. The distance of the line of upstream or downstream anchors from the center line of the bridge should never be less than ten times this maximum depth. This distance should be increased if the nature of the river bottom is such as to allow considerable dragging of the anchors before they finally take hold.

d. The line of upstream anchors and the line of downstream anchors should be located by reconnaissance prior to the construction of the bridge. For the convenience of the anchor sections the location of the lines of anchors should be marked by ranges of signal cloth on one side of the river or by stretching a light line well above the water so as not to interfere with traffic.

e. The table below shows the proper spacing and method of casting anchors for various current velocities.

Anchor spacings			Method of casting anchors		
Current	Upstream spacing	Downstream spacing	Outboard motors	Number of 5-man rowing crews	Number of 7-man rowing crews
Miles per hour	*Bay*	*Bay*			
None	4	4	Desirable	4	Not necessary.
1	2	4	Desirable	4	4.
2	1	4	Desirable	Not suitable	3.
3	1	4	Desirable	Not suitable	3.
3-5	1	4	Essential	Not suitable	Not suitable.
Tidal	Use upstream spacing on both sides of bridge to suit maximum expected velocities.		Use method which is suitable for maximum current to be expected while bridge is under construction. Outboard motors always save manpower and speed up bridge building operation.		

f. Unless the anchor cables generally follow the directions of the current, there is a tendency to move the floating part of the bridge longitudinally. Anchors therefore should be dropped directly upstream from the final positions of the pontons to which they are to be affixed. Small deviations of an anchor cable from the direction of the current will do no harm. Every effort should be made to avoid crossing of anchor lines in order to avoid difficulty in raising the anchors. It is not necessary that the anchors are exactly spaced on the line of anchors.

g. Where good holding ground is not available in streams of appreciable current, special measures must be taken to secure the bridge. This may be done by casting additional anchors for each ponton or group of pontons, or by attaching more than one anchor, each with a separate lead, to each anchor cable. If the width of the stream will permit, long cables may be made fast at several points along the bridge and their other ends attached to trees or suitable holdfasts on both banks upstream of the abutments.

h. Panniers of stone, picks lashed together, cribs filled with stone and similar expedients may be used as a substitute for anchors. A rail bent in the form of a V makes a powerful anchor. It may sometimes be advisable to use piling for an anchorage. In this case either single piles or clusters of piles are driven and the cable is attached as near the bottom as practicable. Anchorages out of the water are preferable as they are more readily inspected and made secure. An island or a bridge pier makes an excellent anchorage.

57. Upstream and downstream balk.—*a.* Balk (stringers) are laid parallel to the center line of the bridge. Since all balk except those in the two abutment spans lap over the balk of adjacent spans at both ends, it is necessary that they be laid either upstream or downstream of some reference point on the trestles or the pontons. On the trestles the points of attachment are arranged in pairs which automatically fix the position of the trestle balk if laid parallel to the bridge center line. (See fig. 22.) On each gunwale of the ponton there are eight reference points which are deeply scored to facilitate locating them by touch in the dark.

b. In the first floating span and all odd numbered floating spans the balk should always be laid so that the downstream edge is directly above the reference points on the gunwales. On the second floating span and all even numbered floating spans the balk are laid so that the upstream edge is against the downstream edge of the balk in odd numbered spans and directly above the reference points on the gunwales. The balk in the odd numbered spans are referred to as

upstream balk since they lie entirely upstream of the reference marks, and the balk in the even numbered spans are referred to as *downstream* balk for the opposite reason. (See fig. 23.)

c. It follows that the trestle balk of the hinge span will be downstream balk and that the next fixed span shoreward will be upstream balk, whether it is laid between two trestles or between a trestle and the abutment sill. Where one or more trestles are used in the shore connection, the construction parties building the shore connection must exercise care in placing the balk of the abutment span in order to insure the placement of downstream balk in the hinge span.

SECTION VI

SELECTION OF BRIDGE SITE

	Paragraph
General	58
Tactical requirements	59
Technical requirements	60
Reconnaissance	61

58. General.—The selection of a bridge site is governed by both tactical and technical requirements. Selection should be preceded by a thorough study of the tactical plan, the map and the aerial photograph. A ground reconnaissance is essential. Observation from the air is desirable. The engineeer must be prepared to make recommendations on the best site and possible alternatives. Tactical requirements will normally fix the general area in which the bridge will be built. Technical requirements will usually fix the exact location and may, in some cases, be of such importance as to eliminate the sites considered best from the tactical point of view. Final decision rests with the tactical commander of the unit the bridge will serve.

59. Tactical requirements.—See FM 5-5.

60. Technical requirements.—The following factors influence the selection of a bridge site from a technical point of view:

a. Approaches.—Short, easily constructed approach roads from the site to the existing road net on both sides are of primary importance. Within 150 feet of the bridge, approaches should be straight and without excessive grades, particularly on the far shore. The prior construction of the near approach is often essential in order to get the ponton equipment to the river. The time required to construct approaches is often the controlling factor in the selection of the site.

b. Current.—The current should be steady, parallel to the bank and moderate. A location in a straight reach or gentle bend is favorable.

c. Bed.—The bed of the river should be free from snags, rocks, shoals, and other obstructions which would interfere with the movement of the pontons. It should be sufficiently firm to hold the anchors and support the trestles. Before construction a careful underwater examination should be made, particularly in the area to be occupied by trestles, so that obstructions such as stumps and snags may be located and removed if necessary.

d. Banks.—Banks should be firm enough to support the sill and approach. They should not be so high or steep as to require excessive grading for the approach. They should not be so low that normal rises will overflow the site or unnecesarily increase the required length of bridge.

e. Launching pontons.—A 15-foot stretch of bank having a gentle slope to the water either at the site or convenient to it is needed for launching pontons. In a swift current, a point well upstream is desirable.

f. Mooring pontons.—A place for mooring pontons along the bank is necessary about 250 feet from the site. Mooring points may be upstream or downstream of the site, or both, depending upon the plan for casting anchors or for using the anchor cable. Easy access from the land side, deep water, free from snags or other obstructions, and suitable anchorages along the bank are desirable.

g. Stacking balk and chess.—A cleared area on the near shore at the site is needed for unloading and stacking balk, chess, and other equipment.

h. Transportation park.—Provision must be made for moving trucks and empty trailers completely away from the site or parking them nearby under cover.

i. Holdfasts.—In case it is not advisable to use anchors on the bed of the river to hold the pontons, the presence of large trees or other holdfasts near the bank is desirable for fastening steel anchor cables and guy lines. When a bridge is located downstream from existing pile clusters or bridge piers, these may be used as holdfasts.

j. Rise and fall of water surface.—Selection of the site must consider the effect of normal changes in the water surface on the construction and operation of the bridge. Tides, floods, drought, and the manipulation of dams may change the level many feet.

k. Existing ponton ferries.—If ponton equipment in existing ponton ferries is to be used in the construction and maintenance of the

bridge, a site downstream from the ferry favors the movement of this equipment.

l. Demolished bridge sites.—The ponton bridge should be located far enough away from a demolished bridge site so that there will be no interference with the reconstruction of the fixed bridge.

m. Tributary stream.—A site just below the mouth of a tributary stream favors launching boats and constructing parts or rafts in the tributary under cover and floating them down into position when needed.

61. Reconnaissance.—Reconnaissance must be made well in advance of construction, having in mind both tactical and technical requirements. If practicable, the tactical commander and the engineer, or their assistants, should make a joint reconnaissance to insure that all factors are considered on the ground. The engineer, or his assistant, must make a careful technical reconnaissance in any case. The following technical data should be obtained as far as the need for secrecy will permit.

a. Width of stream.—This must be obtained with sufficient accuracy to determine the amount of equipment to be used. A narrow stream can be measured by stretching a line across. Any stream can be measured by the use of a prismatic compass or pocket sextant, and a paced or taped base line, using the principle of similar triangles.

b. Velocity.—A satisfactory approximation can be made by timing the speed of a floating object over a short course. Eddies should be noted.

c. Depth.—Depth is of importance near the bank or near shoals to determine boat movements and the number of trestles needed. Sounding poles or lines are useful. The character of the bed and the necessity of snagging or dragging should be noted.

d. Banks.—The character and shape of the bank should be determined with sufficient accuracy to establish where the sills must be placed to avoid being submerged by high water, because this affects the amount of equipment needed.

e. Rise and fall below present water level.—These data can be obtained by noting drift and marks on trees or structures, by questioning local inhabitants and consulting tide tables and flood records.

f. Approaches.—The length should be paced off and an estimate prepared of the men, materials, and transportation needed for construction.

g. Tributary streams.—The location, approach and stream characteristics should be noted, if tributary streams are to be used for launching equipment.

h. Location of thalweg.—The thread of the current, or "thalweg," generally occupies a deep channel meandering from bank to bank and occupying relatively a small portion of the width of the stream bed. In planning the location and construction of any bridge, it is of prime importance to locate and delimit the thalweg since the force of its greater current has a preponderant effect upon the manuevering of pontons during construction as well as upon the stability of the completed structures.

SECTION VII

PREPARATION OF EQUIPAGE FOR USE

	Paragraph
General	62
Location of trailers	63
Location of unloaded equipment	64
Construction directly from trailers	65

62. General.—Construction of the bridge, after arrival of the equipment at the site, consists of three phases: The preparation of the site, the preparation of the equipage for use, and the actual construction of the bridge itself. In the general case, the first and second phases will be more time consuming and more demanding of careful organization and planning. In the training of bridge building troops, these phases of the work should not be neglected by confining erection practice to previously prepared and thoroughly familiar sites.

63. Location of trailers.—*a.* The trucks towing the trailers should be brought as far forward as the last available turnaround and there unhooked from the trailers. At this point the trailers should be hitched to light tractors, or they should be manhandled forward to the point where the bridge materials are to be stacked, or to the point where the pontons are to be unloaded and placed in the water. The pontons should be unloaded from the trailers and moored to the shore on the upstream or downstream side of the bridge, or on both sides of the bridge as current and other special conditions may indicate. The other bridge materials should be segregated and stacked as close to the near abutment as possible.

b. As the trailers are unloaded all clamping beams should be carefully replaced and secured. The trailers should then be moved clear of the traffic resulting from the bridge-building operation and the traffic which will use the completed bridge. It is best to move the trailers back to the trucks for removal to a position which is completely out of the way.

64. Location of unloaded equipment.—*a. Balk.*—Trestle balk are stacked separately from ponton balk. The two stacks are arranged to the left of the approach to the bridge, with the ponton balk nearer the river. Trestle balk are stacked by placing three balk on the ground about 6 feet apart and parallel to the river bank. Across and perpendicular to these three balk place a layer of balk nearly in contact, with their 4-inch faces vertical. Across this layer place three balk directly above the first three balk, then another layer of balk, etc. The ponton balk are stacked in a similar manner except that the first three balk are placed about 12 feet apart.

b. Chess.—The chess are placed on the right side of the approach to the bridge, as follows: 3 piles of 3 chess each are laid on the ground parallel to each other, about 4 feet apart; on these a course of 10 chess, nearly in contact; across these 10 more chess at right angles to the first layer, etc.

c. Anchors.—The anchors and anchor cables should be distributed to the pontons from which the anchors are to be cast. The officer, who is in charge of this particular phase of the preparation of the equipment work, should be thoroughly familiar with the schedule for the anchor sections and should arrange the pontons to facilitate embarkation of the anchor crews in pontons having the right number of anchors and anchor cables. Anchor cables in the pontons must be neatly coiled at all times.

d. Auxiliary equipment.—(1) Several ½-inch lashings will be required, their number and length depending upon the method chosen for the construction of the bridge. For each trestle to be erected in the bridge sixteen ½-inch lashings 20 feet long will be required. These are used to secure the trestle balk to the trestle transom. Two 60-foot ½-inch lashings must be provided for the use of the siderail section in maneuvering the river ponton of the hinge span raft until upstream and downstream anchor cables are delivered by the No. 1 anchor section. When outboard motors are used to cast anchors and distribute pontons, a 30-foot ½-inch lashing should be provided for each ponton to connect the upstream ends of adjacent pontons as they are delivered to the axis of the bridge. When an outboard motor is used, the pontons will usually be spotted before they are actually needed by the construction party at the head of the bridge. The lashings at the upstream ends are provided so that the pontons may be pulled in as needed.

(2) Trestle material should not be stacked but should be laid out on the ground in such a way that each part can be picked up as needed.

(3) The oars and oarlocks should be laid out conveniently near the point where the pontons are moored.

(4) If outboard motors are to be used, they should be placed on the power pontons, filled with fuel and checked before the command CONSTRUCT THE BRIDGE *is given.* This allows the outboard motors to be handled with the deliberation and care which are essential in order to prevent damage.

65. Construction directly from trailers.—*a.* The trailer loads of the equipage are designed to facilitate building the bridge directly from the trailers. This method will be used where no space is available near the abutment for stacking the material. The trailers are pulled in by hand or by tractor, the material unloaded and placed in the bridge, and the trailer returned to the parking place before the next trailer is brought to the abutment for unloading.

b. It may be convenient to build directly from the trailers because the bridge is situated on an extensive beach or because a road parallel to the shore line is available. In these cases trucks may approach the abutment in column and halt for unloading the material. The trailers can be left attached to the trucks, which pull them out of the way as soon as all clamping beans have been replaced and secured.

c. Building the bridge directly from the trailers requires a carefully planned organization and should be attempted only by troops who are thoroughly familiar with the method of building the bridge from stacked material.

SECTION VIII

CONSTRUCTION BY SUCCESSIVE PONTONS

	Paragraphs
Ponton drill	66
Personnel	67
Formation of sections	68
Sequence of events	69

66. Ponton drill.—For the purpose of prescribing a drill and setting up an organization therefor, the method of successive pontons with two trestles at each end of the bridge will be considered the normal procedure. The details of this drill should be followed as closely in actual service as circumstances will permit. As soon as the prescribed drill has been thoroughly mastered by an organization, the troops should be instructed in the method of parts along less formal lines. Methods of construction to fit special conditions will

present no great problem to any organization which has mastered the technique of the normal method of successive pontons.

67. Personnel.—The following table shows the minimum working party required for construction of a bridge with two trestles at each end of the bridge, one placed by the shallow water method and one by the deep water method, and pontons maneuvered by rowing. Fewer men may be successfully employed by eliminating certain sections and assigning their duties to other sections. Thus the balk carrier section may be eliminated and its duties assigned to the chess section. This procedure, however, retards the work and adds materially to the labor performed by the section. In the case of long bridges, in order to maintain the same speed of construction as is possible with the shorter bridges, personnel must be added to the balk carrier, chess, anchor, and siderail sections.

Name of section	Noncommissioned officers	Privates	Total
Abutment	1	8	9
Abutment span [1]	3	10	13
Balk fastener	1	8	9
Balk carrier	2	16	18
Chess	2	18	20
Anchor (4 sections) [2]	4	16	20
Siderail	1	8	9
Cable	1	4	5
Total	15	88	103

[1] If no shallow water trestle is to be erected, this section is omitted. An abutment span section should be organized for each shallow water trestle to be placed. Otherwise, the construction of the bridge will be delayed while one section erects the trestles successively.

[2] In currents up to 1 mile per hour the bridge can best be constructed by employing two anchor sections upstream and two anchor sections downstream of the bridge. In currents over 1 mile per hour three anchor sections of 7 oarsmen each, all operating upstream of the bridge, are required. When outboard motors are used, one section made up of 1 noncommissioned officer and 12 oarsmen will suffice.

68. Formation of sections.—When the bridge is to be constructed as a drill, the sections are formed in double rank, in line, with three paces between sections and section chiefs in front of their sections. When two or more noncommissioned officers are with a section, the senior takes his post as section chief and the others take post in the line of file closers behind the section.

69. Sequence of events.—The actual construction of the bridge commences at the command CONSTRUCT THE BRIDGE given by the senior officer present. The operation should normally proceed without further command, the section chiefs keeping close watch upon the progress of the work and seeing that their sections are on hand at the instant they are required. The chronological sequence of events is shown in the following table. This table is made up to cover the construction of the bridge under the following special conditions:

Method of successive pontons.
Two trestles at each end, one of which is placed by the shallow water method and the other by the deep water method.
Twelve pontons in the floating portion of the bridge.
Pontons propelled by rowing instead of outboard motors.
Current in excess of 1 mile per hour.

Such a table gives the various sections a clear picture of the order in which their tasks are to be undertaken. A modified table to fit special conditions should be made up and published before training is started, or made up as part of the plan to construct a bridge at any given location.

SECTION IX

DUTIES OF SECTIONS

	Paragraph
Officers	70
Abutment	71
Abutment span	72
Balk fastener	73
Balk carrier	74
Chess	75
Anchor	76
Siderail	77
Cable	78

70. Officers.—*a. Senior officer.*—The senior officer supervises the entire bridge building operation. Prior to the start of construction he sets conspicuous range poles which will mark the center line of the bridge. These are placed well clear of the lines of traffic which will result from the bridge building operation. They should be exactly vertical and placed so as to be visible from all parts of the completed bridge. The senior officer will also select the location of the lines of upstream and downstream anchors, and cause them to be marked.

b. Junior officers.—(1) One officer locates the near abutment and supervises the construction of the near shore connection to include

chess and secure with two stakes. Start filling and tamping. Two men place trestle balk used to assemble shallow water trestle as Nos. 1 and 8 of abutment span when required by noncommissioned officer in charge of abutment span section.	of shallow water trestle as Nos. 1 and 8 of the abutment span to locate the trestle longitudinally. Adjusts position of shoes until trestle is centered and columns are vertical. Noncommissioned officer in charge calls for balk Nos. 2, 3, 4, 5, 6, and 7 and supervises placing by balk carriers. Two men on each of the two guy lines extending riverward continue to steady trestle until all abutment span balk are in place.		

both trestles. As soon as his work on the near shore is completed, he takes charge of work on the far shore connection to include the hinge span and hinge span raft.

(2) One officer is assigned to the construction of the near shore hinge span raft and the floating portion of the bridge. He supervises the work of all sections while they are on the bridge after the near shore connection has been completed.

(3) Another officer is assigned to supervise the work of the anchor sections.

71. Abutment.—*a. General.*—This section installs the abutment sill, does minor grading on the immediate approach to the bridge and assists the abutment span section in the erection of such trestles as are erected by the shallow water method. This section will normally require the following:

1 abutment sill.
12 pickets.
1 chess.
2 mauls or sledges.
1 tape, metallic, or a light rope lashing.
4 picks.
4 shovels.

b. Placing of abutment sill.—At the command CONSTRUCT THE BRIDGE the section carries its equipment to the site of the abutment. The sill is embedded in the ground, approximately horizontal, perpendicular to the axis of the bridge, with its center on the center line of the bridge and with its narrow faces vertical. Eight pickets are then driven along the river side of the sill, one near each end and the other six evenly spaced along the sill. Two pickets usually will be sufficient on the shore side of the sill. As soon as the sill is staked in place and the balk which are to rest on top of the sill are in position, a chess is placed on its edge against the ends of the balk so that its upper edge will be flush with the top surface of the chess of the abutment span. This chess forms the end dam (fig. 33). The chess is held against the balk by means of two pickets driven near the ends of the chess. After the balk and the end dam chess are placed, the sill is further secured in place by back filling and thoroughly tamping all around it. It is desirable to disturb as little of the adjacent soil as possible while installing the sill.

c. Squaring and centering of abutment sill.—Two light stakes or rack sticks are driven on the center line of the bridge, one at the location of the sill and the other about 20 feet shoreward of the first. The sill is then laid near its final position with the center of

one vertical face against the river stake. By means of a tape or light rope lashing the distances from the shore stake to the ends of the sill are measured. The sill is perpendicular to the axis of the bridge when its center is on the center line of the bridge and these two distances are equal. As soon as the sill is centered and

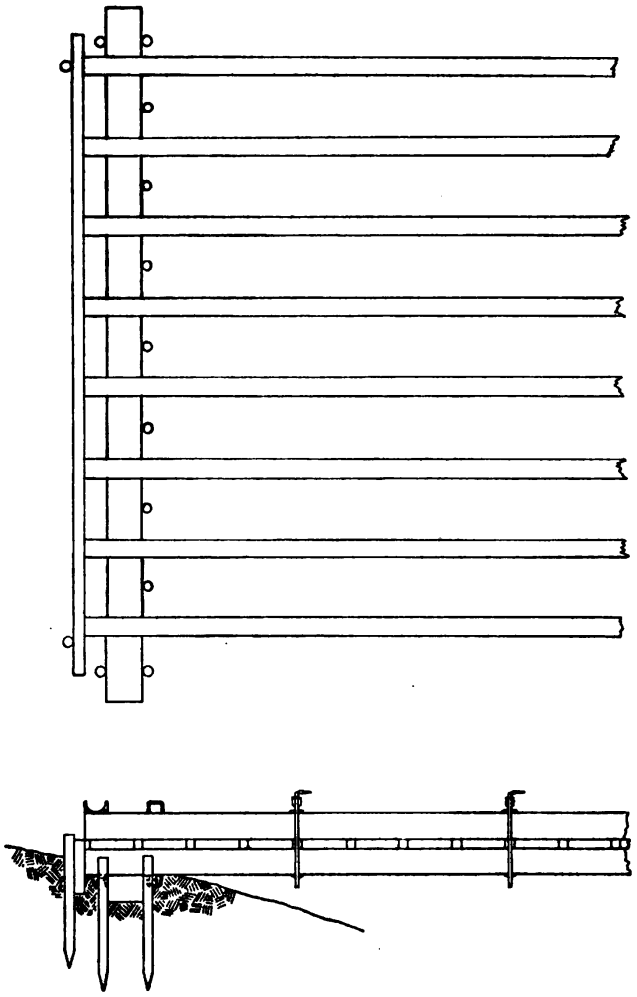


FIGURE 33.—Abutment, with trestle balk resting on sill and chess used as end dam.

squared as indicated, its outline should be marked on the ground as a guide in excavation.

d. Further duties.—Upon completion of the installation of the abutment sill the section stands by to assist the abutment span section as directed in erecting the shore trestle when it is placed by the shallow water method.

72. Abutment span.—*a. General.*—(1) The abutment span section erects all the trestles of the shore connections including the

actual placing of trestles erected by the deep water method. The section chief, under the officer in charge of the shore connections, is in immediate charge of the erection of all trestles.

(2) When more than one trestle is to be erected by the shallow water method, an abutment span section must be organized for each trestle or the construction of the bridge will be delayed. With water of sufficient depth adjacent to the bank, only one trestle will be required which can be erected by the deep water method. In this case, the abutment span section is eliminated and the erection of the trestle is handled by the balk fastener section, assisted by the abutment section, the cable section, and the siderail section.

(3) The section will normally require the following material:

1 trestle to be erected in shallow water.
2 chain hoists for each trestle of the near shore connection.
2 trestle balk for assembling the shallow water trestle.
10 windlass sticks (steel tubing) to be used as ladder rungs in attaching chain hoists.

At the command CONSTRUCT THE BRIDGE the abutment span section carries its equipment to a position near the abutment and erects the shallow water trestle.

b. Assembly of trestle—shallow water method.—(1) Two trestle balk are laid in the shallow water, one on top of the other, parallel to the river bank and as near the final position of the trestle as possible. The shallow water trestle must be assembled far enough from its final position in the bridge to avoid interference with the work of placing the abutment sill.

(2) The trestle transom is laid on its side on top of the two trestle balk on the riverward side, and the trestle is assembled with the transom in this position. (See fig. 34.)

(3) The trestle columns are inserted in the transom and secured with the trestle pins. In general, the lowest practicable set of holes in the column should be used, allowing for a difference in the elevation of the footings on which the column shoes are to rest. The column for the low footing should extend through the trestle transom by a greater distance so that the transom will be approximately level when the trestle is placed in its final position.

(4) The shoes are then attached to the foot of the columns. One of the hooks chained to the shoe should be secured in the eye at the bottom of the column. The other should be secured in the bottom pair of the column holes as soon as they are cleared by raising the transom to its final position. (See fig. 22.) Three-fourths-inch

lines should be attached to the shoes so that they can be anchored to holdfasts.

c. Erection of trestle—shallow water method.—(1) As soon as the trestle is assembled, the cable section delivers two ½-inch lines about 60 feet long. The cable section makes these two lines fast, by clove hitches at their middle points, to the spools at the tops of the trestle columns. The four 30-foot lines thus made available are used to steady the trestle after it has been raised to an upright position and during the process of manhandling it into its final location. The two lines which extend shoreward are handled by the cable section, two men to each line. The two lines which extend toward the river are

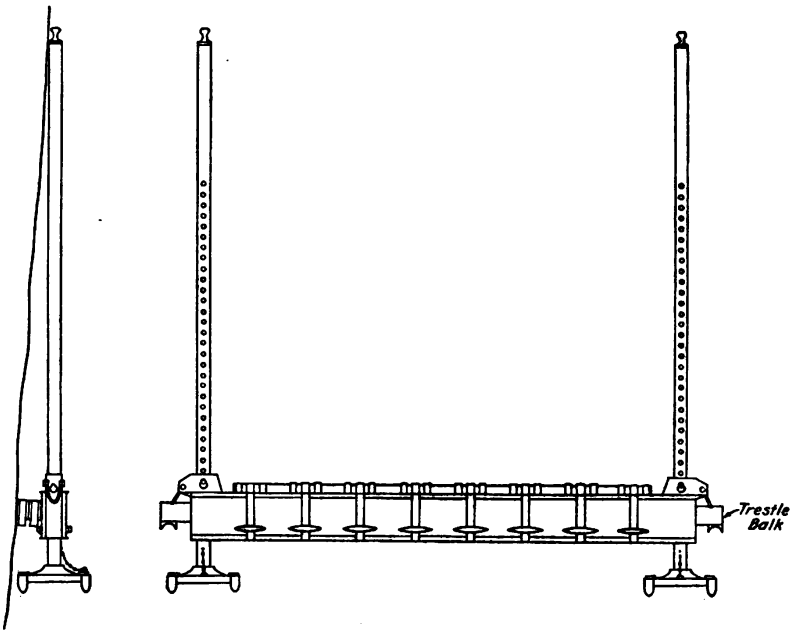


FIGURE 34.—Assembly of trestle.

handled by four men of the abutment span section in the same manner. These lines are not required after the trestle balk have been placed in position.

(2) As soon as the abutment sill is properly imbedded and the seats for the trestle shoes prepared, the trestle is raised to a vertical position and manhandled to its approximate position in the bridge. The trestle is spaced at the proper distance from the abutment sill by placing balk Nos. 1 and 8 in position. Balk are numbered from 1 to 8 from the upstream to the downstream side of the bridge. The trestle is moved by hand until the two spacing balk are seated at both ends. The other six balk required for the span are then delivered and placed by the balk carriers as directed by the noncommissioned officer in charge of the abutment span section.

(3) When the trestles are in their final position and secured by all eight balk, the chain hoists are suspended from the top of the trestle columns. Steel windlass sticks are placed through holes in the trestle columns to form ladder rungs to reach the top of the columns.

d. Erection of trestle—Deep water method.—After erecting the shallow water trestle, the abutment span section takes charge of the hinge span raft upon which the deep water trestle has been floated to the centerline of the bridge. During the erection of the deep water trestle, the balk fastener section, the abutment section, the siderail section, and the cable section are under the control of the noncommissioned officer in charge of the abutment span section. The deep water trestle is plumbed and steadied with light hand lines to the column tops and spaced with balk Nos. 1 and 8. These two balk are delivered and placed by four wading men of the balk carrier section as directed by the noncommissioned officer in charge of the abutment span section. The light lines which extend shoreward are handled by four men of the cable section while those which extend riverward are handled by four men of the balk fastener section. As soon as the center of the transom is on the centerline of the bridge, the columns are dropped. (See figs. 35 and 36.) Balk Nos. 2, 3, 4, 5, 6, and 7 are delivered and placed by the balk carrier section as directed.

e. Far shore duties.—After erecting all the near shore trestles, the abutment span section reports to the officer in charge of the shore connection for instructions concerning similar work on the far shore.

73. Balk fastener.—*a. General.*—(1) The balk fastener section constructs the raft which is to become the first floating bay of the bridge and on which the hinge sill is placed. When a trestle is to be erected by the deep water method, the balk fastener section assembles the trestle on this raft and assists the abutment span section in placing the trestle in the bridge. It places and secures all balk in the ponton spans and the hinge span on the near shore.

(2) The chief of the balk fastener section, under the supervision of the officer in charge of the construction of the floating portion of the bridge, is in direct charge of this construction.

b. Assembly of hinge span raft.—(1) At the command CONSTRUCT THE BRIDGE, the section, assisted by the siderail section, secures two pontons. One of these pontons is held against and parallel to the shore by two men of the siderail section, and the other is held alongside the shore ponton by two other men of the siderail section. Two light shore lines to the river ponton, one upstream and one downstream, are procured, made fast, and handled by the other four men

of the siderail section. The two pontons are usually spotted near and upstream from the abutment. The front rank of the balk fastener section enters the river ponton and the rear rank enters the shore ponton.

(2) The rear rank fasteners in the shore ponton receive the river ends of balk Nos. 1, 3, 5, 6, and 8 from the balk carriers and hand them

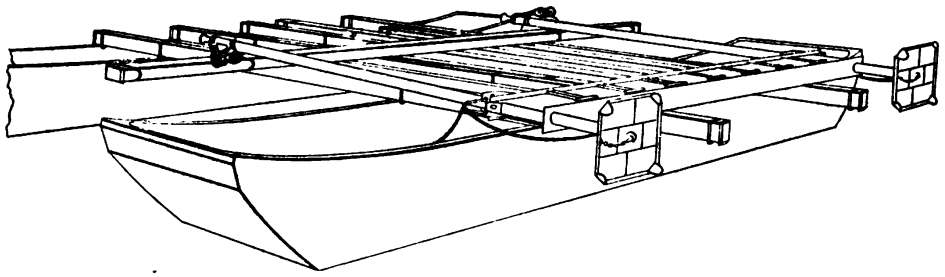


FIGURE 35.—Erection of trestle, deep water method, first step.

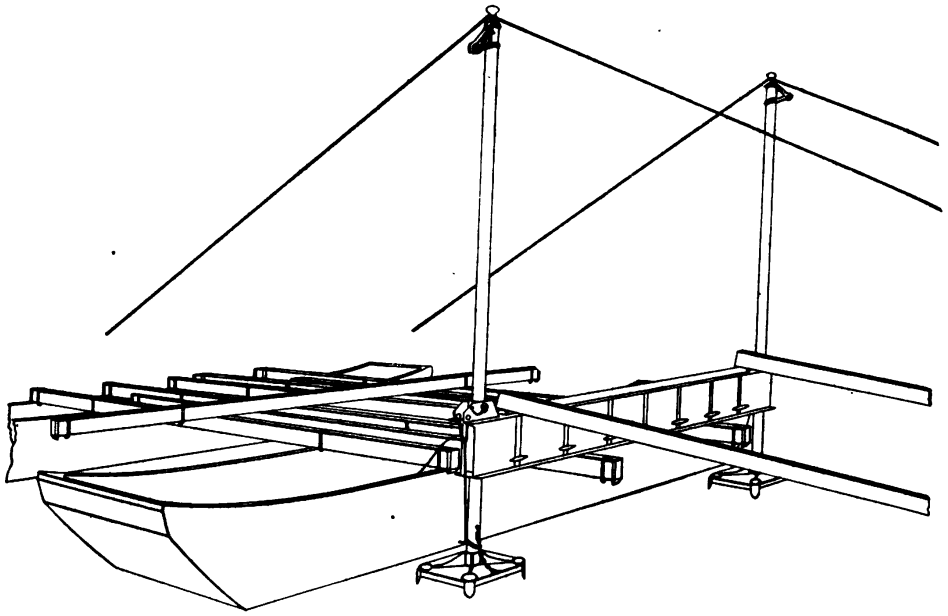


FIGURE 36.—Erection of trestle, deep water method, second step.

over to the front rank fasteners in the river ponton, who engage the ends of the balk at their proper places on the river gunwale, engage and partially tighten the balk fasteners. The fasteners at the shore gunwale of the river ponton are not engaged at this time.

(3) At the command SHOVE OFF, given by the chief of the balk-fastener section, the river ponton is pushed out into the stream until the shore ends of the balk may be engaged at their proper places on

the shore gunwale of the shore ponton. The balk carriers shove off the ponton by pushing on their ends of the balk. During the shoving off of the river ponton and thereafter during the construction of the raft, the river ponton is kept on line and maneuvered by the siderail section by means of the temporary shore lines attached to the upstream and downstream ends of the river ponton. The shore ponton is held to the shore by hand. As soon as upstream and downstream anchor lines are delivered by the anchor section, the light shore lines are coiled and turned over to the noncommissioned officer in charge of the balk fasteners.

(4) As soon as the shore ends of the balk are engaged at the proper places on the shore gunwale of the shore ponton and the pontons properly alined, all balk fasteners are applied and tightened.

(5) Next, the remaining balk are received from the balk carriers, placed and fastened in their proper places if the raft is not to be used for launching a deep water trestle. If the raft is to be employed in the erection of a deep water trestle, balk No. 4 is placed on top of and perpendicular to the odd-numbered balk midway between the pontons, and balk Nos. 2 and 7 are extended shoreward by about 5 feet and the river ends fastened at the shore gunwale of the river ponton. (See figs. 35 and 36.)

(6) The balk fastener section receives from the balk carrier section the hinge sill and the hinge sill hangers. The hinge sill is placed between the two pontons 1 foot clear of the river gunwale of the shore ponton, and is attached and made fast to balk Nos. 1 and 8. The other hinge sill hangers are laid aside, but the hangers are applied to balk Nos. 3, 5, and 6 by the balk fasteners in the shore ponton while the raft is being moved to its position in the bridge by the siderail section. After the transom of the trestle is raised clear of the hinge span raft, balk Nos. 2, 4, and 7 are placed and secured in the raft, and attached to the hinge sill by the hangers.

c. Assembly of trestle.—To assemble the deep water trestle, the trestle transom is placed on its side on the two projecting balk Nos. 2 and 7, parallel to the ponton, with its bottom toward shore and its top directly over the shore gunwale of the shore ponton. The trestle columns are then handed onto the raft with their upper ends riverward and are run through the wells in the ends of the transom so that about 2 feet of the trestle columns project shoreward beyond the bottom of the transom. The upper portions of the columns rest on balk No. 4 which was placed across the other balk of the raft. The trestle shoes are assembled to the columns and secured in place with the hooks chained to the shoes. Three-fourths-inch lines

should be attached to the shoes so they can be anchored to prevent slipping on the stream bottom. The two 60-foot ½-inch lines used by the siderail section to maneuver the river ponton are made fast, by clove hitches at their middle points, to the column tops. The four 30-foot lines made available are used to steady the trestle as it is placed in its final position. The two lines extending shoreward are handled by the cable section and the two extending to the river ponton of the raft are handled by the front rank balk fasteners in the river ponton. (See fig. 36.)

d. Movement of hinge span raft.—When the raft has been constructed and equipped as above, it is moved to the axis of the bridge, close to the shallow water trestle. This is accomplished by four men of the siderail section, who manipulate the upstream and downstream anchor lines which have been made available by the first anchor section. Some poling may be necessary to keep the raft clear of shallow water near the shore. Poling should be done by designated members of the balk fastener section and the four other men of the siderail section. However, where conditions permit, four wading men of the siderail section should push the raft clear of the shore obstructions instead of poling it.

e. Erection of trestle and completion of trestle span.—(1) The raft is turned over to the chief of the abutment span section who proceeds to erect the trestles. Four men of the siderail section from positions in the ends of the river ponton keep the raft near the center line of the bridge by proper handling of the up and down stream anchor lines during the erection and placing of the deep water trestle. They are assisted by four other men of the same section who wade alongside the shore gunwale of the shore ponton. When the water is too deep for this procedure, these four men assist by poling from the shore ponton. The cable section manipulates the two light lines, attached to the tops of the trestle columns, which extend shoreward. Four men of the balk fastener section from positions in the river ponton of the raft handle the two light lines which extend riverward from the tops of the columns. These light lines to the tops of the columns are used to keep the trestle steady and vertical as it is placed in its final position. The deep water trestle is spaced from the shallow water trestle by balk Nos. 1 and 8 which are delivered and placed in position by four wading men of the balk carrier section when required by the noncommissioned officer in charge of the abutment span section. As soon as the trestle is in a vertical position and properly spaced by balk Nos. 1 and 8, the raft is maneuvered until the center of the transom is on the center line of

the bridge. When the noncommissioned officer in charge of the abutment span section is satisfied with the centering of the trestle, he orders the dropping of the trestle columns.

(2) As soon as the deep water trestle is erected and secured by all balk, the chain hoists are installed and the trestle transom raised clear, the abutment span section and the siderail section go ashore and the raft is left to the control of the chief of the balk fastener section. The cable section boards the raft and takes over the duties at the anchor cables which were previously performed by the side-rail section.

f. Completion of hinge span.—After placing balk Nos. 2, 4, and 7 of the hinge span raft in their final position and installing hinge sill hangers on these balk, the balk fastener section installs the balk of the hinge span. Odd numbered balk are brought out by the balk carriers who hand the river ends to the balk fasteners. The balk fasteners engage the balk in the proper places over the hinge sill. At the command SHOVE OFF each pair of balk carriers shoves off the raft by pushing on the shore end of their balk until it engages on the trestle transom. The raft is alined on the axis of the bridge by means of its anchor cables. The remaining balk are brought up and slid out to the hinge sill on the balk that have been installed. The raft is checked for alinement and the upstream anchor cable is made fast.

g. Remaining floating spans.—When the hinge span and hinge span raft have been floored with chess to within 1 foot of the shore gunwale of the river ponton and ponton No. 3 is alongside the river ponton of the hinge span raft, the rear rank of the balk fastener section enters ponton No. 3. The odd numbered ponton balk are now brought out by the balk carriers who pass the river ends to the rear rank fasteners. The odd numbered balk are secured loosely at the river gunwale of ponton No. 3 only, and the ponton is pushed off as in constructing the hinge span raft. The balk fastener section chief directs the cable men to move ponton No. 3 up or down stream to a position which facilitates fastening the odd numbered balk securely at the four gunwales of pontons Nos. 2 and 3 regardless of whether or not the hinge span raft is exactly on line. The alinement of the completed portion of the bridge is a duty of the cable section who effect adjustments subsequently. The even numbered balk are then placed and secured at all four gunwales. The front rank balk fasteners now cross on the balk, holding on to each others shoulders, to ponton No. 4. The rear rank balk fasteners remain in ponton No. 3. The foregoing procedure is followed successively as each floating span is added to the bridge.

74. Balk carrier.—*a. General.*—(1) This section delivers to the balk fastener section the balk, hinge sill, and hinge sill hangers necessary in assembling the hinge span raft, and then delivers the balk for each span of the bridge to the section engaged in its construction.

(2) The section is organized into eight pairs of balk carriers numbered consecutively from 1 to 8. In addition to supervising the work of the whole section, the section chief controls the work of the odd numbered balk carriers while the other noncommissioned officer of the section takes charge of the even numbered carriers.

(3) At the command CONSTRUCT THE BRIDGE the section carries the following, in the order stated, to the site of the construction of the hinge span raft where the materials are delivered to the balk fastener section:

8 ponton balk.
8 hinge sill hangers.
1 hinge sill.

(4) After delivering the above materials to the balk fastener section, each noncommissioned officer stands by with his carriers, ready to carry out and deliver to the sections concerned, when required, the balk for each bay of bridge. For each bay the odd numbered balk are carried out first, followed at the proper time by the even numbered balk.

b. Carrying of balk.—To carry out the balk, the balk are laid abreast on the ground 2 or 3 feet apart. The two carriers of each numbered pair take their places at their balk, one man at each end. At the proper time in order for the balk to arrive on the bridge when required, the section chief commands: ODD NUMBERS, LAY HOLD; RAISE; SHOULDER; FORWARD, MARCH. The carriers concerned raise their balk and place them on their shoulders, those in the front on the right shoulder, the others on the left, and then move on in line to the head of the bridge where the noncommissioned officer commands HALT, LOWER. At this command the leading carriers pass their ends of the balk to the personnel who are to use the balk and step back to assist the rear carriers in handling the rear ends of the balk.

c. Delivery of balk.—(1) After delivering the balk to the balk fastener section for the construction of the ponton spans, the odd numbered balk carriers shove off the ponton at the command SHOVE OFF, given by the chief of the balk fastener section, by pushing on the shore ends of the balk. The even numbered balk carriers deliver their balk by sliding them out on adjacent odd numbered balk already in place.

(2) After delivering the balk, the balk carriers are marched off the bridge in single file, keeping to the extreme right of the roadway. After reaching the shore, they procure from the stack and lay out on the ground the next eight balk to be used, and stand by.

75. Chess.—*a. General.*—The chess section, consisting of 2 noncommissioned officers, 2 chess layers, and 16 carriers, delivers trestle parts to the hinge span raft, carries and lays the chess with which the bridge is floored. The senior noncommissioned officer is the section chief who is assisted by the other noncommissioned officer of the section.

b. Carrying of chess.—At the command CONSTRUCT THE BRIDGE the section chief forms his section prepared to secure the chess from the stack when needed. At the proper time, the junior noncommissioned officer takes post at the stack and raises one end of each chess to assist the chess carriers in laying hold of the chess as they pass in single file with the stack on their right. The senior noncommissioned officer anticipates the call for chess and directs the timely distribution of the chess to the carriers, who then stand by prepared to move out promptly at command. The chess carrier carries the chess under the right arm, the forward end well up and steadied by the left hand placed on top of the chess. The section, led by the two chess layers without chess, is marched in single file on the right hand side to the head of the bridge where the chess are to be laid.

c. Delivery and laying of chess.—The chess layers place themselves, facing toward the near shore on the bay to be covered, one on balk Nos. 2 and 3 and the other on balk Nos. 6 and 7. They receive the chess from the carriers and place them on the balk, shoving each chess hard against the preceding chess. The center line of the bridge is on alternate upstream and downstream edges of balk No. 4. The center score mark of the chess is laid directly over that edge of balk No. 4 which is on the center line of the bridge. This will keep the chess in proper alinement. Attempting to aline the chess by sighting back on the score marks inevitably will result in loss of alinement with respect to the center line of the bridge. Each chess carrier delivers his chess to the chess layers and moves off the bridge keeping well to the right of the roadway. The chess of each bay are laid to within one chess width of the shore gunwale of each boat or of the trestle transom, as the case may be. As soon as each bay is completed, the chess layers clear the bridge on the run, and are ready with chess when the call is again made.

76. Anchor.—*a. General.*—(1) The anchor sections cast anchors which serve to hold the floating portion of the bridge in the stream and to maneuver the pontons to the point where construction of the bridge is under way and where they are turned over to the cable section. Anchors are cast from pontons which may be propelled by oars or by outboard motors. Care must be exercised to prevent puncturing the pontons with the anchors as they are cast.

(2) The organization of the anchor sections and the method of placing the anchors and maneuvering the pontons to their positions in the bridge will vary with local conditions, particularly with the velocity of the current. In general, three different methods to meet most efficiently the following conditions may be employed:

(*a*) With oars in currents not over 1 mile per hour.

(*b*) With oars in currents exceeding 1 and not more than 3 miles per hour.

(*c*) When outboard motors are used.

b. In currents not over 1 mile per hour (par. 56*e*).—(1) Two upstream and two downstream anchor sections are employed when the current does not exceed 1 mile per hour. Each section consists of the section chief, who handles the steering oar, and four oarsmen. The upstream anchor sections drop anchors and operate upstream of the axis of the bridge. The others drop anchors and operate downstream of the bridge. The upstream anchor sections are numbered 1 and 2, respectively, and the downstream sections are similarly designated. Upstream anchors are required for the river ponton of the hinge span raft, ponton No. 3, and every other ponton thereafter. Downstream anchors are required for the river ponton of the hinge span raft, ponton No. 5, and every fourth ponton thereafter. A downstream anchor line is used for maneuvering several pontons by passing it forward as the bridge is built. After a downstream anchor line has served its purpose as a line for controlling pontons while they are being placed in the bridge, it is made fast to the ponton for which its anchor was cast. Downstream anchor lines should invariably be made fast to pontons which have upstream anchor lines in order to prevent torque on the axis of the bridge.

(2) At the command CONSTRUCT THE BRIDGE each anchor section procures five oars, five oarlocks, and one boathook, and embarks. On its first trip only the first upstream anchor section provides its ponton with two anchors and two anchor cables instead of one, and proceeds to the line of upstream anchors where it casts both of its anchors, No. 1 over the right and No. 2 over the left gunwale. The ponton is then rowed to the point where the hinge span raft is under

construction along the shore. The cable of the shore anchor just cast is transferred to the members of the siderail section who are in the upstream end of the river ponton of the hinge span raft, and this anchor is used to maneuver the hinge span raft and finally is made fast to the river ponton No. 2 of the hinge span raft. The anchor section then drops downstream to the axis of the bridge and rides on the other anchor cast ready to turn over the ponton when it is required as the third ponton in the bridge. Anchor No. 2 is used to maneuver pontons Nos. 3 and 4 and finally is made fast to No. 3.

(3) The first downstream anchor section proceeds to the line of downstream anchors, casts downstream anchor No. 1, rows upstream, and transfers the cable to the members of the siderail section who are in the downstream end of the river ponton of the hinge span raft. This downstream anchor is used to maneuver the hinge span raft, the third, fourth and fifth pontons in the bridge, and finally is made fast to the river ponton of the hinge span raft No. 2. The section then stands by to put its ponton in the bridge as No. 4, by holding ponton No. 4 against ponton No. 3.

(4) The second upstream ponton proceeds to the line of upstream anchors, casts its anchor and drop its ponton downstream to the axis of the bridge at the proper time to place it as No. 5. This anchor is used to maneuver pontons Nos. 5 and 6 and finally is made fast to No. 5.

(5) The second downstream anchor section casts downstream anchor No. 2 and all downstream anchors thereafter. Downstream anchor No. 2 is used to maneuver pontons Nos. 6, 7, 8, and 9 and is finally made fast to ponton No. 5. The downstream anchor section No. 2 after casting downstream anchor No. 2 delivers ponton No. 6 to the center line of the bridge and rides at anchor holding ponton No. 6 against ponton No. 5.

(6) The casting and use of the other anchors proceeds similarly for the remainder of the bridge. As the pontons are taken over by the cable section, the anchor sections go ashore and embark in their next ponton. (See fig. 37.) This shows which sections drop the various anchors and place the various pontons to include ponton No. 10. The order indicated is repeated until the bridge is joined with the far shore connection.

c. In currents exceeding 1 mile per hour.—(1) Three anchor sections are employed in currents which exceed 1 mile per hour. Each section consists of a chief of section who acts as steersman and six oarsmen.

(2) Where currents exceed 1 mile per hour an upstream anchor is generally required for each ponton of the bridge. A downstream

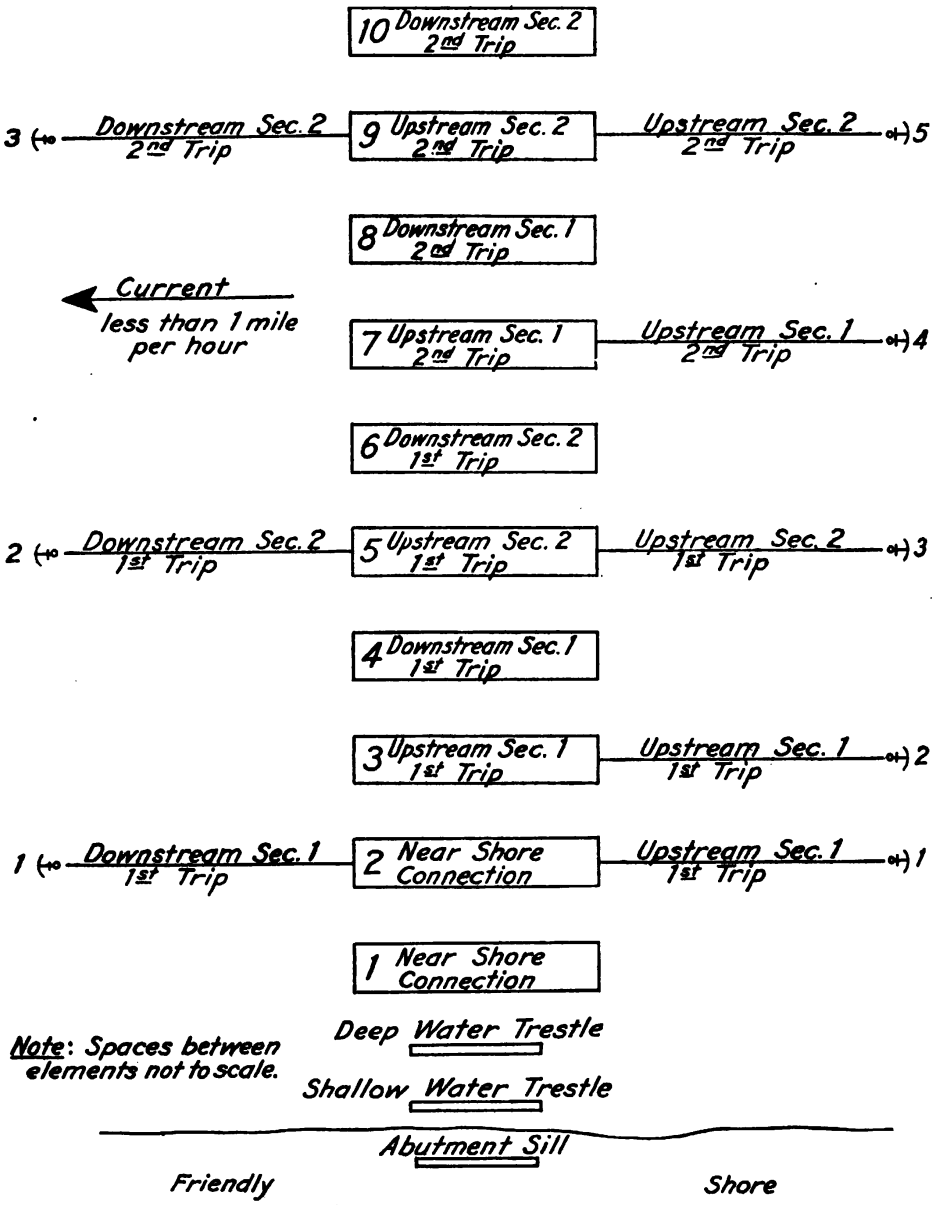


FIGURE 37.—Casting anchors—duties of various anchor sections.

anchor is provided for the second ponton in the bridge and for every fourth ponton thereafter. See figure 38 for final arangement.

(3) Because of the difficulty of rowing upstream against appreciable currents, each anchor section leaves the shore near the line of upstream anchors, preferably upstream of the latter, and casts its anchor as soon as the ponton is over the proper location of the anchor on the line of upstream anchors. All subsequent movements of the

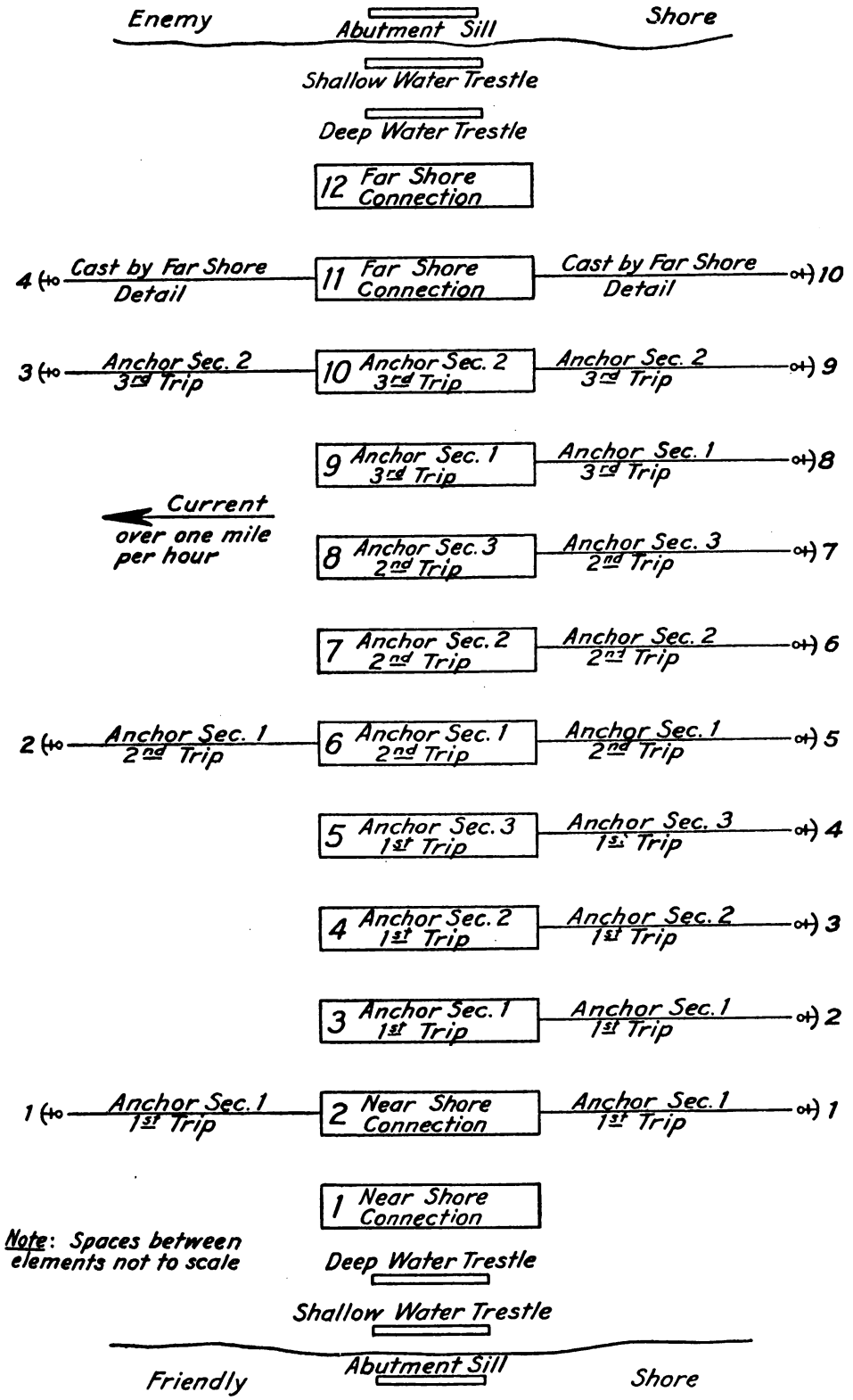


FIGURE 38.—Arrangement of anchors in currents exceeding 1 mile per hour.

ponton can be controlled by the anchor cables, but oars are used to accelerate the downstream movement of the ponton.

(4) The ponton which must cast a downstream anchor casts an upstream anchor as above and then drops down in the current on the upstream anchor cable to the location of the anchor on the line of downstream anchors. This operation may be expedited by using the oars in dropping downstream. If the upstream anchor cable is not long enough to reach the line of downstream anchors, the free end of the downstream anchor line is hitched to the free end of the upstream anchor line to allow the ponton to drop farther downstream. After the downstream anchor is cast, the ponton is pulled upstream to the bridge by means of the upstream anchor cable, the downstream cable being payed out as the ponton moves upstream.

(5) The first anchor section casts two anchors upstream, the first for the river ponton of the hinge span raft which is the second ponton in the bridge and one for its own ponton which is the third ponton in the bridge. The section then rows to the point where the hinge span raft is under construction and delivers the line of anchor No. 1 to the men of the siderail section who are in the upstream end of the river ponton. It then drops downstream to cast the downstream anchor for the hinge span raft and pulls itself up to the river ponton of the hinge span raft. The downstream anchor cable is turned over to the siderail lashers in the downstream end of the river ponton of the hinge span raft. The section then lightly lashes its ponton to the hinge span and moves with it to the axis of the bridge where it stands by, riding on its own upstream anchor cable until the ponton is required in the bridge. As soon as the ponton is taken over by the cable men, the anchor section goes ashore in single file, keeping to the right. The section then procures another ponton, casts an anchor or anchors (see fig. 38), and places the ponton in the bridge when required.

(6) The other two anchor sections proceed in a similar manner, casting anchors and placing pontons as shown in figure 38.

d. When outboard motors are used.—(1) Anchors can be cast more rapidly under all conditions and with the use of less personnel by using pontons powered by outboard motors. The advantage gained in using the motors increases with the current, especially when the current exceeds 2 miles per hour. In currents in excess of 3 miles per hour the use of motors is mandatory. Except in the swiftest currents or very wide streams, one power ponton is sufficient to cast anchors and can place pontons faster than the construction party on the bridge can effectively utilize them. Nevertheless, two power pontons should be provided, one being kept in reserve in case of a motor failure on the other. Both motors are attached to their pon-

tons and made ready for operation prior to the start of the drill. The reserve power ponton is moored along shore at some suitable place with an outboard motor operator on duty prepared to get under way promptly in the event of a motor failure on the power ponton at work. The reserve power ponton is under the control of the officer in charge of the far shore connection.

(2) The anchor section required for one power ponton consists of a chief of section, one outboard motor operator, two anchor men for the power ponton, and two anchor men to cast anchors and maneuver pontons for each ponton towed by the power ponton and from which an anchor will be cast. Normally a power ponton maneuvers a tow of four pontons. The section also includes the outboard motor operator for the reserve power ponton.

(3) When outboard motors are used for placing pontons and casting anchors, it is preferable to have all pontons moored initially downstream of the bridge. This eliminates the possibility of a ponton tow drifting down into that part of the bridge which has already been constructed in the event of motor failure.

(4) On the first trip the power ponton does not tow any other pontons but casts an upstream and a downstream anchor for the second ponton in the bridge, the river ponton of the hinge span raft. The cables of these anchors are delivered to the hinge span raft as promptly as possible.

(5) The power ponton can raft four pontons and thus cast four upstream anchors on each trip. The four pontons are rafted two abreast on each side of the power ponton with the stern anchor cable cleats of the pontons in tow abreast of the bow anchor cable cleats of the power ponton. The details of this arrangement are shown in figure 39. Two men are posted in the upstream end of each of the four pontons in tow to cast the anchors and afterward to maneuver the pontons to their proper places in the bridge. The tow proceeds upstream to a point on the line of upstream anchors opposite the middle of the portion of the bridge to be occupied by the four pontons of the raft. All four anchors are cast simultaneously at the command of the chief of the section. The anchor is cast from the ponton on the extreme left as far to the left as possible and as far to the right as possible from the right ponton. The anchors from the two middle pontons are cast directly over their upstream ends. Then the power ponton casts off from the tow and proceeds to the downstream line of anchors where one anchor is cast from it opposite the middle point of the four pontons of that tow when placed in the bridge. The four pontons of the tow, from

which upstream anchors were cast, drift downstream to the center line of the bridge, being controlled by the manipulation of the anchor cables by the two men in each ponton. The power ponton delivers the downstream anchor cable to the shore ponton of the tow as soon as it arrives on the centerline of the bridge.

(6) When there is no current, when the current is sluggish, or when there is a strong wind from the downstream direction, difficulty will be experienced in drifting the pontons into position from the line of upstream anchors. Under these conditions the tow should

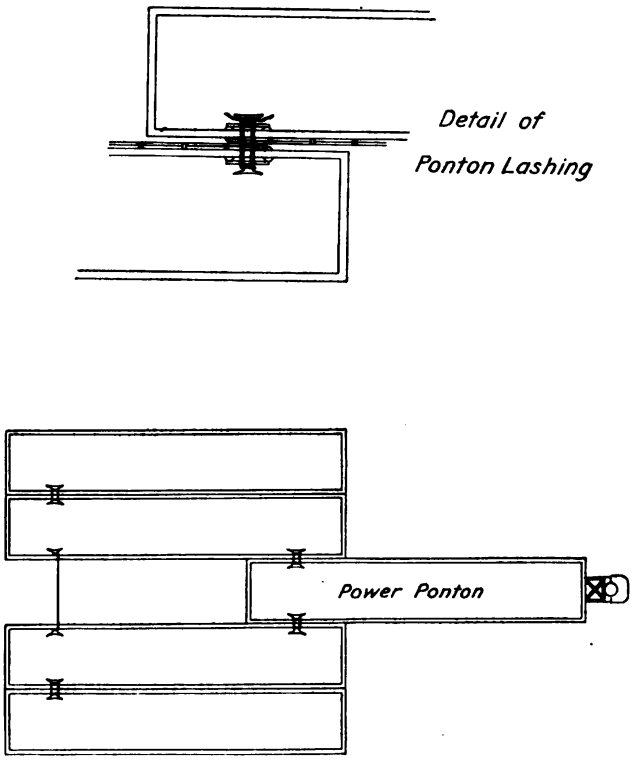


FIGURE 39.—Arrangement for rafting four pontons with one power ponton.

proceed to a point upstream of the line of upstream anchors, turn, and head downstream. The anchor crews should be stationed in the stern of the pontons which are in tow and cast the anchors, at command, as the tow crosses the line of upstream anchors. The power ponton then pushes the tow into its position on the center line of the bridge. The power ponton then casts off from the tow, casts the downstream anchor, and brings the anchor cable to the shore ponton of the tow.

(7) As each group of four pontons arrives on the axis of the bridge, adjacent pontons are lashed together at their upstream ends

with ½-inch lines 30 feet long leaving as much slack as possible between pontons. The shore ponton of each group of four is tied similarly to the river ponton in the previous group of four. These lines are for the use of the cable men in the upstream end of the last ponton in the bridge for pulling each ponton to the head of the bridge as it is needed. The generous length of these light lines provides plenty of slack which allows the pontons to be pulled in one at a time.

(8) As soon as each group of four pontons is secured as above, the power ponton picks up the eight anchor men. The section then makes fast to another tow of four pontons and provides the power ponton with the necessary downstream anchor.

77. Siderail.—*a. General.*—(1) The section assists during the construction of the hinge span raft and during the installation of trestles by the deep water method, lashes all trestle balk to the trestles, and carries out, lays, and fastens the siderails for each bay of the bridge.

(2) The section is organized into a section chief, four siderail carriers and four fasteners. Two carriers and two fasteners are assigned to work on the upstream side of the bridge and the remainder of the section works on the downstream side.

b. Assembly and movement of hinge span raft.—At the command CONSTRUCT THE BRIDGE, the section proceeds to the site for the construction of the hinge span raft. Two carriers of the siderail section hold the shore ponton of the raft parallel to and against the shore by hand. Two fasteners of the siderail section hold a second ponton by hand abreast of the one against the shore. A fastener and a carrier hold opposite ends of a 60-foot ½-inch line, and the fastener stations himself in the upstream end of the river ponton. The carrier stations himself as far upstream on the shore as possible. A carrier and a fastener provide a downstream line to the downstream end of the river ponton in the same manner. These lines are used to aline the pontons after the river ponton is pushed off prior to the delivery of up and downstream anchor lines by the anchor sections. After being pushed off with the balk, the river ponton is moved as required to facilitate the engagement of the balk fasteners at all four gunwales.

c. As soon as the raft is completed, the section moves it to its position on the axis of the bridge. Two of the siderail fasteners take up on the downstream anchor line from a position in the downstream end of the river ponton. Two other fasteners, from a position in the upstream end of the river ponton, pay out on the upstream anchor line as required. The four siderail carriers push the raft

toward the axis of the bridge by wading alongside the shore gunwale of the shore ponton. If it is not feasible for these four men to wade, they assist in moving the raft by poling from positions in the shore ponton.

d. Erection of deep water trestle.—(1) During the erection of the deepwater trestle the siderail fasteners, from their positions in the upstream and downstream ends of the river ponton, perform the duties of cable men. The siderail carriers wade and assist in spotting the raft in exactly the right position as the deep water trestle is being placed. If the water is too deep for wading, they assist by poling from positions in the shore ponton of the raft. During erection of the deep water trestle the members of the siderail section carry out the orders of the chief of the abutment span section.

(2) As soon as the deep water trestle is erected and raised free of the raft, the anchor cables are turned over to the cable section which enters the river ponton. The siderail section goes ashore and procures 32 light lashings with which it secures the trestle balk to the two trestles. To carry out this task properly the siderail section will usually have to wade into the water.

e. Placing and securing of siderails.—(1) As soon as the trestle balk have been fastened to the trestles, the fixed spans and the hinge span will have been floored with chess. The siderail section can then proceed with the task of placing and clamping the siderails of the bridge. The siderail section, however, should not place and clamp siderails until a bay of the bridge is completely cleared of other working parties. The siderail section has a relatively light task during the building of the floating portion of the bridge and should exercise care to avoid interference with other working parties, such as the balk carriers and the chess carriers. In the fixed and hinge spans trestle balk are used for siderails and placed directly above balk Nos. 1 and 8. The siderail fasteners, as soon as the siderails are in place, apply the clamps. Three clamps are used for each siderail in the fixed spans. One is placed at the center and one at each quarter point. In the hinge span they are similarly placed except that the quarter point clamps nearest the hinge sill must be eliminated. Ponton balk are used as siderails in all spans of the floating portion of the bridge except the hinge spans. All clamps are placed in the space between the pontons. Three clamps are used on each siderail. One clamp is placed in the middle and the other two as close to the pontons as possible. It is not necessary that two clamps be placed opposite each other on the inside and outside siderails where the lap occurs, as was required for the rope siderail lashing with M1869 equipage.

Siderails are laid and clamped as shown in figure 23 for the various types of span.

(2) The siderail carriers of the section return to the shore after carrying out the siderails for each span. The fasteners get into the river ponton of the span to which they have just fastened the siderails and wait until the next siderails are laid, or they return to the shore and procure the necessary siderail clamps with which to secure the next several siderails.

78. Cable.—*a. General.*—The section consists of a section chief and four cablemen, two of whom work on the upstream side of the bridge and two on the downstream side.

b. Erection of trestles.—(1) The cable section applies the light guy lines to the spools at the tops of the shallow water trestle columns and during the erection of all trestles handles the free ends of these light lines which extend shoreward. After all the trestles have been erected, the cable section receives the anchor cables and pontons from the anchor sections as they are delivered at the head of the bridge. They manipulate each successive ponton to facilitate the simultaneous engagement of the balk fasteners to the odd-numbered balk at all four gunwales.

(2) The cable section is responsible for the alinement of the bridge, and during the interval after the odd-numbered balk are made fast in each span, two men of the section should let out or take up on any anchor cables in accordance with alinement signals given by the officer in charge. The noncommissioned officer in charge of balk fasteners uses a range pole or similar marker, placed vertically at the center of the ponton, to obtain this line.

c. Construction of floating spans.—(1) When the deep water trestle has been erected and raised free of the hinge span raft, the cablemen enter the ends of the river ponton of the hinge span raft, two men to each end, and take over the handling of the anchor lines from the siderail section which leaves the raft.

(2) When the hinge span raft has been placed in the bridge and the first additional ponton to be added to the bridge arrives at the bridgehead, the cablemen, two to each end of the ponton, get in the ponton, take over the upstream anchor line, move a downstream anchor line forward, if necessary, and secure the ponton to the river ponton of the hinge span raft by hand. When the odd-numbered balk of the span to be added to the bridge are engaged and secured lightly on the river gunwale of the new ponton, and at the command SHOVE OFF, given by the chief of the balk fastener section, the cablemen release their handholds on the ponton at the head of the bridge

and keep the ponton alined by means of the anchor cables as it is shoved off. It is possible that the end of the bridge may be somewhat off the centerline established by the two range poles. In this case the cablemen maneuver the new ponton in order to facilitate engaging the balk fasteners at all four gunwales.

(3) As soon as the odd-numbered balk have been secured at all four gunwales, the cablemen bring the center of the new ponton directly on the centerline of the bridge established by the range poles. During the placing of the even-numbered balk and the laying of chess on the new span the section chief will have ample opportunity to readjust any upstream and downstream anchor lines which appear to be pulling the end of the bridge off the centerline established by the two range poles. At times it may be necessary for the chief of the cable section to send both an upstream and a downstream cableman back several spans and make adjustments on several lines.

(4) Whenever a downstream anchor line is moved forward into the next ponton to be added to the bridge, the upstream anchor line should be slacked off from 6 inches to 1 foot before making it fast at the upstream end of the ponton. There is a tendency for the upstream line to pull the bridge slightly upstream when its pull is no longer balanced by an anchor line at the downstream end of the ponton.

SECTION X

CONSTRUCTION BY METHOD OF PARTS

	Paragraph
General	79
Assembly of parts	80
Incorporation of parts into bridge	81

79. General.—*a.* In this method the bridge is started as in the method of successive pontons. Simultaneously, at other points on the near shore or in a tributary stream, other floating parts of the bridge are constructed. These parts are built by the method of successive pontons generally as in the normal case.

b. The floating part of the bridge build out from the abutment and all parts constructed separately should begin and end with upstream balk in order to prevent confusion in joining successive parts of the bridge. It follows that each part and the part build out from the abutment must consist of an odd number of spans made up of an even number of pontons.

c. Each working party constructing a part should have its full complement of balk fasteners, balk carriers, chess carriers, siderail

carriers and fasteners, cable men, and the necessary anchor sections to provide the requisite number of pontons and to deliver the pontons successively to the head of the part. In addition to the foregoing, the working party which starts the bridge from the abutment should include all of the sections which are necessary for expeditious construction by the method of successive pontons.

d. Any appreciable decrease in the number of men assigned to the construction of a part will materially decrease the speed of construction and defeat the ends to be gained by the use of this method.

80. Assembly of parts.—*a.* In streams of appreciable current the shore ponton of each part must be positively moored to the bank and the necessary shore lines or anchor lines must be provided upstream. At least one downstream shore cable or anchor cable must be provided to assist in alining the pontons as they are added to the part. In still water or in streams of practically no current, an upstream and a downstream anchor line must be provided to aline the pontons as they are added to the part.

b. In general, the construction of a part is accomplished in the same manner as a floating portion of the bridge where the method of successive pontons is used.

81. Incorporation of parts into bridge.—*a.* It will sometimes be feasible to construct at least one part downstream of the section of the bridge which is built out from the abutment, mooring the former to latter as the latter is being built. When the part is ready to be placed in the bridge, it is moved out into the stream by men handling its mooring lines from the roadway of the bridge. When the part has been moved by this method as far as possible into the stream, the free ends of the anchor cables to which it will be moored when it is in the bridge are passed on to the part from one or more pontons of the anchor section or the end of the bridge, wherever these anchor lines have been temporarily secured. The part is then swung out below its final position by means of the anchor cables and with the aid of the current and pulled up to the axis of the bridge in prolongation of the completed section.

b. If the parts are not too long and unwieldy, they can be handled expeditiously by a 22-hp. outboard motor on a separate power ponton. In general, the method of casting anchors and bringing the parts to the center line of the bridge should proceed as outlined under the duties of the anchor section when outboard motors are used in the construction of the bridge by the method of successive pontons. In still water seven-span eight-ponton parts may be maneuvered successfully if a 22-hp. outboard motor mounted on a separate ponton is

available and the power ponton is attached to the part by means of the towing adapter. This towing adapter makes wide parts feasible since it adds to the length of the lever arm through which the steering component of the propeller's thrust acts. If the stream has any appreciable current, it will be impossible to row the parts into their position in the bridge. Some form of power boat is absolutely essential in most situations.

c. When a part has been completed, the balk, chess, and siderails for one floating span of bridge are loaded on the part and the part is moved to the axis of the bridge in prolongation of the completed portion. The balk which were loaded on the deck of the part are placed in their proper position on the gunwales of the last ponton in the completed portion of the bridge and the first ponton of the part which is to be added. The part is manipulated by its anchor lines to facilitate the engagement of the fasteners of the balk of the connecting span. After the balk fasteners are engaged and tightened, the chess and siderails of the connecting span are laid. As soon as a working party has placed its part in the bridge, it comes ashore and proceeds to construct another part if necessary.

Section XI

DISMANTLING BRIDGE

	Paragraph
General	82
Personnel	83
Dismantling procedure	84

82. General.—The bridge may be dismantled and the equipment stacked as it was when the command CONSTRUCT THE BRIDGE was given in the reverse order of the operations prescribed for the construction of the bridge by successive pontons. The reloading of the equipment on its trailers does not lend itself to precise procedure and must be handled to fit conditions.

83. Personnel.—A minimum working party for the smooth, continuous dismantling of the bridge should consist of 1 officer, 8 noncommissioned officers, and 58 privates organized into a balk fastener, balk carrier, chess, siderail carrier, and far shore sections. All sections, except the far shore and the chess sections, are organized as set forth in paragraph 67. The far shore section consists of 2 noncommissioned officers and 12 privates. This is a convenient far shore organization since it can be readily broken up into two 7-man rowing crews. The chess section does not include the chess layers.

84. Dismantling procedure.—*a.* The bridge should be dismantled in the following order:

(1) The far shore section removes the siderails from the far shore hinge span raft and span No. 2 adjacent thereto, while the siderail section removes the siderails from floating span No. 3, counting from the far shore. The siderail section carries the siderail balk and the clamps of floating span No. 3 to the near shore.

(2) The chess section removes and carries 16 of the chess covering the ponton balk of floating span No. 2 (measured from the far shore) and carries them to the near shore. The remaining 6 chess of this group covering ponton No. 2 are removed by the far shore section and laid on the far shore.

(3) The balk fastener section disengages the fasteners at all four gunwales on the ponton balk of floating span No. 2 (measured from the far shore). The balk are then laid with their 6-inch fact horizontal. The balk fasteners in the river ponton of the far shore hinge span raft walk across the balk holding on to each other's shoulders and take their place in the ends of ponton No. 4, counting from the far shore.

(4) The balk carrier section removes the ponton balk covering the span adjacent to the far shore hinge span as soon as they are made available by the balk fastener section.

(5) The siderail section removes and carries to the near shore the siderails and the siderail clamps of the fourth floating span, counting from the far shore.

(6) The chess carriers remove and carry to the near shore 16 more chess.

(7) The balk fasteners disengage the balk of floating span No. 3 (measured from the far shore) at all gunwales.

(8) The balk carriers pick up the ends of the disengaged balk resting on ponton No. 4 and pull ponton No. 3 against ponton No. 4, counting from the far shore.

(9) Balk carriers carry seven balk to the near shore and place them in the stack.

(10) The balk fasteners in ponton No. 4 hold ponton No. 3 against ponton No. 4 while the balk fasteners in ponton No. 3 move to the ends of ponton No. 5.

(11) The far shore section dismantles the far shore connection and ferries the materials to the near shore in the two pontons of the hinge span raft.

b. The balk fastener, balk carrier, chess carrier, and siderail sections continue dismantling the floating spans in the order indicated until

the near shore hinge span raft is reached. A near shore section of 2 noncommissioned officers and 12 men is then organized to dismantle the near shore connection. The remaining men, including those of the far shore section, are then organized into rowing crews to pick up the pontons, raise the anchors, and moor the pontons along the near shore.

SECTION XII

DRAWSPAN IN BRIDGE

Paragraph
General 85

85. General.—It will sometimes be necessary to remove a part of the bridge to provide an opening for the passage of navigation or large floating objects likely to damage the bridge. To do this, a swing line is attached to the upstream end of the center ponton of the part to be removed, and the other end to the downstream end of that ponton behind which the part will be swung. To open the draw, remove the bays of siderails, balk, and chess, which connect the part to be removed to the rest of the bridge and ease off on the upstream anchor cables of the part. When the part has dropped down clear of the bridge, the swing line is tightened and the anchor cables are loosened. The part will then swing over behind the ponton to which the swing line is attached. To replace the part, the slack is taken out of the anchor lines and the swing line is loosened. When the part has swung out below its place in the bridge, it is pulled upstream to the axis of the bridge by means of the anchor cables and reconnected. In some cases special connections may be devised to facilitate this operation if of frequent occurrence.

SECTION XIII

CARE AND MAINTENANCE OF BRIDGE

Paragraph
General 86
Traffic rules 87
Useful suggestions 88
Capacity 89

86. General.—*a.* An engineer officer with a suitable detail of engineer troops is assigned to the supervision, maintenance, and guard of each completed bridge. This officer is responsible for the safe and speedy passage of traffic and his orders and those given by the bridge guard, pursuant to his instructions, must be strictly complied with by all persons using the bridge.

b. A bridge guard is detailed from the engineer detachment assigned to the bridge. The bridge guard posts a sentinel in an observation post near each end of the bridge to give warning of the approach of columns and one or more sentinels should be stationed on the floating part of the bridge to watch for floating objects likely to cause damage. These sentinels give warning when the bridge is in danger from any cause and see that the regulations for passage are complied with.

c. To prevent damage to the bridge from floating objects a detachment in boats or pontons is stationed about 1,000 yards above the bridge. The detachment is provided with cables, anchors, grapnels, hammers, axes, explosives, and other materials and equipment which conditions may suggest. Dangerous floating objects should be towed ashore well above the bridge if possible. If this cannot be done an anchor line should be made fast to the object which will prevent its movement downstream until it can be broken up with explosive or towed ashore and made fast.

d. Patrols should be sent well upstream to watch for dangerous floating objects whenever this appears desirable for the safety of the bridge.

e. The work of the bridge guard may be lightened by constructing a boom above the bridge composed of timbers or logs, united by chains and forming a continuous barrier to floating objects. It should form an angle of about 20° with the current, which will require the length to be about two and three-quarter times the width of the river. If constructed in this manner large floating objects will slide along the boom and be forced to the shore at the point where the downstream end is made fast.

87. Traffic rules.—*a.* Traffic should never be permitted to halt near the approaches of the bridge. Traffic control posts, connected to the bridge guard by motor messenger or telephone, should be established on all roads about a mile from the bridge.

b. When a body of troops approaches the bridge its commander should be informed of any special precautions which are necessary for passage. Cavalry and other mounted troops cross in column of twos at normal intervals. Foot soldiers cross in column of threes or fours.

c. Horse-drawn artillery may cross without special precautions as to the spacing of the successive vehicles.

d. Halts on the bridge should be avoided but if it is necessary to halt a column, or part of it, on the bridge for any reason, the necessary directions for halting and resuming the march should be given by the officer in charge of the bridge maintenance detail.

e. The traffic priority schedule for the use of the bridge is established by proper authority, usually by the division or higher commander. Priority as to direction is especially important. Questions of priority not covered by standing instructions from higher authority should be decided by the officer in command of the bridge detail.

f. That portion of the chess which lies outside of the siderails forms a walkway on each side of the bridge which is reserved for the use of the bridge detachment.

88. Useful suggestions.—*a.* Since the siderails of the bridge lap over, the inside surface of the siderails is not continuous. If heavy vehicles, especially track layers, ride up on the exposed ends the siderails will be damaged and there is danger that the vehicle will be thrown from the bridge. The maintenance detail can render the bridge much safer for wheeled and track laying traffic if they fill up the spaces between the inside line of siderail balk with 4- by 6-inch material. The inside surface of the siderails then becomes smooth and unbroken and it is much more feasible to run traffic at fairly high speed when this becomes necessary. When the 4- by 6-inch material has been cut to the proper length and fitted in the openings between the inside row of siderails, holes should be bored vertically in at least two places which coincide with the openings between the ends of the chess. Half-inch rope can then be placed through these holes and made fast to the outer row of siderails.

b. A screen of brush or branches placed between the ends of the chess outside of the siderails on both sides of the bridge gives confidence to animals and aids in keeping them quiet while crossing the bridge. This is especially important for crossing cattle and loose animals.

c. The officer in charge of the bridge will frequently inspect the cables to see that they are not chafing and that the anchors are not dragging. He will cause the mechanical balk and siderail fasteners to be tightened if they work loose and the pontons to be bailed out when they leak or ship water.

d. There should be collected near one abutment a supply of spare balk, chess, cordage, and other materials with which to repair any damage to the bridge.

89. Capacity.—*a.* The safe capacity of this bridge is limited to 10-ton vehicles. This rating of 10 tons provides a small factor of safety to cover certain contingencies such as an accumulation of water in the pontons, defective balk, failure to engage all balk fasteners, broken balk fasteners, current and wave action, and improper spacing of successive loads.

b. Ten-ton loads should be exceeded only when all concerned are fully cognizant of the risks involved. The load limit should not be exceeded unless conditions are favorable and the officers and noncommissioned officers in charge of the bridge detail are thoroughly familiar with every precaution which must be taken when heavy loads are carried on the bridge.

c. When it becomes essential that loads exceeding 10 tons be allowed to cross the unreinforced bridge the following precautions must be taken:

(1) All boats must be bailed dry.

(2) All balk must be sound. This is best indicated by a record of previous use with heavy loads.

(3) All balk fasteners must be secure.

(4) All siderail clamps must be properly placed and tightened.

(5) The speed of vehicles must not exceed 5 miles per hour.

(6) Last, and most important, vehicles must be properly spaced in column.

d. When a concentrated load is placed near the middle of the bridge, well defined vertical waves will appear in the balk. The distance from crest to crest or from trough to trough of these waves is from 60 to 75 feet. Balk stresses are a maximum and ponton free boards are a minimum when the centers of gravity of successive vehicles are spaced at this distance. Balk stresses are a minimum and ponton free boards are a maximum when the centers of gravity of the same vehicles are spaced at one-half this distance or slightly less.

e. When a single load or a group of loads each exceeding 10 tons cross the bridge, these loads should be preceded and followed by at least two vehicles weighing at least 10 tons spaced at the optimum distance or less.

f. In order to prevent deviation from the desirable 25 to 35 foot (2 bays) spacing between centers of gravity, heavy loads must proceed across the bridge at a speed which does not exceed 5 miles per hour. It may be desirable to connect successive vehicles by short tow ropes in order to make sure that the maximum allowable distance is not exceeded. Locating centers of gravity is an unnecessary refinement. It will usually suffice to measure from tailgate to tailgate or from rear axle to rear axle.

g. Proper spacing between vehicles in column outweighs any other precautionary consideration in its effect on bridge capacity and bridge guards should be trained to estimate spacing distance by comparison with bridge spans.

SECTION XIV

REINFORCED BRIDGE

Paragraph
Increased capacity 90

90. Increased capacity.—*a.* To double the capacity of the normal bridge, it is reinforced as follows:

(1) Fourteen balk are placed in the fixed and hinge spans.

(2) Each ponton span is given additional buoyancy by interposing one ponton at the center of each ponton span, the ponton being fastened to the outer ends of the chess to hold it in place.

(3) The best position of the hinge sill remains unchanged and will be about half way between the shore ponton and the adjacent added ponton.

b. Thus reinforced, the bridge will carry two-axle trucks, three-axle trucks, and track layer loads of 20 tons with safety and without special precautions.

c. The precautions already enumerated which are necessary to reduce stresses in the 10-ton bridge apply with equal force to the 20-ton bridge. Balk stresses in the reinforced bridge can be materially decreased and the free board of the pontons slightly increased if a center to center load spacing equal to one-half the load wave length is maintained. As in the case of the 10-ton bridge, balk stresses will be dangerously increased and the free board of the pontons will be considerably decreased if load spacings of one full wave length are permitted.

SECTION XV

FERRYING

Paragraph
Single ponton 91
Raft ferries 92

91. Single ponton.—*a. General.*—(1) Single pontons of the equipage may be used for the ferrying of personnel with their combat equipment and such other loads as the pontons will accommodate. The pontons are heavy and clumsy; carrying, launching, loading, and rowing them are noisy operations. Carrying pontons by hand for any considerable distance is a slow and exhausting job. The pontons are required for raft ferries and bridges and scattering them and exposing them to damage and loss before the construction of bridges and ferries is undesirable. The assault boats are designed specifically for ferrying personnel and light equipment during the early stages of a river crossing, when the need for secrecy is paramount. Therefore, pontons should be used for this purpose only when it is unavoidable.

(2) In currents up to 1 mile per hour the crew should consist of a noncommissioned officer in charge of the boat, to act as steersman, and four oarsmen. In currents exceeding 1 mile per hour six oarsmen are required. The loaded ponton cannot be propelled with oars in currents much exceeding 3 miles per hour. In currents not exceeding 5 miles per hour an outboard motor may be used to propel the loaded ponton, in which case the crew consists of a noncommissioned officer, an outboard motor operator, and an anchor man.

(3) Each ponton should be equipped with at least one anchor and its cable, two light hand lines 20 feet long, two extra oarlocks and two extra oars. It is particularly important that these items be carried when the ponton is propelled by an outboard motor.

b. Capacity.—(1) A ponton propelled by oars will carry 25 men with full equipment, in addition to the crew of seven. No special provisions need be made for the 60-mm mortars and the light machine guns. Their component parts make up individual loads which occupy so little room that the capacity of 25 men will not be reduced. The ponton is loaded by placing 6 men in each of the center compartments, 7 men in the bow compartment, and 6 men in the stern compartment. It is important that the oarsmen be in their rowing positions prior to the embarking of the passengers and that they do not permit the latter to push them out of these positions while the ponton is being loaded. Passengers must be placed so as to allow the free action of the oars in rowing.

(2) In general two of the infantry heavy weapons with a supply of ammunition will displace 3 men. Accordingly, a ponton will carry any two of these weapons and 22 men. The heavy antitank gun with its truck will normally be carried only on raft ferries.

(3) When the outboard motor is used, 40 men or 4 infantry heavy weapons and 34 men can be carried. In general, the additional men are distributed in the space made available by the absence of the oarsmen.

c. Embarking.—(1) A landing stage generally will not be required, the passengers wading from the shore directly to the boat and the matériel being handed in by wading men. In some cases chess laid from the shore to the gunwale of the boat will facilitate loading.

(2) At each embarkation point there should be an engineer officer or a noncommissioned officer to see that the personnel are properly formed for embarking and to supervise the actual embarking. It is advantageous to have at least two men standing by to secure the ponton to the shore, place the chess gangplank, if used, and to cast off the ponton when it is loaded. When the water is deep quite close to the shore it may be necessary to use chess gangplanks.

(3) Men enter the ponton in single file over the end or side, depending upon how the ponton is moored. Except in the end compartments, passengers are seated on the floor with their backs against the side or bulkhead, with their heads held down below the level of the gunwales so as not to interfere with the sweep of the oars. In the end compartments, the men sit on the platform as well as on the floor.

(4) The ponton is moored parallel or perpendicular to the shore in water deep enough to float the ponton after it has been fully loaded. The crew takes its post prior to the loading regardless of whether an outboard motor or oars are to be used. When chess gangplanks are provided, they should be placed by the shore detail. At the command EMBARK, given by the officer or the noncommissioned officer in charge at the embarkation point, the men enter their respective compartments and seat themselves as directed. Rifles are carried at the trail during embarkation. The rifles and component parts of the 60-mm mortar and the light machine gun are stowed away in convenient spaces after the passengers are seated.

d. Conduct during crossing.—While the passengers are in the boat, they will promptly carry out the instructions of the engineer noncommissioned officer in charge of the boat and will remain steady in the ponton under all conditions. There will be no firing during the crossing. The passengers will maintain silence. They will avoid interfering with the oarsmen. Passenger officers and noncommissioned officers will assist the engineer noncommissioned officer in charge of the ponton and see that his orders and instructions are promptly carried out.

e. Disembarking.—(1) The ponton should be moored to the far shore perpendicular or parallel thereto as conditions may indicate. It is desirable to have two men stationed at the unloading point to secure the ponton to the shore during the unloading operation and cast it off after the unloading operation is complete.

(2) When the unloading point is reached and the ponton is secured against the shore, the passengers will debark under the instructions from the engineer noncommissioned officer in charge of the boat. In general, it will be necessary for the passengers to debark in water which is about 18 inches deep since this is the draft of the boat when fully loaded with personnel and light equipment.

92. Raft ferries.—*a. General.*—(1) Rafts may be constructed with the equipage which are suitable for all loads which do not exceed the capacity of the normal or reinforced bridges. In general, the freeboard of the individual pontons in the raft should be at least 9 inches, after the load has been placed in its final position. This is the

amount of freeboard available when each ponton has a live load of seven tons. Often available floor space will govern the loading rather than the flotation capacity of the raft. Rafts are usually of the same construction as one or more ponton spans of the normally constructed bridge, reinforced if necessary.

(2) In general, a uniformly distributed load on the deck of the raft will cause the center pontons to show less freeboard than the end pontons. The same is true of a single heavy vehicle. When several vehicles are loaded or when the raft is loaded with personnel, judicious distribution and spacing of the load will give a uniform freeboard on all pontons and reduce balk stresses to a minimum. When loading personnel in column of sixes (double column), this can best be accomplished by dividing the load into two columns of sixes, each closed up and placed as close to the ends of the raft as possible. This should leave an open space in the middle of the raft.

(3) When vehicles are carried on rafts, the full length of the raft cannot be occupied by the load. When vehicles are being loaded, the landing stage is first lower than the raft, and then higher as the load leaves the stage and passes onto the raft. The reverse action occurs during unloading. Accordingly, the junction between landing stage and raft must be bridged by chess or planks and space must be provided on the raft for placing them.

b. Capacity.—The various types of rafts which will be most commonly used with their capacities, are given below:

(1) *Two ponton—one bay.*—This raft consists of one normal ponton span of the bridge. It provides a platform 10½ feet by 21 feet. Its capacity is—

72 infantrymen in column of sixes closed up so as to distribute the load uniformly over the roadway of the raft.
1 truck having a gross weight not over 5 tons.
4 animals in column of twos.

(2) *Three ponton—two bay.*—This raft consists of two normal ponton spans of the bridge. It provides a platform 10½ feet by 37 feet. Its capacity is—

108 infantrymen in column of sixes closed up so as to distribute the load uniformly over the roadway of the raft.
8 animals in column of twos.
1 animal-drawn vehicle with either a two-line or a four-line team.
2 pick-up trucks.
2 loaded 1½-ton trucks or larger vehicles of gross weight not exceeding 7½ tons each.

(3) *Four ponton—three bay.*—This raft consists of three normal ponton spans of the bridge. It provides a platform 10½ feet by 53 feet. Its capacity is—

168 infantrymen in column of sixes closed up so as to distribute the load uniformly over the roadway of the raft.
4 pick-up trucks.
10 animals in column of twos.
2 animal-drawn vehicles with two-line teams.
1 animal-drawn vehicle with a four-line or a six-line team.
1 carriage of 75-mm animal-drawn artillery and its animals.
1 truck-drawn 75-mm gun.
3 loaded 1½-ton trucks or larger vehicles of gross weight not exceeding 7½ tons each.

(4) *Three ponton—one bay.*—In this raft a third ponton is placed under the center of the span. Its capacity is the same as the two ponton—one bay raft, except that loads not exceeding 15 tons can be taken.

(5) *Five ponton—two bay.*—In this raft an additional ponton is placed under the center of each span. However, when single heavy vehicles are to be carried it is desirable to place the extra pontons closer to the center pontons than to the end pontons. Where the available space governs, the capacity of this raft will be the same as that of the three ponton—two bay raft. The single vehicle capacity is the same as that of the reinforced bridge, 20 tons. Where two or more vehicles or any well-distributed load is possible the aggregate live load should not exceed 25 tons.

c. Propelling rafts.—(1) Rafts cannot be rowed effectively, except for the two ponton—one bay type, and even in this case the use of oars is rather unsatisfactory and becomes out of the question in currents which exceed 1 mile per hour.

(2) The 22-hp. outboard motors of the equipage provide an excellent means of maneuvering rafts of various sizes in all streams whose currents are within the power capabilities of the motors. The method of attaching the 22-hp. outboard motor to the power ponton and the method of attaching the power ponton to the raft together with general considerations covering the use of outboard motors are discussed in paragraphs 42–50.

d. Trail and flying ferries.—(1) The trail ferry principle may be used to propel the raft if the current exceeds 2 miles per hour at all points between landing stages. A cable is stretched across the stream and made fast to suitable trees or hold-fasts. If hold-fasts are used, the cable may be elevated by passing it over an A-frame erected near

each end of the cable. A block and tackle is provided to take excess sag out of the cable from time to time as it stretches. A snatch block is fixed to the cable so that its sheave will be free to roll on the cable. Maneuvering lines are attached to the hook of the snatch block and are run to the upstream ends of the end pontons of the raft. To operate the ferry the raft is turned at an angle to the current by means of the maneuvering lines running to the block so that the upstream ends of the pontons of the raft incline towards the shore to which it is desired to move the raft. The current impinges upon

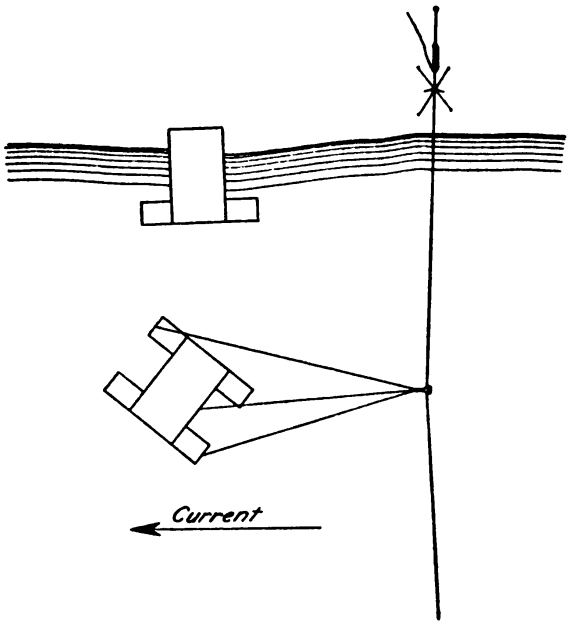


FIGURE 40.—Lay-out for trail ferry.

the exposed sides of the pontons of the raft and forces it to move across the stream, the snatch block traveling on the cable. The speed of the raft increases the further the raft is pointed out of the current up to about 45°. The lay-out for the trail ferry is shown in figure 40.

(2) The flying ferry works upon the same principle as the trail ferry, except that the raft is held in the stream by means of an anchor cable which is made fast to an anchorage well upstream from where the crossings are to be made. If the strongest current is near one shore, the anchorage must be located near the other shore. If the current is uniform between landings, the anchorage should be located in midstream. The length of the cable must be at least one and one-half times the width of the stream. The cable is supported at intervals by pontons or other floats to keep it out of the water. The cable is made fast to the raft at its center, and maneu-

vering ropes for turning the raft toward one shore or the other are made fast to the cable. As the raft moves from shore to shore it swings on the arc of a circle about the anchor as a center. The flying ferry requires a current velocity of about 2½ miles per hour minimum from landing to landing, or slightly more than the trail ferry. The lay-out for the flying ferry is shown in figure 41.

(3) Where currents less than those indicated in (1) and (2) above are encountered, the principle of the trail and flying ferry is useful in providing security against drifting downstream, but the movement between landings should be accelerated by the use of an outboard motor.

(4) When ferrying operations are conducted on very wide bodies of water with moderate currents, it may be desirable to dispense with the trail or flying ferry and operate several free rafts propelled

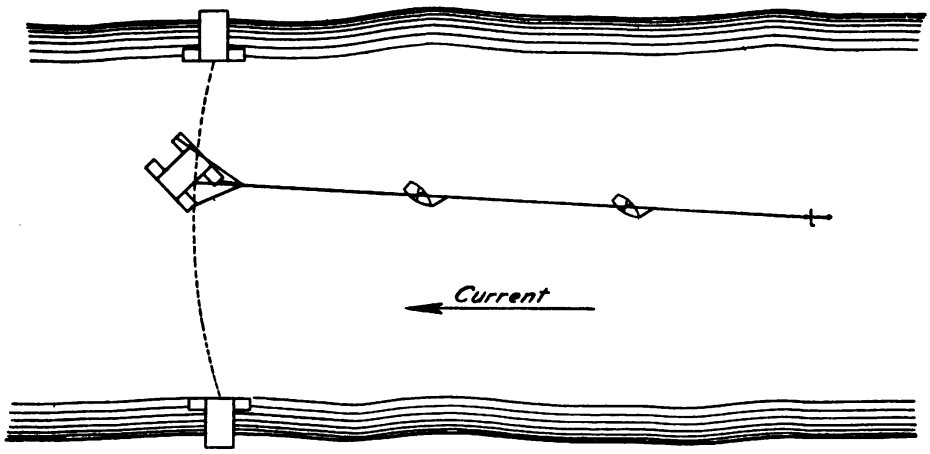


FIGURE 41.—Lay-out for flying ferry.

by outboard motors between the same set of landings. The number of free rafts which can be operated between one pair of landings without interference will depend upon the ratio of crossing time to either loading or unloading time.

e. Landing stages.—(1) Landing stages must be provided at each bank for ferrying vehicles. The simplest form of landing stage is constructed by laying a span of the bridge from an abutment sill on shore to the far gunwhale of a ponton moored at the proper distance from and parallel to the abutment sill. Ponton balk are used for this purpose and since the effective clear span from the river edge of the abutment sill to the center of the ponton is about 18 feet, 10 balk should be used instead of 8 as normally in the abutment span of the unreinforced bridge. Two ponton balk should be used as siderails and a mechanical siderail fastener placed and secured

at the middle point and at the quarter points of each siderail. The balk fastener loops nearest the end of the ponton balk should extend shoreward of the shore edge of the abutment sill. A chess should be placed on edge against the ends of the 10 balk with its upper edge on a level with the upper surface of the floor of the landing stage The details of this form of landing stage are shown in figure 42.

(2) The simple landing stage described in (1) above will suffice whenever deep water is available near the shore and when it is possible to place the abutment sill in firm ground with its upper surface not less than 1 foot and not more than 3 feet above the

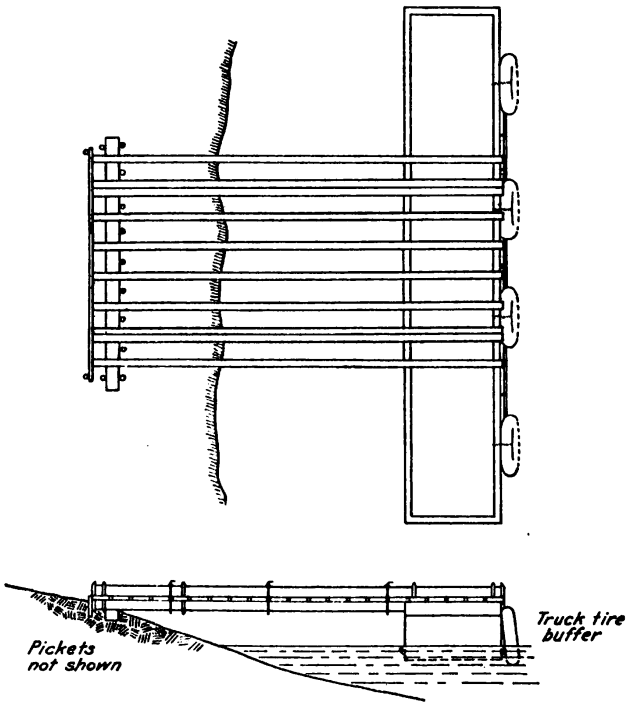


FIGURE 42.—Landing stage for ferrying operations.

water with a reasonable amount of grading. The loads should not exceed those allowable on the normal bridge.

(3) In other cases it will be necessary to erect one or more trestles in order to reach water which is deep enough to float all of the pontons of the landing stage freely under the loads which are to be expected. Trestles sometimes are required to ease the slope from the abutment sill to the end of the landing stage when it is necessary to place the abutment sill more than 3 feet above the water.

(4) When loads move from the landing stage onto the raft and vice versa, the floors of the two structures will assume different levels because of the action of the pontons under the load. When the

difference in elevation between the floor of the landing stage and that of the raft caused by a load on one or the other is appreciable, some means of transferring the load from the landing stage to the raft or vice versa must be provided. For light loads this may be accomplished by laying tracks of chess on the loaded or lower part with not over 6 inches of the ends of the chess engaged over or on the higher part. When animals are loaded, at least 10 chess should be laid side by side in order to cover the crack between the raft and the stage completely so that there is no danger of animals stepping into the opening. When the load comes on the tracks of chess, the higher floor level will be forced down so that the elevation of the stage and of the raft will be the same as the load transfers from one to the other. Where axle loads exceeding 2 tons are expected, two 6-inch by 12-inch timbers or hewed logs about 10 feet long beveled on the ends should be used in place of chess. Four timbers must be provided, two for use on the landing stage of the embarkation side and two for use on the raft at the disembarking end.

(5) Several thick rope or truck tire buffers should be suspended along the river side of the landing stage to cushion the shock of collision between the landing stage and the raft.

f. Loading.—(1) Vehicles must be chocked to keep them from rolling while on the raft. A trestle balk or chess, laid across the roadway of the raft on top of the siderails with its wider faces horizontal makes a good chock. It is placed against the wheels and lashed to the siderail.

(2) Nervous and otherwise troublesome animals should be led onto the raft and held by a dismounted man during the crossing. Animals should be handled by the personnel to whom they are accustomed. If a large number of animals are to be ferried, it will help to keep the animals quiet if a rope rail is placed along the sides and the ends of the raft. The addition of brush, secured to the rope rail at the top and to the siderails at the bottom, will aid in keeping them quiet. Particularly troublesome animals should be blindfolded.

(3) Personnel to be ferried are formed in columns of sixes and marched onto the raft with normal marching distance between ranks. The separate ranks close up to the distance which will give uniform distribution of the load on the roadway of the raft or which will give the favorable load distribution suggested in paragraph 92*a*(2). Personnel stand at ease while on the raft. The ranks resume normal marching distance as they march off.

g. Crew and equipment.—(1) An engineer officer with a suitable detail of engineer enlisted men is assigned to the supervision and operation of each raft. This officer is responsible for the safe and speedy loading, passage, and unloading of the raft.

(2) The raft should be provided with the necessary anchors and anchor cables attached with which to hold the raft in the stream in case the outboard motor fails or the trail or flying ferry cable parts. Men should be stationed at these anchors with no other duties than to cast them in case of necessity.

h. Conduct during the crossing.—From the time the loads are turned over to the engineer officer in charge of the raft for loading until they are unloaded on the opposite bank, the loads are under his orders and those of the noncommissioned officers of his crew. All instructions issued by them will be promptly and strictly complied with. All officers and noncommissioned officers who are passengers on the raft will assist the engineer officer or the noncommissioned officers under him in any way that may be necessary.

SECTION XVI

TIME AND LABOR REQUIREMENTS

Paragraph
General ---------- 93

93. General.—*a.* The tables which follow show the time and labor requirements for performing the various operations described in this chapter. It must be understood that the figures given are to serve as guides only and are based upon the conditions stated in the table. Time and labor requirements will vary widely from these figures depending upon conditions. The figures given under the conditions shown apply to work in daylight with personnel fairly well trained in their duties, familiar with the equipment, and in good physical condition. Work at night without lights and with inexperienced personnel not accustomed to the hard labor required will consume much greater time for each operation than the figures shown. In general, night operations will consume twice as much time as in daylight.

b. No figures can be given for the handling of the transportation immediately preparatory to unloading. The time required for these operations depends upon the terrain, the conditions of the road or the soil, the weather, the size of the area available, and the traffic circulation which the site provides. In any plan for the use of the equipment, ample estimates must be made for this phase of the operation.

Operation	Personnel required	Time	Conditions
Unloading trailers.			
Ponton load	2 squads	3 minutes	Almost any—trailer spotted at unloading point.
Trestle load	1 squad	5 minutes	Do.
Deck or abutment load	1 squad	5 minutes	Carry from trailer to piles not over 25 feet away.
Handling ponton.			
Carrying and launching	16 to 20 men	2 minutes first 100 feet; add 5 minutes for next 200 feet; 10 minutes for each 100 yards thereafter.	A clear path to the water—fairly level and even ground—no difficulties at river bank.
Sliding along ground and launching.	Variable—16 men a minimum on level and fairly smooth ground.	Same as for carrying	Same as for carrying. No objects liable to puncture pontons.
Loading trailers.			
Ponton load	2 squads	3 minutes	Ponton behind trailer ready for loading.
Trestle load	1 squad	5 minutes	Trestle parts on the ground near trailer.
Deck or abutment load	1 squad	5 minutes	Carry from piles to trailer not over 25 feet.
Bridge construction.			
By successive pontons.			
Near shore connection, including abutment, abutment span, 1 trestle, hinge span, and end ponton bay, all spans floored.	15 noncommissioned officers and 88 men.	40 minutes	Current not over 3 miles an hour—holding ground for anchors good—3 anchor sections with 6 oarsmen per crew. Balk and chess and other matériel required not over 100 feet from entrance to bridge. Not over 30 ponton spans in bridge.

For each additional trestle	Add 3 noncommissioned officers and 10 men.	Add 10 minutes.	
Ponton spans	----------	5 minutes per bay	
Far shore connection if installed after floating portion is completed.	----------	10 minutes per bay	
By parts.			
Shore connection as above and as many ponton spans as convenient.	Full party as for method of successive pontons.	40 minutes for shore connection and 5 minutes for each boat span added.	Same conditions as above under method of successive pontons.
Each part	Full party as for method of successive pontons, less 4 noncommissioned officers and 18 men.	5 minutes per bay	Same conditions as above. Parts are constructed simultaneously.
Moving each part to axis of bridge and connecting up.	Variable—the necessary men are taken from party who built the part.	15 minutes	Anchors for the part are cast by its anchor sections.
Ferrying.			
General conditions	River 350 feet wide	Current 3 miles an hour	Water at bank deep enough to float loaded ponton.
Single pontons.			
Single ponton with infantry load.	Crew of 7 and 2 privates on each shore.	8 minutes	Boat manned by 6 oars. Time includes embarking, crossing, debarking, and return trip of empty boat.
Same as above	Crew of 3 and 1 noncommissioned officer and 2 privates on shore.	6 minutes	Boat propelled by outboard motor.

Operation	Personnel required	Time	Conditions
Ferrying—Continued.			
Rafts.			
Construction	4 squads	5 minutes per bay	Normal ponton span construction only. Material for building raft conveniently segregated and stacked.
Landing stage construction.	2 squads	30 minutes to construct single ponton landing stage.	All materials sorted and stacked not over 100 feet from abutment.
Time to construct landing stages involving use of one or more trestles and hinge span raft.	See requirements for shore connections in method of successive pontons.		Unreinforced construction only Material for building raft not over 100 feet from site.
Time to load rafts	Varies, depending upon nature of load.	1 to 3 minutes, depending on type of load.	Raft loaded from landing stage.
Crossing time of rafts	Depends on conditions and size of raft.	2 to 4 minutes, depending on size of raft.	Free raft propelled by an outboard motor.
Same as above	do	2½ minutes	Trail ferry only.
Same as above	do	3 minutes	Flying ferry only.
Same as above	do	1½ minutes	Trail or flying ferry with outboard motor.

SECTION XVII

SHIPMENT BY RAIL

	Paragraph
General	94
Balk and chess load	95
Ponton load	96
Trailer load	97
Miscellaneous items	98

94. General.—*a.* For shipment by rail the equipment should be unloaded and segregated into four classifications, namely, balk and chess, pontons, trailers, and miscellaneous items. When so segregated one unit of equipage can be loaded on eight 40-foot flatcars or wood floor gondolas and one boxcar. The loading will be as follows:

Number of cars	Type	Load each car
1	Flat or gondola	Balk and chess and 1 trailer.
4	do	3 pontons and 1 trailer.
3	do	9 trailers.
1	Boxcar	All miscellaneous items and 1 trailer.

b. The balk and chess occupy 33 feet 6 inches of car length and can be loaded on any car 36 feet or over in length. Pontons and their bracing occupy about 30 feet of car length. Additional car space should be used to load trailers thus dispensing with one or more of the cars used for this lading. If shorter cars are used, not permitting trailer loading with balk and chess and pontons, more cars will be required. The approximate capacity of cars is shown on the following table:

Car length	Balk and chess load	Trailers	Ponton load	Trailers	Trailers
Feet					
36	1	0	3	0	8
40	1	1	3	1	9
45	1	2	3	2	11
50	1	4	3	4	13
60	1	7	6	0	16
65	1	9	6	1	18

c. All loads must be well secured against lateral and longitudinal shifting. Longitudinal shocks caused by starting or stopping are frequently severe. Lateral shifting is caused by centrifugal effect on curves and car rolling. Improperly secured shipments cause damage and delay. Cars should be examined carefully and all defects remedied before loading. All cars must be so loaded that the hand brake is accessible and operative. There must be a clearance of at least 6 inches between the brake wheel and the lading immediately back of the brake wheel, and a clearance of at least 12 inches between the brake wheel and the lading on either side of the brake wheel. These clearances must extend to the top of the lading. There also must be a clearance of at least 4 inches under the brake wheel. Beyond this brake wheel clearance, the clearance between the lading and outside face of end sill must be not less than 12 inches, except on gondola cars where the lading may be against the end.

d. All stakes, clamping pieces, bearing pieces and braces must be sound straight-grained lumber (hardwood preferred) and free from knots that materially impair their strength, or may be rolled or built up steel sections of equal strength. All bolts and rods used in securing bearing pieces, braces, etc., should have the nuts secured in place by riveting over end, nicking the threads, or by means of an effective lock nut or cotter pin.

95. Balk and chess load.—*a.* Each pile of balk or chess must be stacked between stakes placed in all stake pockets adjacent to the stack. The stakes must not be less than 4 inches by 4 inches in either a gondola or flatcar. The stakes may be hewed from green saplings 5 inches in diameter at the center, tapered at the larger ends to fit accurately and extending through and completely filling the stake pockets. If stakes are of smaller dimensions than the stake pockets, they must be wedged to completely fill the pockets by driving wedges in from the top of the pocket and securely nailing them to the stakes. Care must be taken to keep the stakes from spreading at the top while the car is being loaded. Tops of opposite stakes must be pulled together and held by two boards 1 inch thick by 4 inches wide fastened at least 4 inches from each end by not less than three 10d. nails or by wire equal to two wrappings (4 strands) of good ⅛-inch diameter wire. The crossboards or wire should clear the top of the lading by at least 2 inches.

b. A layer of ponton balk should be laid flat on the floor of the car with the fittings staggered, occupying the full width of the floor. Normally 14 ponton balk can be placed in each layer. The pile of balk should be built up, layer upon layer, with the trestle balk on

top of the ponton balk. The shorter trestle balk should be placed so that the trestle balk layers will be flush with the ends of the ponton balk against the chess stack. Strips of lumber not less than 7/8-inch thick by 6 inches wide should be placed across the full width of the stack to act as binders, not over 6 feet apart, dividing the stack into tiers of not to exceed four layers each. Not less than four binder strips will be required between tiers of ponton balk and not less than three binder strips will be required between tiers of trestle balk.

c. Chess should be laid flat in layers occupying the full width of the floor. Normally nine chess can be laid thus. The stack of chess should be built layer upon layer with strips of lumber not less than 7/8-inch thick by 6 inches wide placed across the full width of the stack so as to divide it into tiers of not more than ten layers each. Not less than three strips will be required between tiers of chess. The unused end of the car, if any, should be loaded with one or more trailers, depending upon the available space. Trailers should be loaded and braced as described in paragraph 97.

96. Ponton load.—Pontons must be loaded inverted. With only about 6 inches of water in the ponton, its weight will be increased by about 3,300 pounds, and it will hold about 9 tons of water. The car should be prepared for loading by bolting two timbers about 8 feet long transversely to the floor of the car. These timbers must be at least 10 inches high, so as to raise both ends of the inverted ponton off the car floor. The first of these should be about 7 feet from the end of the car floor and the second 14 feet center to center from the first. The first ponton should be placed upside down on the timbers and the second and third pontons placed above it, each separated from the ponton beneath it by two 2- by 6-inch pieces of lumber about 8 feet long placed directly above the sills under the first ponton. The stack of pontons then should be braced longitudinally and transversely.

97. Trailer load.—The drawbars of the trailers should be adjusted to their shortest length. All of the clamping beams should be secured in the places provided on the empty trailer. The first trailer should be placed on the car with its pole inclined upward and located so that the end of the pole is directly above a point 12 inches from the outside face of the end sill of the car, if on a flat car, or in line with the inside face of the end if in a gondola. The upward inclination of the pole is fixed when the rear end of the trailer touches the floor. Chocks should be placed before and behind both wheels of the trailer and the front end supported to main-

tain the proper inclination. Succeeding trailers should be arranged with the same inclination of the drawbar and the wheels brought in contact with the wheels of the preceding trailer. Each trailer should be chocked in front and rear of each wheel and the front ends supported by blocking between the trailers. A 4- by 4-inch timber rail should be spiked or bolted to the floor of the car outside the tires to prevent lateral movement. Two pieces about 4 by 4 inches should be placed over the axles inside the chassis frames and secured on the floor of the car by tie rods or wires.

98. Miscellaneous items.—All other items of the equipage should be loaded in a boxcar and secured so that they will not come in contact with side or end doors, or roll or shift in transit.

SECTION XVIII

MAINTENANCE OF EQUIPAGE

	Paragraph
General maintenance	99
Repairs	100

99. General maintenance.—*a. General.*—(1) Proper care and maintenance of the ponton equipage in accordance with a routine program is essential to keep it in condition for use as required, and to avoid any possibility of failure of any of its parts either to operate properly or to carry the heavy loads that the equipment may be subjected to. This is especially true because of the number of mechanical devices included in the equipage, and the fact that factors of safety in all parts of the equipment have been kept small in order to keep weight down. Moreover, proper maintenance will insure the appearance of general smartness expected of all military equipment.

(2) A regular program of inspection, cleaning, replacement, repair, and painting should be set up and adhered to. It is especially important that all parts of the equipment be carefully inspected and corrective measures taken when the equipment is put away after extended use.

(3) It is important that all parts of the equipment be kept clean. This is particularly true of the numerous mechanical devices which often will not operate properly when foul. The equipment must be thoroughly cleaned before being stored for any considerable period or serious deterioration will result. Keeping the aluminum pontons and trestles and the wooden parts of the equipage thoroughly painted is essential. In general, the various mechanical devices are designed to operate satisfactorily without lubrication. Screw parts particularly should not be lubricated because experience has shown that this leads

to an accumulation of dirt and dust in service use, which is apt to cause more fouling and damage to the screw parts than results without lubrication.

(4) The equipment should always be stored under cover, when practicable. When open storage must be used, parts of the equipment should be so disposed that water will drain from the stacks, there will be adequate ventilation, and none of the pieces of the equipment will be placed in direct contact with the ground. It is especially important that equipment is well painted when stored in the open for any extended period.

(5) Points regarding the care and maintenance of the several parts of the equipment are covered in the succeeding paragraphs.

b. Pontons.—(1) The aluminum alloy of the ponton is subject to corrosion, which not only causes a break-down of the surface of the metal, as with iron and steel, but also of the whole structure of this metal. This process is accelerated by salt or brackish water. Accordingly, care must be taken to keep the pontons painted.

(2) Periodically when in use, and invariably before storing, the ponton should be thoroughly cleaned and washed, both inside and out, and thoroughly dried. This process should include removal and cleaning of the grating.

(3) The pontons may be stored under cover, stacked or loaded on the trailers, as desired and as space permits. When stored stacked under cover, they may be placed in the stacks either upright or inverted, with stacks no higher than three pontons. The bottom ponton in the stack should be held off the ground or floor by timbers or other materials at least 10 inches thick, placed so that the ponton will rest evenly on at least the four points where the outside bulkheads intersect the sides of the pontons. Cross timbers should be placed similarly between pontons in one stack.

(4) Pontons should never be stored in the open on the trailers nor upright on the ground. This is especially important if the pontons are stacked in the open because serious damage may result from an accumulation of rain water or snow in them. Even for temporary storage prior to use, it is desirable to place them bottom side up, to avoid having to pump them out.

(5) Care should be taken to avoid resting or dragging the ponton over sharp obstructions. When pontons are being turned over, particular care should be taken to avoid damaging the carrying rail.

(6) Balk fasteners should be kept fast in their keepers, except when actually in use. Particular care should be taken that the mousing on the spare balk fasteners remains in place to avoid their loss.

c. Trestles.—(1) The trestle is made of aluminum alloy throughout, except for a few parts of the shoes, and requires the same care to avoid corrosion as does the ponton.

(2) The trestle parts may be stored in any convenient fashion provided care is taken to prevent crushing or bending of the columns and transoms. Preferably, the transoms should be placed erect, to avoid any possibility of bending or damage to its lashing cleat castings by placing loads upon it when laid flat. Trestle shoes may be stacked or laid side by side, teeth down, on top of the columns also laid side by side.

(3) It is especially important that no load is placed on the transom, when the trestle is in use, before the pins have been inserted which secure the transom to the columns.

(4) Chests are provided for the storage and transportation of the chain hoists and they should always be used for these purposes. It is especially important that the chain and other parts of the chain hoist be kept clean or excesive wear and damage to the working parts will result. Lubrication should follow the manufacturer's instructions.

d. Balk, chess, and sills.—The factor of safety utilized in the design of these members is small. Accordingly, it is of particular importance that these items be kept well painted and stored in the proper manner so as to keep the action of decay at a minimum. Minor damages through cuts or abrasions are particularly subject to incipient decay and should be trimmed off and painted as soon as practicable. Metal parts should be kept clean and greased or painted to reduce rusting. It is of particular importance that these items be placed in well ventilated stacks well off the ground, and with one end higher than the other to allow for drainage when in storage in the open.

e. Fittings.—Chests are provided for storing and transporting the side rail clamps, hinge sill hangers, windlass sticks, oarlocks, and small trailer spare parts and should be used for these purposes.

f. Outboard motors.—The care and maintenance of outboard motors is covered fully in paragraph 47.

g. Miscellaneous items.—These include rope, anchors, oars, boathooks, and pickets. These items are transported loose in the body of the prime mover trucks and can be stored in any convenient fashion. The anchor should have the stock unlatched and tied to the shank. Rope should be coiled, handled, and stored as prescribed in engineer field manuals. Rope also should be washed thoroughly free of grit and dirt, periodically and before storage, which otherwise will work into the fibers cutting them and materially reducing the strength of the rope.

h. Trailers.—(1) In general, the care and maintenance for the trailers are the same as is generally prescribed for motor vehicles. Special attention must be given to lubrication and tire inflation. The latter should be checked frequently, especially when going into service after a period of idleness. When the trailers are stored, they should be blocked up. The clamping beams should never be used as crowbars. The ponton clamping beam should be removed from the drawbar and placed in carrying position immediately after unloading a ponton from a trailer.

(2) *The trailers must not be backed when in tow. Failure to observe this precaution will result almost invariably in bending or breaking the drawbar. When it is necessary to back in close quarters, the trailer must be unhitched and moved by hand.*

(3) The ponton has been designed primarily to carry loads only when it is floating freely in water. The transportation of the necessary accessories for its operation should be limited to a minimum.

100. Repairs.—*a. Balk, chess, and sills.*—In general, repairs to these items will be limited to removing crushed or splintered wood, reshaping, and painting minor cuts and blemishes, and straightening and refastening the metal fixtures. Fittings should be removed from condemned timbers and retained for use as future replacements.

b. Trailers.—Repairs to the running gear of the trailers are comparable to similar work on other types of automotive vehicles. Repairs to the trailers, other than the replacement of parts, usually require the facilities of a depot.

c. Fittings.—Most of the repairs to the siderail clamps, hinge sill hangers, and similar fittings will consist of straightening deformations of metal parts and removing burrs from threaded parts. Taps and dies are provided in the ponton repair kit for truing the threads of the screw parts.

d. Trestle.—Slight bends in the transom and columns may be straightened in the field. Minor punctures and damage to the transom may be effected with the equipment and material provided for the purpose in the ponton repair kit. Repairs other than these generally require the facilities of a depot.

e. Ponton repair kit.—This kit is mentioned in paragraph 35 and its contents are listed in table I (par. 102). It is designed for the repair of the aluminum pontons and the aluminum parts of the trestle transom. It includes dies for the screw threads of the siderail clamps, hinge sill hangers, and similar fittings. In each chest there is a small amount of sheet aluminum, impregnated fabric, plastic material for sealing seam leaks, rivets, bolts, nuts, and wood screws.

All tools are manually operated and designed so that no special training is required for their use.

f. Minor and temporary repairs to the ponton.—(1) Dents in the skin have no immediate effect upon the serviceability of the ponton but should be removed as they may cause further damage. They can be removed by light blows of a hammer, mallet, or a block of wood. Care should be taken to avoid stretching the metal at the rivets, which may cause a leak that will be difficult to stop without replacing the affected portion of the skin.

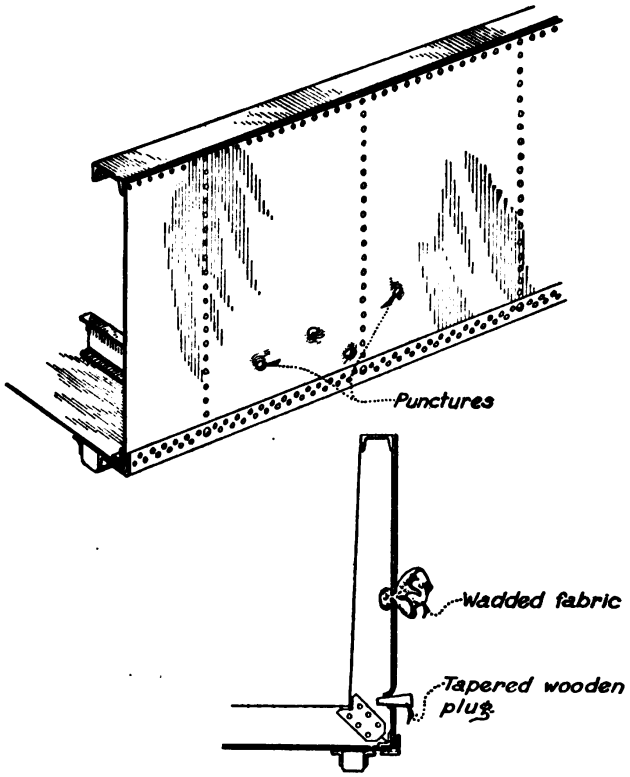


FIGURE 43.—Plugs driven in hole from direction from which puncture occurred.

(2) Usually bent framing will not render the ponton unserviceable, except in the case of extensive bending of the gunwale between the bulkheads which may prevent the engagement of the balk fasteners. This should be corrected as soon as practicable because it weakens the ponton and may lead to subsequent damage. Slight distortions can be removed by hammering or bumping with a large wooden block.

(3) The most satisfactory hasty method of stopping a leak below the water line is to stuff the aperture with wadded fabric, forcing it through in the direction from which the tear or puncture was made and leaving enough on both sides to insure keying of the material about the aperture. A more durable method, usually appli-

cable only to round holes, is to drive a conical plug of wood into the aperture from the direction from which the puncture occurred. (See fig. 43.)

(4) Often short and regular tears above the water line can be closed sufficiently for a temporary repair by peining. The dent in the material in the vicinity of the tear is first flattened; then a flat dolly is held on one side of the tear, which is closed by hammering just above and below the tear with the ball end of a pein hammer. The peining will force the material at the tear together so that

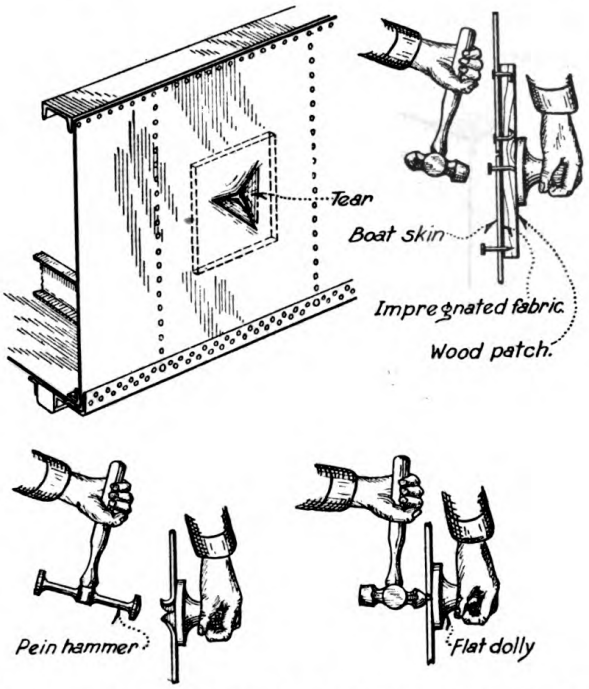


FIGURE 44.—Temporary skin repairs: peining short regular tear above waterline; placing fabric and board patch.

the application of a heavy coat of paint or similar plastic material will form a temporary watertight joint. (See fig. 44.)

(5) A more permanent hasty repair of holes is made by placing a piece of wooden board over the opening with a piece of impregnated fabric between the wood and the aluminum skin. The board is bolted or nailed over the aperture, and if nailed, the nails are driven through the aluminum skin and clinched to the wood. Impregnated fabric is provided in the ponton repair kit and is used between the wood and the aluminum skin to assist in making a watertight joint between them. If no prepared fabric is available, a piece of canvas or similar material thoroughly soaked with wet paint is a reasonably satisfactory substitute. (See fig. 44.)

g. Major and permanent repairs to the ponton.—(1) Patching with a piece of sheet aluminum, with impregnated fabric between the patch and the skin of the ponton, is the most permanent method of effecting a repair to a hole in the skin. The ponton repair kit was designed primarily to effect this type of repair, and it contains all necessary tools and supplies. The procedure is as follows: (See figs. 44 and 45.)

(*a*) Flatten and smooth out the distorted metal in the vicinity of the rupture and the surface of the skin to be under the patch,

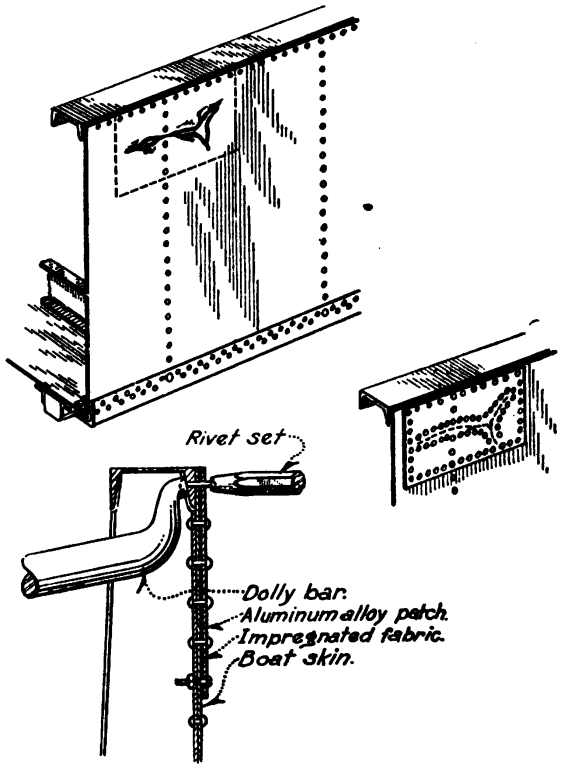


FIGURE 45.—Permanent skin repairs: placing aluminum sheet patch.

trimming away all frayed edges and burrs. The patch must *always* be placed on the *outside* surface of the ponton.

(*b*) Cut an aluminum patch of size necessary to cover the hole and to provide space for the rivets to hold the patch in place. The size of the patch must be kept to a minimum because the larger it is the more difficult it is to secure a tight job.

(*c*) Using the patch as a templet, cut a gasket from the impregnated fabric.

(*d*) Lay out the rivet spacing on the patch, center punching the location for each rivet.

(*e*) Drill one or more of the rivet holes in the patch and then in the skin using the drilled patch as a template. Then temporarily attach the patch to the skin, with the gasket between it and the skin, and bolt in place with $\frac{3}{16}$-inch round head stove bolts.

(*f*) Drill all the rivet holes and then rivet. The first rivets driven must be scattered throughout the patch followed by riveting through the intervening holes. This procedure is necessary because an attempt to drive the rivets progressively from one hole to the next will cause the patch to creep and produce a misalinement of the rivet holes in the patch and the ponton.

(2) Punctures of less than $\frac{5}{16}$-inch diameter can be closed effectively and more simply by flattening the metal about the hole and removing burrs, drilling and reaming out the puncture, and then driving the proper size rivet in the resulting hole.

(3) In the absence of aluminum sheet, sheets of galvanized iron or plain sheet steel can be used, but these metals are likely to set up mild electrolytic action destructive to the aluminum. It is essential that the aluminum of the ponton be thoroughly insulated from the patch by the impregnated fabric furnished with the ponton repair kit. This type of repair should be considered as temporary and replaced by an aluminum patch as soon as practicable.

(4) Bent framing will present varying difficulties, depending on the magnitude of the distortion. Minor corrections have already been covered in paragraph 98*f*, for which the tools supplied in the ponton repair kit are adequate. Methods of correcting more serious distortions are illustrated in figure 46. In all these cases special care must be taken to avoid loosening rivets or stretching the skin around the rivets so as to produce leaks. More serious damage may require the facilities of a depot.

h. Painting of ponton and trestle.—(1) All surfaces should be cleaned thoroughly of all loose or cracked paint, grease, oils, and other foreign matter, and polished surfaces should be roughened by sand papering. The surfaces may be etched by treating them with a solution of 2 parts ethyl alcohol, 5 parts phosphoric acid, and 93 parts water. The etching solution should be applied thoroughly, allowed to remain for about 15 minutes, and then rinsed off with clean water.

(2) After drying, a primer coat is applied to the prepared surface. Any standard commercial brand of zinc chromate primer can be used. If none of these are available, a satisfactory primer can be made by mixing aluminum powder with a good grade of spar varnish. The powder content of the mixture should be sufficient

to permit covering the surface thoroughly, but should not be so thick as to prevent the paint from flowing freely from a brush. Then a seal coat of aluminum paint is added, similar to the priming mixture just described. If spraying equipment is available, bakelite varnishes mixed with aluminum powder are suitable and convenient for the seal coat. The finish coat should be of quick drying enamel of the standard olive drab color.

(3) No paint should be applied until the preceding coat has thoroughly dried. Paint applied in very cold weather dries very

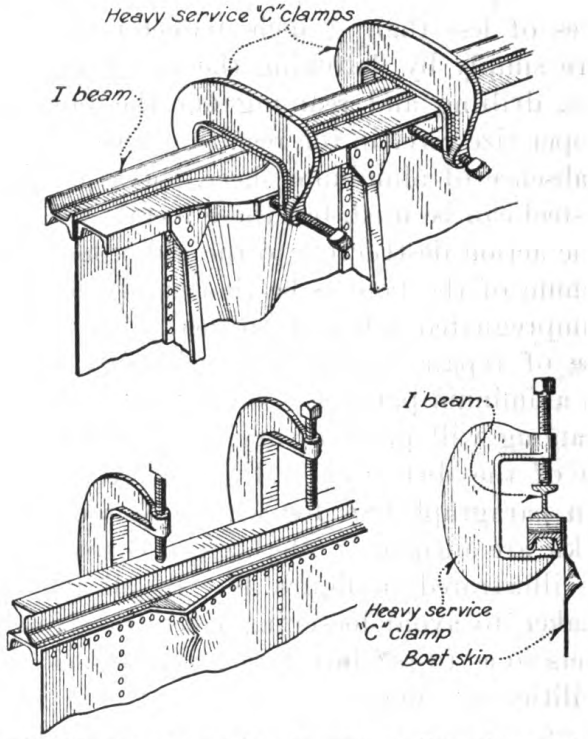


FIGURE 46.—Method of straightening serious distortions of framing.

slowly and generally produces poor results, usually blistering or peeling in warm weather. Paint applied at a temperature of about 70° F. produces the best results, but sufficiently good results can be obtained so long as temperatures are above 40° F.

SECTION XIX

PONTON BRIDGE, 7½-TON, MODEL 1926

Paragraph
Description of equipment 101

101. Description of equipment.—A number of units of a similar type of ponton bridge equipment, the 7½-ton ponton bridge,

model 1926, have been manufactured and issued and may be continued in use for some time. This 7½-ton equipage is similar in all major respects to the 1938 equipage, except for the size of the pontons which are 26 feet 6 inches long, 5 feet wide, and 2½ feet deep, with a maximum displacement of 18,500 pounds—and the use of seven balk per bay instead of eight. The length of the boat span is 16 feet rather than 15½ feet. Further details of the 7½-ton equipage may be found in FM 5–10.

SECTION XX

LIST OF EQUIPAGE

Paragraph
List of equipage 102

102. List of equipage.

TABLE I.—*Light ponton equipage, model 1938*

(1 bridge unit, approximately 250 feet, using all of basic quantities.)

Article	Basic quantity	Spares	Total number
Adapter, towing	4	0	4
Anchor, kedge, 100 pound	18	6	24
Balk, ponton	111	9	120
Balk, trestle	70	30	100
Boat, assault	1	0	1
Bracket, stern attachment, for 22-hp. outboard motor	4	0	4
Chess	272	16	288
Chest, chain hoist	5	0	5
Chest, for transporting 4.5-hp. outboard motor, spare parts, instruction book, and accessories	2	0	2
Chest, for transporting 22-hp. outboard motor, spare parts, instruction book, and accessories	4	0	4
Chest, spare parts and accessories, to carry siderail clamps, oarlocks, wire rope clips, small trailer spare parts, and hinge sill hangers	8	0	8
Clamp, siderail	102	12	114
x Clip, wire rope, ½-inch	36	0	36
Hanger, hinge sill	14	7	21
Hoist, chain, 1-ton (part of trestle assembly)	8	1	9
Hook, boat, ball point, 10-foot handle	24	6	30

x Expendable items.

Article	Basic quantity	Spares	Total number
Kit, repair, for aluminum ponton, containing	1	0	1
x Aluminum, sheet, 1/16-inch thick, square feet	10	0	10
x Aluminum, sheet, .0808 inch thick, square feet	2	0	2
Blades, hacksaw 12 inches (fine teeth)	12	0	12
x Bolts, stove, round head, 5/16-inch diameter, 1 inch long	100	0	100
x Canvas, bitumastic impregnated, square feet	10	0	10
x Cement, dolphinite, 6 ounces, tubes	4	0	4
Chisel, rivet cutting	1	0	1
Chisel, chipping	1	0	1
Die, 1/2-inch diameter, 20 R. H. S. A. E. threads	1	0	1
Die, 3/4-inch diameter, 10 Acme threads R. H	1	0	1
Die, 3/4-inch diameter, 10 Acme threads L. H	1	0	1
Dolly, for 5/16-inch diameter, R. H. rivets	1	0	1
Dolly, for 1/4-inch diameter, R. H. rivets	1	0	1
Dolly, flat surface	1	0	1
Drill, breast, medium size, complete	1	0	1
Drills, straight shank, 21/64-inch diameter	4	0	4
Drills, straight shank, 17/64-inch diameter	4	0	4
Drills, straight shank, 15/64-inch diameter	4	0	4
Drills, straight shank, 13/64-inch diameter	6	0	6
Files, 12-inch aluminum	2	0	2
Files, 10-inch flat smooth	2	0	2
Frame, hacksaw, 12-inch	1	0	1
Hammer, ding	1	0	1
Hammer, ball pein, 1 1/2-pound	1	0	1
x Nuts, S. A. E., 5/16-inch diameter	150	0	150
x Nuts, S. A. E. 1/4-inch diameter	100	0	100
x Nuts, S. A. E. 1/2-inch diameter	6	0	6
Pins, drift, 5/16-inch to 5/16-inch	2	0	2
Pliers, slip joint, side cutting 7 inches long	1	0	1
Punch, center	1	0	1
x Rivets, aluminum, R. H. 5/16-inch diameter, as follows, pounds: 1 inch long—1/2 pound; 3/4 inch long—1 pound; 5/8 inch long—2 pounds; 1/2 inch long—1 1/2 pounds	5	0	5
x Rivets, aluminum, R. H. 7/32-inch diameter, 3/4-inch long, pounds	1	0	1
x Rivets, aluminum, R. H. 1/4-inch diameter, as follows, pounds: 1 1/2 inches long—1/2 pound; 1 inch long—2 pounds; 3/4 inch long—1 1/2 pounds	4	0	4
x Screws, S. A. E., 1/2-inch diameter, 1 inch long	6	0	6
x Screws, S. A. E., 5/16-inch diameter, 3/4 inch long	100	0	100
x Screws, S. A. E., 1/4-inch diameter, 3/4 inch long	50	0	50
x Screws, mach., F. H. 5/16-inch diameter, 1 inch long, 24 threads	25	0	25

x Expendable items.

Article	Basic quantity	Spares	Total number
Kit, repair, for aluminum ponton, containing—Con.			
x Screws, mach., F. H. ¼-inch diameter, ¾ inch long, 28 threads	25	0	25
Screws, brass, wood, F. H. No. 10—1½ inches long	144	0	144
x Screws, brass, wood, F. H. No. 6—1¼ inches long	144	0	144
Screwdriver, 8-inch	1	0	1
Screwdriver, 3-inch	1	0	1
Set, for 3/16-inch diameter R. H. rivets, straight	2	0	2
Set, for 3/16-inch diameter R. H. rivets, offset	1	0	1
Set, for 7/32-inch diameter R. H. rivets, straight	1	0	1
Set, for ¼-inch diameter R. H. rivets, straight	2	0	2
Shears, sheet metal, pair	1	0	1
Stock, for 2-inch round dies	1	0	1
Tap, ½-inch diameter 20 R. H., S. A. E. threads	1	0	1
Tap, ¾-inch diameter 10 Acme threads, R. H	1	0	1
Tap, ¾-inch diameter 10 Acme threads, L. H	1	0	1
Wrench, double open ends, for ¼-inch and 5/16-inch S. A. E. nuts	1	0	1
Wrench, double open ends, for ⅜-inch and ½-inch S. A. E. nuts	1	0	1
Wrench, closed end, 12 point, for ½-inch S. A. E. nuts	1	0	1
Wrench, socket, 12 point, handled, for ½-inch S. A. E. nuts	1	0	1
Wrench, socket, 12 point, handled, for ⅜-inch S. A. E. nuts	1	0	1
Wrench, socket, 12 point, handled, for 5/16-inch S. A. E. nuts	1	0	1
Wrench, socket, 12 point, handled, for ¼-inch S. A. E. nuts	1	0	1
Wrench, tap, adjustable, size No. 6	1	0	1
Motor, outboard, 4.5-hp., with	2	0	2
Book, instruction, outboard motor	2	0	2
Can, fuel, 2-gallon, emergency, outboard motor	2	0	2
Cover, motor	2	0	2
Filler plate, outboard motor	2	0	2
Funnel, filtering, 120-mesh screen, outboard motor	2	0	2
Pin, shear, outboard motor	0	12	12
Propeller, outboard motor	0	4	4
Spark plug, outboard motor	0	12	12
Motor, outboard, 22 horsepower, with	4	0	4
Book, instruction, outboard motor	4	0	4
Can, fuel, 5-gallon, flexible spout, emergency, outboard motor	4	0	4

x Expendable items.

Article	Basic quantity	Spares	Total number
Motor, outboard, 22-hp. with—Continued.			
Cover, motor	4	0	4
Funnel, filtering, outboard motor	4	0	4
Pin, shear, outboard motor	0	24	24
Propeller, outboard motor	0	8	8
Spark plug, outboard motor	0	24	24
Oar, ponton, 13-foot	84	24	108
Oarlock, ponton	96	24	120
Picket, steel, 2 by 36 inches	24	50	74
Ponton, aluminum, 7½-ton	12	0	12
Pump, bail, ponton	12	3	15
x Rope, manila, ½-inch diameter, feet	2, 400	0	2, 400
x Rope, manila, 1-inch diameter, feet	10, 800	7, 200	18, 000
x Rope, wire, ½-inch diameter, 6 by 19, cast steel, feet	500	0	500
Sill, 5¾ by 7¾ inches by 13 feet	4	0	4
Stick, windlass, steel, 1 1/16 by 42 inches	4	8	12
Trailer, 2-wheel, pneumatic tires	33	0	33
Trailer spare parts:			
Beam retainer assemblies, complete	0	4	4
Beam clamping screws and hooks	0	4	4
Boat clamping beams	0	2	2
Boat clamping beam pins with chains, complete	0	2	2
Boat clamping beam hooks and wing nuts	0	6	6
Boat clamping chains with hoop, clevis and pin, complete	0	2	2
Clamping beams, complete, without wearing strips	0	6	6
Clamping beam chains with clevis and pin, complete	0	4	4
Drawbars, complete, with stand assembly	0	2	2
Drawbar pins with chains, complete	0	4	4
Hub caps, with bolts and gasket	0	2	2
Wheels, with tires and tubes mounted	0	8	8
Wheel nuts	0	12	12
Trestle, complete (without hoist)	4	0	4
Tools:			
Mattock, pick, large, handled	2	0	2
Pole, ranging, 6-foot, 2-section, metal, tubular, 6-inch white and red graduations, with canvas case	2	0	2
Shovel, general purpose, D-handle, round point, type A, size 2	4	0	4
Sledge, double face, 12-pound, handled	2	0	2
Tape, metallic, 50-foot, graduated in feet and inches	1	0	1

x Expendable items.

TRAILER LOADS

2 trestle loads each of 2 trestles.
2 abutment loads, each of 10 trestle balk, 16 chess and 2 sills.
3 abutment loads, each of 10 trestle balk, 16 chess and 2 shore lines (720 feet each).
1 abutment load of 10 trestle balk, 16 chess, 2 shore lines (720 feet each) and 1 assault boat.
12 ponton loads, each of 1 ponton, 1 anchor, 1 anchor cable, 2 boat hooks, 8 oars, 8 oarlocks, 1 pump, and six 20-foot lashings.
12 deck loads, each of 10 ponton balk and 16 chess.
1 load of 30 spare trestle balk.

—
33

The remaining accessories and spare parts will be carried in the organic transportation or in the trailer loads.

CHAPTER 5

HEAVY PONTON BRIDGE, 23-TON, MODEL 1924

	Paragraph
Purpose of bridge	103
Composition and assignment of equipment	104
Detailed description of equipment	105
Care and storage of equipment	106
Transportation of equipment	107
Construction of bridge	108
Time and labor requirements	109
Ferrying	110

103. Purpose of bridge.—*a.* The 23-ton (heavy) ponton bridge is a type of floating equipment capable of transporting the heaviest army loads. It is for use under conditions demanding the prolonged and continuous passage of corps and army loads across deep and wide streams.

b. The 23-ton equipment is very much heavier, and hence more difficult to tranport and handle than the light equipment. Consequently, the construction of this bridge is more difficult and requires more time than the reinforced light bridge. The chief advantage of the 23-ton equipment over the lighter type, when reinforced, aside from the slight increase in capacity over the 20-ton bridge, lies in the possibility of bridging a given stream with fewer individual articles of equipment and fewer units of transportation.

c. A heavy ponton bridge, model 1940, has been approved to replace the 23-ton equipment. In general it will be similar to the model 1924 but in addition to its increased capacity which will be in excess of 25 tons, it will have the following special characteristics:

(1) Sixteen semitrailers transport the twelve pontons, ponton balk, trestle balk, chess, and four trestles of one unit of equipment. Twelve semitrailers each carry one ponton and all the balk and chess needed for one complete floating span. Two semitrailers carry two trestles each and two semitrailers carry the abutment loads.

(2) If wooden balk are not obtainable in quantity to meet the desired specifications, the roadway will be supported on metal balk or on trusses.

(3) Power equipment (truck cranes, tractors, etc.) are organically assigned to facilitate the handling of the increased weights of equipment.

(4) The organization will have all transportation needed to move the entire unit as a whole and provide great mobility. The prime movers are 4-ton trucks (4x4) organically assigned; these draw the semitrailers at speeds up to 45 miles per hour under favorable conditions.

104. Composition and assignment of equipment.—*a. The bridge unit.*—Basically, the unit of equipment consists of twelve pontons and four trestles. The unit provides for the construction of from 246 to 262 feet of bridge, depending upon the exact location of the hinge sill used in connecting the fixed span to the boat spans. For rough estimation the length of the unit is generally given as 250 feet. A complete list of the articles included in a single unit of the equipment is given in table II; reference may also be made to the Engineer supply catalog. In addition to the items given in the table, a number of trailer spare parts are included.

b. Issue.—One unit of the equipment is issued to each of the four bridge platoons of the heavy ponton battalion. Additional issues may be made for training purposes, as ordered by the War Department.

105. Detailed description of equipment.—*a. Ponton.*—(1) The ponton is 32 feet 6 inches long, 6 feet 6 inches in beam, with a depth at bow and stern of 3 feet 9 inches, decreasing to 3 feet 3 inches amidships. The gross displacement of the ponton, with a freeboard of 10 inches, is about 28,000 pounds; with a freeboard of 6 inches the displacement is increased to 30,500 pounds; at the point of swamping it becomes about 37,000 pounds.

(2) Pontons have been designed of various materials as follows:

Material	Approximate weight
	Pounds
Wood (Douglas fir and white pine)	4, 000
Plywood (Weldwood)[1]	3, 300
Steel (ordinary carbon)	3, 700
Steel (high tensile alloy)[1]	2, 800
Aluminum [1]	1, 800

[1] Never actually constructed or tested.

TABLE II

Articles	Basic quantity	Spares	Total number
Anchor, kedge, 150 pounds	18	6	24
Balk, ponton	121	27	148
Balk, transverse	17	2	19
Balk, trestle	66	12	78
Boat, assault (as accompanying boat)	1	0	1
Chess	272	34	306
Clip, wire rope, ⅝-inch	36	0	36
Hanger, hinge sill	18	7	25
Hanger, transverse balk	34	8	42
Hoist, chain, 2-ton (trestle)	8	1	9
Hook, boat, ball point, 10-foot handle	24	6	30
Load fastening device, trestle trailer, set	0	1	1
Load fastening device, ponton trailer, set	0	1	1
Motor, outboard, 22-hp., 2-cylinder, heavy duty, bronze, 3-blade propeller, tilting type	6	0	6
Pin, shear	0	36	36
Propeller	0	3	3
Spark plug	0	36	36
Motor, outboard, 4.5-hp., 2-cylinder	2	0	2
Pin, shear	0	12	12
Propeller	0	1	1
Spark plug	0	12	12
Oar, ponton, 14-ft	84	24	108
Oarlock, ponton	96	24	120
Picket, steel 2 inches by 36 inches	24	50	74
Ponton, 23-ton	12	0	12
Pump, bail, ponton	12	3	15
Rope, manila, ½ inch—feet	4, 800	2, 400	7, 200
Rope, manila, 1 inch—feet	13, 500	7, 200	20, 700
Rope, wire, ½ inch, galvanized, 6 by 19 cast steel—feet	500	0	500
Sill, 6 inches by 9 inches by 13 feet 6 inches	4	0	4
Stick, rack [1]	102	50	152
Stick, windlass, steel, 1 1/16 inches by 42 inches	10	50	60
Tools:			
Mattock, pick, large, handled	2	0	2
Pole, ranging, 6-foot, 2 section, metal, tubular, 6-inch white and red graduations, with canvas case	2	0	2
Shovel, D-handle, round point	4	0	4
Sledge, double face, 12-pound, handled	2	0	2
Tape, metallic, 50-foot, graduated in feet and inches	1	0	1
Trailer, ponton, 4-wheel, pneumatic tires, complete with spare parts	13	0	13
Trailer, trestle, 4-wheel, pneumatic tires, complete with spare parts	4	0	4

[1] Will be replaced by balk fasteners and siderail clamps of the type used with the light equipage.

NOTE: Medium tractors will be added to the equipment.

The aluminum ponton is unquestionably the best so far as ease of handling is concerned, but procurement is expensive in peacetime and may become impossible in wartime. The high strength steel boat may become the standard if the 23-ton equipment is procured in quantity for extensive use.

b. Trestle.—(1) The complete trestle consists of a latticed steel girder transom, two columns of cold drawn steel tubing, a steel shoe for each column, and two chain hoists for adjusting the transom on the columns. The transom is secured in position by steel pins passing through the columns. The total weight is 1,690 pounds.

(2) A lighter trestle, utilizing a duralumin transom and smaller shoes, and embodying a number of minor modifications, has been designed. The weight of this improved trestle is about 1,200 pounds.

c. Balk.—(1) The ponton balk, 23 feet long and $5\frac{3}{16}$ inches by $7\frac{3}{4}$ inches in section, are of the finest grade of Douglas fir. Each balk weighs about 225 pounds.

(2) The trestle balk are identical with the ponton balk in every respect except length, being only 16 feet $4\frac{1}{2}$ inches long. Each balk weighs about 160 pounds.

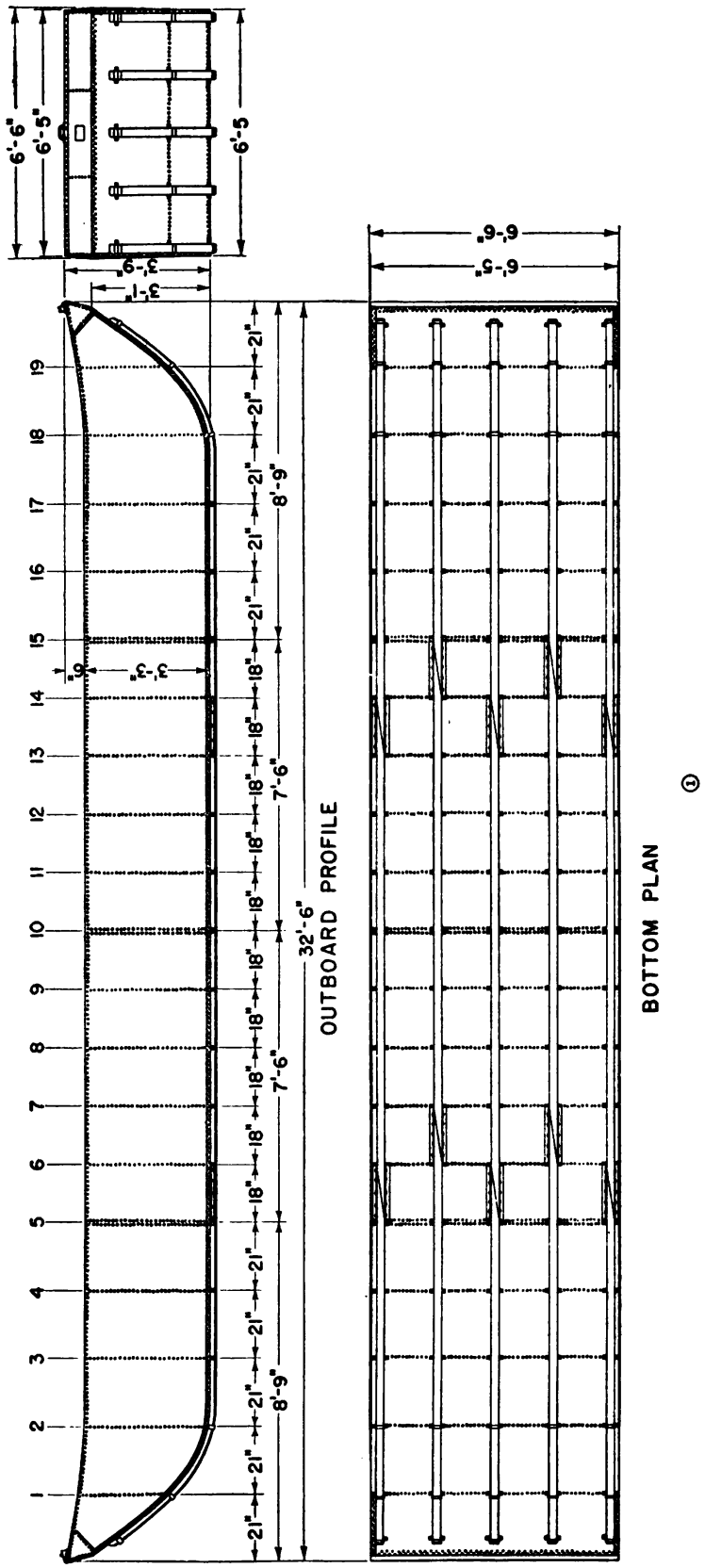
(3) The transverse balk are of Douglas fir, 13 feet 6 inches long and $5\frac{1}{2}$ inches by 10 inches in section. Each balk weighs about 180 pounds.

d. Chess.—The chess are of white pine, southern yellow pine, or Douglas fir, 13 feet 6 inches long, $11\frac{3}{4}$ inches wide, and $2\frac{7}{8}$ inches thick. Each chess weighs about 110 pounds.

e. Sill.—The sills are also of Douglas fir, 13 feet 6 inches long and 6 inches by 9 inches in section. Each sill weighs about 175 pounds.

106. Care and storage of equipment.—All parts of the equipment should be kept clean and dry when not in use. Protective coatings should be maintained on all painted surfaces, and unpainted metal should be covered with a film of oil or grease. The instructions in chapter 4 on the care and storage of the light equipage apply with equal validity to the 23-ton equipment.

107. Transportation of equipment.—The heavy ponton battalion is completely motorized. The unit of equipment, as assigned to a platoon, is carried on seventeen 3-ton, four-wheel drive trucks and



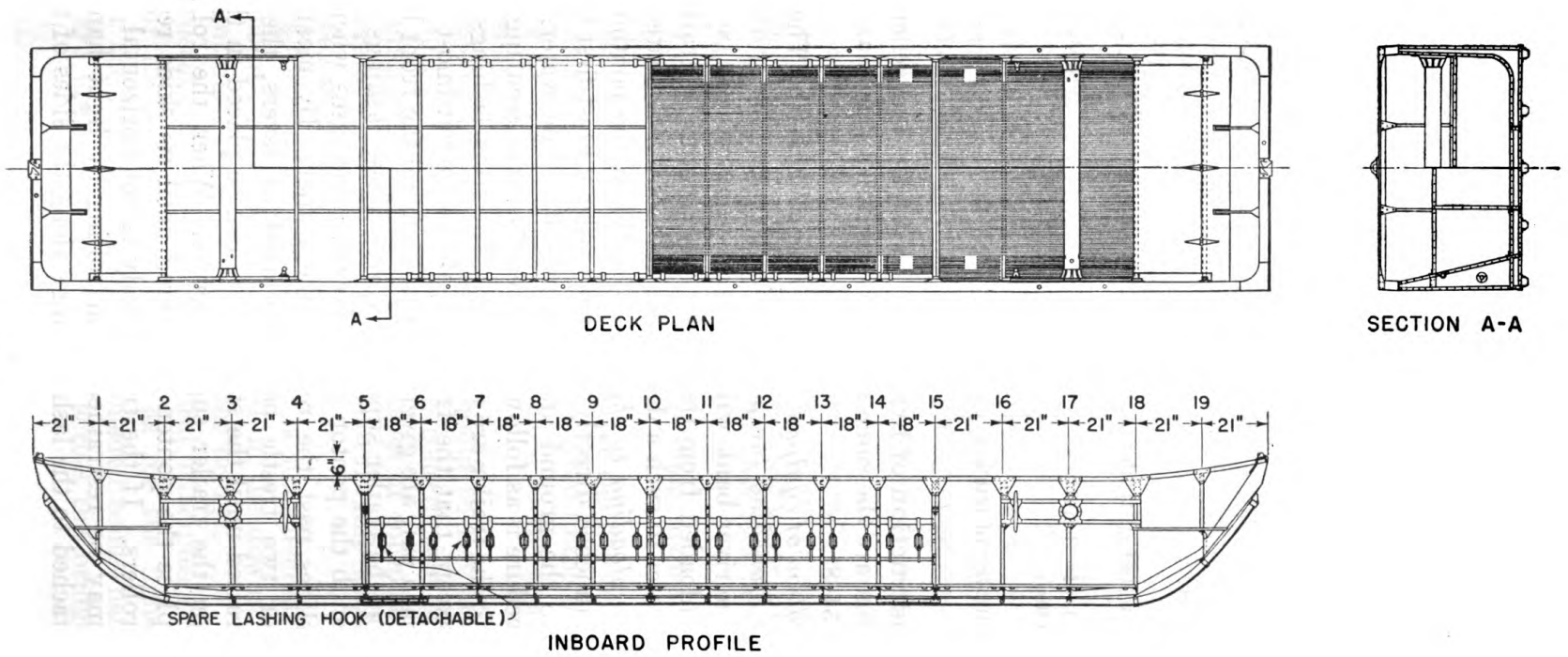


FIGURE 47.—Heavy (23-ton) ponton, model 1924.

seventeen pneumatic-tired, four-wheel trailers drawn thereby, as shown below:

Unit of transportation	Load	Number in platoon
Ponton trailer	1 ponton; 11 balk (sufficient for one floating bay).	12
Trestle trailer	1 trestle; 18 balk (sufficient for one trestle bay).	4
Spare balk trailer	22 boat balk; 12 trestle balk	1
Total number of trailers		17
Truck (with body length of 13 feet 6 inches).	18 chess; miscellaneous articles of equipment.	17
Total number of trucks		17

108. Construction of bridge.—*a. General.*—The general methods of construction are the same as for the light equipage, as outlined in paragraphs 54–81.

b. Preparation of equipment.—(1) *Unloading.*—(*a*) The pontons—

1. By launching the ponton directly from the trailer.—Where the river bank will permit, the ponton may be most easily unloaded from the trailer by backing the trailer into the water to such a depth that the ponton is floated off.

2. By unloading to the ground.—When the ponton cannot be launched directly from the trailer it must first be unloaded to the ground and then moved to the water. The procedure is as follows: The rear lashings securing the ponton to the trailer are removed. The front lashings are undone except that the free ends of the forwardmost lashings of each pair are given two turns around the front lashing eyes on the trailer superstructure. These lashings are used to snub the ponton as its forward end rises when its center slides past the rear of the trailer. By means of jacks or two trestle balk employed as levers, the ponton is raised until the steel rollers can be placed in the brackets on the trailer superstructure. When the rollers are in place the ponton is lowered until its skids rest on these rollers. If the trailer body is not horizontal the ponton may be restrained from rolling by light hand lines attached to the lashing rings along the sides of the ponton.

Two balk are placed as skids at the rear of the trailer and parallel to the long axis thereof. One end of each balk rests, under the ponton, upon the rear transom of the trailer in the space cleared by removal of the balk from their carrying positions, and the other end rests upon the ground. The ponton is rolled to the rear on the rollers until its center passes the rear roller. The front of the ponton is prevented from rising by the two lashings snubbed as described above. A roller is held across the two skid balk near their midpoint, and the rear end of the ponton is allowed to drop upon the roller gradually by slacking off on the snubbed front lashings. When the ponton has been lowered onto the skid roller it may be allowed to roll to the ground. The ponton is now slid along the ground to the water, drawn by a tractor or truck; or a track of balk narrower than the length of the rollers may be laid on the ground, and the ponton rolled by hand over rollers placed on the truck.

NOTE.—The four-wheeled trailers are difficult to back and maneuver and should therefore be properly located when first brought up. If the ponton is to be launched by floating it off the trailer the trailer should be brought as near to the water as possible while still hitched to the truck or tractor. The trailer is then controlled as it rolls into the river by a line snubbed about some holdfast or led to a winch.

(*b*) The trestles are unloaded in the same manner as those of the 10-ton equipage.

(2) *Location of the material.*—(*a*) After the pontons and trestles have been unloaded, the trailer should be moved to the point at which the balk are to be spotted—a point as close to the abutment as the site will permit.

(*b*) Balk, chess, anchors, and sills should be left on their transportation until they are required in the construction of the bridge. Thus rehandling is avoided. These articles of equipment should be grouped carefully to allow ready removal and avoid confusion among the carrying parties.

(*c*) Since the pontons will ordinarily be maneuvered by means of outboard motors, they should be moored on the downstream side of the abutment until they are needed in the bridge.

c. Construction proper.—(1) The general principles governing construction of the bridge are the same as for the light equipment, except that the bays and balk are numbered somewhat differently. The bays are numbered consecutively across the bridge, beginning

with number one as the near bank abutment bay. The balk of each bay are numbered from one to nine, the upstream balk being number one.

(2) *Method of assembling the various parts of the bridge.*—(*a*) *Abutments.*—See paragraph 71.

(*b*) *Abutment spans when trestles are used.*—When the water near the shore will not float a two-boat raft loaded with a trestle, the shallow water method of erection should be used, as prescribed in chapter 4, except as follows: After the abutment sill has been spaced from the trestle by the two outside balk, three balk (Nos. 1, 5, and 9) rather than two are lashed to the transom. When the loaded raft may be floated the procedure differs only in that the balk numbered 2 and 7, and 1 and 8, become 2 and 8, and 1 and 9, respectively.

(*c*) *Abutment span when no trestles are used.*—When no trestles are used the abutment span is erected exactly as for the light equipage for the 23-ton equipment.

(*d*) *Hinge span.*—Paragraph 73*b*, *d*, and *f* applies to the erection of the hinge span as modified to fit the different number of balk.

(*e*) *Chess.*—Chess are laid as outlined in paragraph 75.

(*f*) *Siderails.*—The siderails are laid on the chess, directly over balk numbers 1 and 9. The siderails are balk, either ponton or trestle according to the type of balk in the bay, and are placed top for bottom as compared with the balk proper. The siderails are secured at their centers to the balk below by means of the transverse balk hangers, and at their ends by lashings (clamps may be substituted in the improved design). Each end lashing encompasses two balk and two siderails where they overlap over the ponton. The lashings are tightened with rack sticks.

(*g*) *Transverse balk.*—The position of the transverse balk is at the center of the bay, under and perpendicular to the other balk, with the opening between the sides of the transverse balk under an opening formed by the narrowed portions of adjacent chess. To install the transverse balk and its hanger, a light line is tied to each end of the balk which is then floated under the span. The balk is raised to its position by means of the hand lines and the hangers engaged. The hanger legs are dropped over the siderail, through the openings in the chess and the transverse balk, and the legs then turned outward in opposite directions so that the feet support the bottom of the two sides of the transverse balk. Lastly, the hand lines are removed and the hanger then tightened by turning the screw with a windlass stick.

(*h*) *Floating portion of the bridge.*—The remainder of the bridge is assembled, according to the general method of construction being followed, just as is the light bridge.

(3) *General methods of construction.*—The bridge may be constructed by either the method of successive pontons or that of parts. Ordinarily, the former method will be employed.

(4) *Organization of the working parties for construction by successive pontons.*—(*a*) The table below shows the minimum strength working party required under normal conditions for the rapid and orderly construction of the bridge. In order to maintain the same rate of construction for long bridges the balk carrier, chess, outboard, and siderail sections must be increased.

Section	Noncommissioned officers	Pontoniers	Total
Abutment	1	8	9
Abutment span	3	10	13
Balk fastener	1	10	11
Balk carrier	2	36	38
Chess	2	35	37
Outboard (anchor)[1]	2	10	12
Siderail	1	12	13
Cable	1	4	5
Ferrying		2	2
Totals	13	127	140

[1] The table is based upon the use of outboard motors for maneuvering the pontons for the casting of anchors and to their place in the bridge. If the current is negligible, oars may be substituted for the motors. In such an event there should be four anchor sections of 1 noncommissioned officer and 6 oarsmen each, 3 sections to operate as upstream anchor sections, and 1 as the downstream section.

The construction detail is formed as a whole and divided into sections in the same manner as for the light bridge.

(*b*) *Duties of the sections.*—With certain exceptions, the officers and the various sections perform the same duties as those explained in chapter 4 on the light equipment. The relation of the duties of the sections engaged in the construction of the 23-ton bridge to those of the sections used in constructing the lighter bridge is indicated in the summary below.

1. Officers.—Those prescribed in paragraph 70.

2. Abutment section.—Those prescribed in paragraph 71.

3. *Abutment span section.*—Those prescribed in paragraph 72, except that 1 noncommissioned officer and 5 pontoniers work on the upstream side of the trestle, while the other noncommissioned officer and the remaining pontoniers work on the downstream side.
4. *Balk fastener section.*—Those prescribed in paragraph 73, except that the balk numbered 2 and 7 become 2 and 8, respectively.
5. *Balk carrier section.*—Those prescribed in paragraph 74, except that the section is divided into 9 groups of 4 carriers each, and the balk are carried by 2 men at each end.
6. *Chess section.*—Those prescribed in paragraph 75 with the following changes: The section is organized into 3 chess layers and 16 pairs of chess carriers. Each pair of carriers brings a single chess forward at a time; 1 man is at each end of the chess, with the chess carried under his right arm. Each of the chess layers stands on a pair of balk; the three receive a chess together from the carriers and shove it hard against the preceding chess, making certain that its center is directly over that edge of the center balk (No. 5) which is on the center line of the bridge.
7. *Outboard section.*—Generally, in order to avoid rowing the heavy pontons, which is not feasible in currents exceeding 1 mile per hour, the outboard motors are used to maneuver the boats. The outboard or anchor section is divided into two boat crews, each consisting of a motor operator and assistant and three men. At least one upstream anchor is cast for each ponton of the bridge; on poor holding ground more than one anchor per ponton may be necessary. Only enough downstream anchors are cast during construction of the bridge as may appear necessary to aline each ponton as it is brought into position in the bridge; additional downstream anchors are cast as required after construction of the bridge.
8. *Siderail section.*—Those prescribed in paragraph 77 with the following exceptions: In addition to assisting in the construction of the near bank ponton span and carrying, laying, and lashing the siderails throughout the bridge as for the 10-ton bridge, the siderail section attaches the transverse balk. The section is organized into a section chief, 8 carriers and 4 lashers; 4 carriers and 2 lashers

work on each side of the bridge. As soon as the first 2 bays of the near shore connection are completely floored with chess, the siderail carriers bring out 4 siderails, 2 for each bay; they then go ashore and prepare to carry out the next pair of siderails. The 4 lashers bring out 2 transverse balk, with hangers and lashings, and install the transverse balk and lash the siderails; they then go ashore and prepare to lash the siderails and attach the transverse balk of the next bay.

9. Cable section.—Those prescribed in paragraph 78.

(5) *Construction by parts.*—The procedure and the duties of the sections (which vary somewhat in number) in construction by parts will be apparent from (4) above, and paragraphs 79–81.

109. Time and labor requirements.—The following figures are representative of the time and personnel required in the various operations:

Operation	Personnel required	Time required	Conditions
Unloading:			
To unload ponton directly to water.	1 to 2 squads (assisted by truck or or tractor).	20 minutes	Such that trailer may be backed into water by gravity and ponton floated off. Trailer spotted at top of bank.
To unload ponton to ground	1 squad	15 minutes	Almost any—trailer spotted at unloading site.
To unload trestle from trailer to ground.	1 squad	7 minutes	Almost any—trailer spotted at unloading site.
To launch ponton from ground	2 squads (1 squad laying track; 1 squad rolling ponton).	5 minutes per 100 feet.	Clear even ground to edge of water.
Loading:			
To load ponton directly from trailer.	1 squad (assisted by truck or tractor)	20 minutes	Such that trailer may be backed into water by gravity and ponton floated on. Trailer at top of bank.
To load ponton from ground to trailer.	1 squad (assisted by truck or tractor)	15 minutes	Ponton at rear of trailer ready for loading.
To load trestle onto trailer	1 squad	10 minutes	Trestle parts on ground near trailer.
Bridge construction:			
By successive pontons.			
Near shore connection (abutment, abutment span, 1 trestle, hinge span, end ponton bay, all spans floored).	14 noncommissioned officers and 131 pontoniers.	45 minutes	Current not over 3 miles per hour—good holding ground for anchors—outboard motors used—material all within 100 feet from abutment—not over 20 pontons in bridge.

Each additional trestle	do	10 minutes	Do.
Each boat span	do	10 minutes	Do.
Far shore connection	do	15 minutes per trestle	Do.
By parts.			
Shore connection as above plus as many ponton spans as convenient.	do	45 minutes for shore connection plus 10 minutes for each boat span.	Do.
Each part	10 noncommissioned officers and 113 pontoniers.	10 minutes per part	Do.
Moving each part to bridge and making connections.	Variable—the necessary men are taken from the party which assembled the part.	15 minutes	Do.
Far shore connection	Abutment and abutment span sections from party which makes near shore connection.	15 minutes per trestle	Do.

110. Ferrying.—*a.* A single ponton may be used to ferry 2 infantry rifle platoons (48 men and 1 officer each) with an engineer crew of either 9 men or 2 men with outboard motor.

b. (1) Raft ferries capable of carrying the heaviest army loads may be constructed of the equipment. In general, the rafts are the same as one or more ponton spans of the bridge, reinforced if necessary. The various types of rafts which will be most commonly used, together with the capacities, are listed below.

Type of raft	Clear platform space	Maximum safe load
	Feet	*Tons per bay*
2-boat–1-bay	11 by 22½	12
3-boat–2-bay	11 by 38½	10
4-boat–3-bay	11 by 54½	10
3-boat–1-bay	11 by 22½	18
5-boat–2-bay	11 by 38½	15

(2) Rafts may be constructed with interlaced balk as described for the 10-ton equipment.

(3) Rafts of the 23-ton equipment are propelled as are those of the light bridge equipment, except that rowing is not feasible and outboard motors should be used.

CHAPTER 6

PORTABLE STEEL BRIDGES

SECTION I

H-10 CAPACITY

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Time required for the construction of bridge	120
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111. Purpose of bridge.—*a.* The light portable steel bridge provides a means for rapidly effecting the passage of division loads over streams and ravines of limited width.

b. Motorized and mechanized armies are almost completely dependent in their movements upon an unobstructed road net. Large and small bodies of troops alike may be immobilized by unbridged streams, ravines, or ditches interrupting their avenues of advance. Even brief delays to motor columns represent a great loss of potential mobility and of distance which might have been gained. The enemy will appreciate these facts and will take advantage of them by the widespread destruction of bridges. Thus, demands for bridge construction in modern warfare will be more frequent and more urgent than ever before. Speed in bridging operations, always important, becomes essential, and the practice of constructing fixed timber bridges may at times have to be rejected as too slow.

c. The light portable steel bridge has been designed to meet these new bridging demands and afford passage for light armored units and all divisional transportation over relatively narrow ravines and streams not suited to ponton bridges. This steel bridge is simple and may be speedily erected by small combat units of engineers. It is of a type sufficiently flexible to meet a variety of situations and can be transported on fairly light trucks with ordinary bodies.

112. Features of design.—*a. Material and method of fabrication.*—The bridge is made of a high strength manganese steel, fabricated by welding. The high allowable working stresses of this steel permit reduction in the weight of the main structural elements; welding reduces the weight still more, and leaves the top and bottom surfaces of the girders smooth to facilitate the launching operation. The material used and the method by which the girder sections are fabricated contribute materially to the ease of transport, handling, and erection of the bridge.

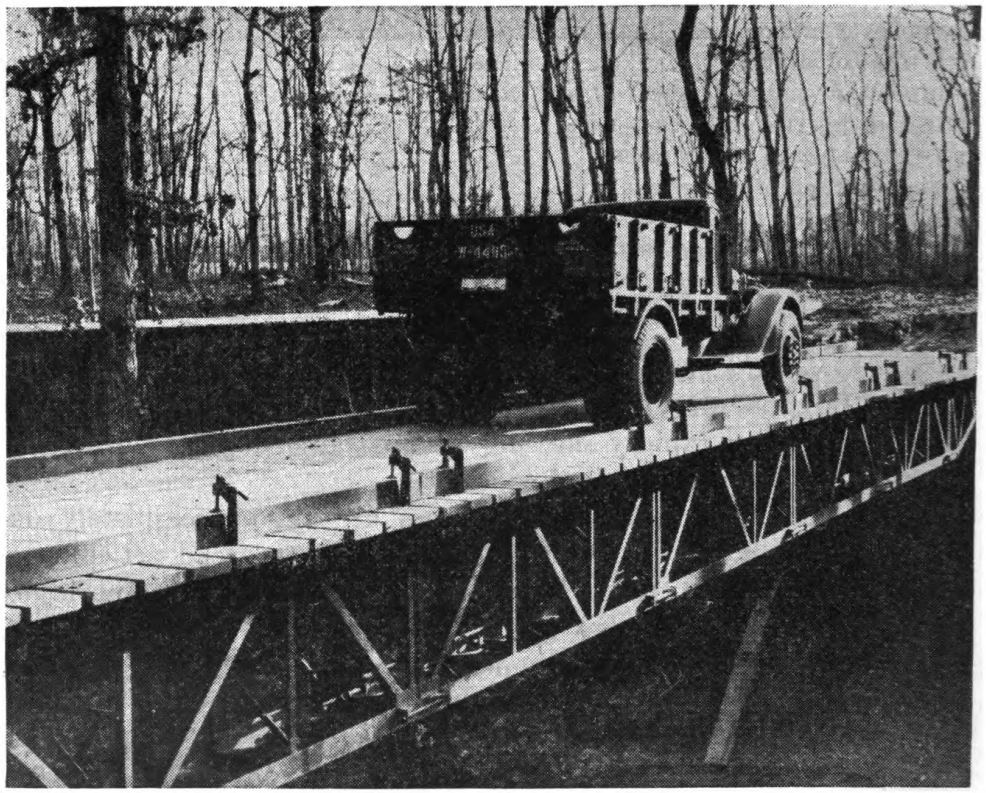


FIGURE 48.—H-10 portable steel bridge.

b. Main supporting members.—The bridge load is ordinarily carried by two sectional latticed box girders (or box trusses) of the deck type. The end girder sections are triangular in elevation; the interior sections are rectangular, and they are reversible end for end and top for bottom. There is no bracing between the girders except that provided incidentally by the floor system or deck. The girders are laid 7 feet 8 inches center to center, and the siderails so placed that a clear roadway width of 9 feet 3 inches is provided.

c. Capacity.—(1) The bridge is designed to carry any of the "light loading" or H–10 combinations (fig. 50) over a maximum

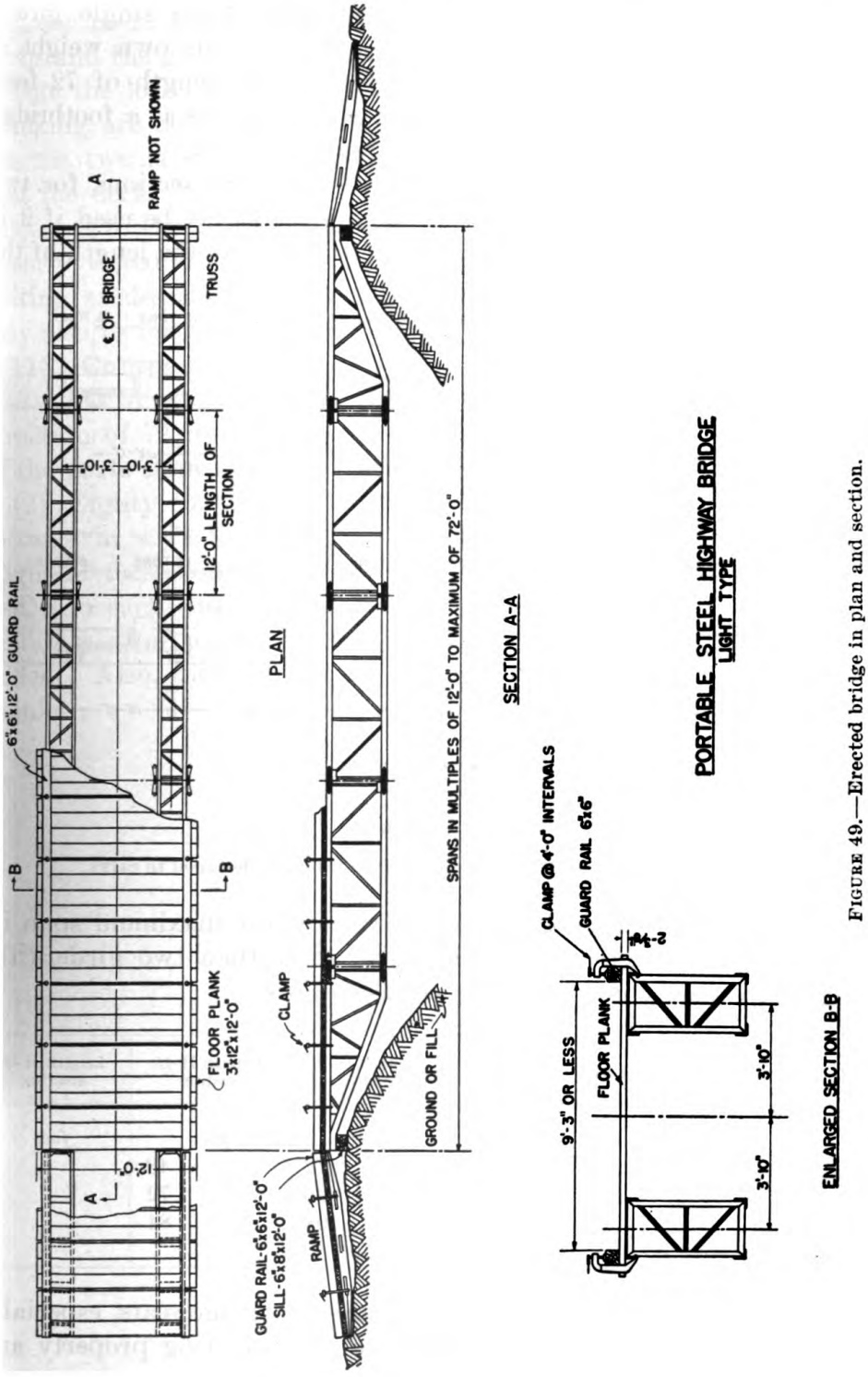
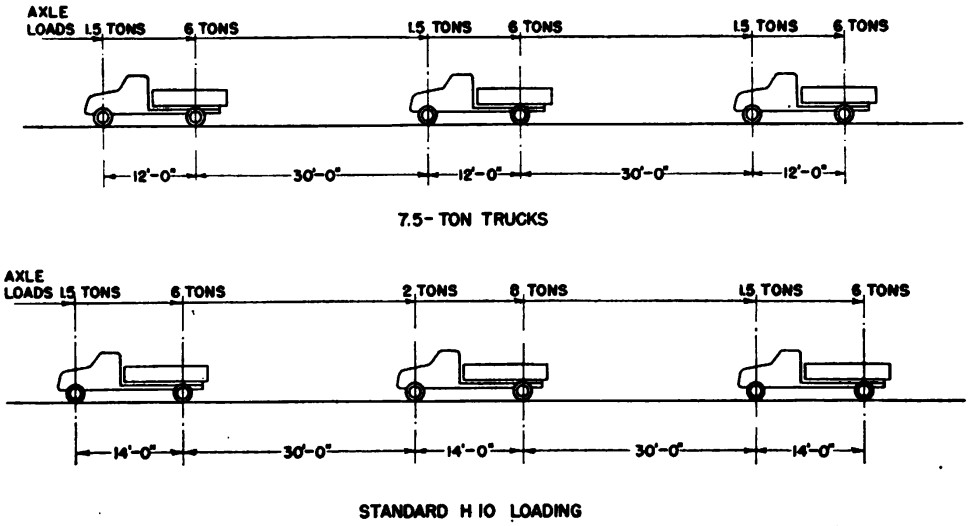


FIGURE 49.—Erected bridge in plan and section.

clear span of seventy feet with two girders. Each single girder when laid on its side will support, in addition to its own weight, a load of about 250 pounds per linear foot on the length of 72 feet. Thus, the girder has ample strength to permit its use as a footbridge 4 feet wide if some type of decking is placed upon it.

(2) (*a*) The unit of equipment affords sufficient sections for two 72-foot girders. However, three or four girders may be used if it is desirable to increase the capacity of the bridge. As the length of the



LIGHT LOADINGS

FIGURE 50.—Light loadings which the H–10 bridge is designed to carry.

standard two girder bridge is reduced below the maximum span its capacity becomes greater, and by using more than two girders the length or capacity may be increased, as follows:

Number of girders	Length H–10 loading	Length H–15 loading	Length H–20 loading
	feet	*feet*	*feet*
2	72	48	36
3	96	72	60
4	108	84	72

(*b*) It is important to level and square the bridge seats, especially in a multiple girder bridge, in order to place flooring properly and to secure a proper distribution of live loads.

(*c*) Although the standard 3-inch deck planking may be used for any of the H–10 bridges, heavier 5-inch planks are necessary for the

2-girder H–15 bridge and for all the H–20 combinations, in order to withstand the greater moments between decking supports and to distribute the loads among the girders properly. Two layers of 3-inch planking are not the equivalent of one layer of 5-inch material, unless the two layers are firmly nailed together. Since it is essential that the decking is firmly secured to the girders when the bridge is subjected to the heavier loadings, the siderail clamps should be frequently tested to make certain that they have not worked loose; bolting as described for the H–20 bridge (see par. 125*e* and *f*(4)) may also be used.

113. Composition and assignment of equipment.—*a. Bridge unit.*—(1) A single unit of the equipment, which permits the construction of 72 feet of bridge for the normal H–10 loading, consists of the parts shown in table III.

(2) Eighty connecting bolts are required to fasten the 12 girder sections in a 72-foot bridge (8 bolts at each section connection). Eight of these bolts are attached to each intermediate girder section, and 6 to each end section, thus providing 8 spares, but since these bolts are vital parts of the bridge another dozen spares have been added. Also, there are 12 spare siderail clamps and 12 spare deck planks.

TABLE III.—*Equipment included in complete (72-foot) unit of H–10 portable steel bridge*

Number in unit	Part	Size overall	Weight each in pounds	Material	Use
108	Bolt, connecting with nuts	1¼ inches		Manganese steel	Connect girder sections.
4	Block, 8-in., double				Launching girders.
2	Block, 8-in., snatch				Launching girders.
48	Clamp, deck				Hold siderail and decking to girders.
2	Jack, 15-ton	22 inches			Launch girders.
2	Nose, launching, complete	1 piece 18 inches by 2 feet by 11 feet 6 inches.	840	Manganese steel	Launch girders.
		1 piece 15 inches by 2 feet by 11 feet 6 inches.			
		4 pins, link, 1¼ inches by 1 foot 1¾ inches.		Manganese steel	Connect 2 pieces of nose.
144	Pin, cotter				Secure nuts on connecting bolts.
4	Pin, launching nose	1 inch by 2 feet 5 inches			Connect nose to girder.
108	Plank, deck	3 inches by 12 inches by 12 feet.	106	Douglas fir	Provide floor support ramp.
4	Ramp girder	8 inches by 2 feet by 12 feet			
4	Roller, erection	4⅜ inches by 13½ inches by 50 inches.	180		Launch girders.
1	Rope, manila, ½-inch, 500-foot length.				Launch girders.

8	Section, girder, rectangular	2 feet by 4 feet by 12 feet	1, 140	Manganese steel	Support bridge, intermediate.
4	Section, girder, triangular	2 feet by 4 feet by 12 feet	820	Manganese steel	Support bridge, ends.
16	Siderail	6 inches by 6 inches by 12 feet	106	Douglas fir	Control traffic, secure decking.
2	Sill, abutment	6 inches by 8 inches by 12 feet	145	Douglas fir	Support girders.
2	Wrench, monkey				Assemble girders.
6	Wrench, socket, rachet				Assemble girders.

(3) The equipment will often be used for the construction of bridges which are less than 72 feet in span. In order to permit more ready utilization of unused remainders of units of equipment at other sites, the following supplementary parts for each unit will be carried in depots:

Article	Number
Bolt, connecting, with nuts	12
Clamp, deck	6
Plank, deck, 3 inches by 12 inches by 12 feet	12
Ramp	2
Siderail, 6 inches by 6 inches by 12 feet	2
Sill, abutment, 6 inches by 8 inches by 12 feet	1
Section, girder, triangular	2

(4) The following tools normally available from other sources will be of assistance during the erection of the bridge:

Article	Number
Pick	4
Pinch bar	4
Pliers	2
Shovel	4
Sledge	2

b. Issue.—The equipment will be stored in corps and army depots and supplied as needed. Tables of Basic Allowances have so far prescribed only the issue to mechanized troops; the proposed allocation is as follows:

(1) *War.*—One bridge unit to the engineer component of each armored division, 6 per corps depot, and 12 per army depot.

(2) *Peace.*—One bridge unit to each separate engineer combat organization for training purposes.

114. Detailed description of equipment.—*a. Rectangular girder section.*—Each rectangular girder section measures 2 feet by 4 feet by 12 feet in over-all dimensions. The dimensions of the angle members are given in figure 51. The weight of the section is 1,140 pounds. Lugs at the outside and inside of each of the eight corners provide for attachment, by means of bolts (see *c* below), to adjoining sections as the girder is assembled. The lugs are so designed that the bolt head is held fast, while the nut is tightened with a wrench. The web members of the sections have brackets or clips in which the con-

necting bolts are secured when the girders are dismantled. Spools welded to the ends of the sections (see fig. 51) serve to aline the sections during assembly and act as shear locks under load. Tubular carrying rods 1 inch in diameter parallel to the long axis of the section are welded to the section members just inside the outer plane of the two 4 feet by 12 feet faces. The rods are of standard commercial grade seamless steel tubing. The sections are reversible, end for end and top for bottom.

b. Triangular girder section.—Each triangular, or end, girder section is 12 feet long, 2 feet by 4 feet at the end to be attached to the interior sections, and 2 feet by 10 inches at the abutment end. The dimensions of the angle members are given in figure 52. The lower surface of the abutment end, which rests upon the sill of the bank seat, measures 2 feet by 1 foot. The section weighs 820 pounds. Two lugs at each of the four corners of the bridge end provide for attachment to the first interior (rectangular) section of the bridge, and alinement and shear lock spools are welded to this end. Two 1½-inch holes in the abutment end of the top chord receive the pins which secure the arm of the launching nose to the section. The triangular section, like the rectangular section, has carrying brackets for the connecting bolts.

c. Connecting bolt.—The connecting bolts are standard 1¼-inch bolts, 21 inches long, made of an alloy steel of the same composition as that used in the structural members. The bolt head is square and cannot turn in the connecting lug, so that the hexagonal nut may be tightened by one man.

d. Erection roller.—The erection roller is used to assist in launching the assembled girders. The roller proper is a mild steel cylinder, 3 inches in diameter and about 3 feet long. The ends are turned to spindles of smaller diameter, concentric with the body of the roller. The spindles revolve in cast bronze bushings attached to a base of yellow pine which measures 2¾ by 13½ by 50 inches. The bearings are provided with standard Zerk fittings for pressure lubrication. Rope lashings should be attached to the base to facilitate handling.

e. Launching nose.—To facilitate launching and placing the girder, the unit of equipment includes two "launching noses." Each nose is a two-piece beam 23 feet long overall. The outer end or front of the nose is supported by a short axle between two wheels each 2 feet in diameter. The other end of the beam is bored to receive two horizontal 1½-inch pins by means of which the beam is attached to the forward end of the triangular bridge girder section. To simplify its transportation, the launching nose beam is made in two 11½-

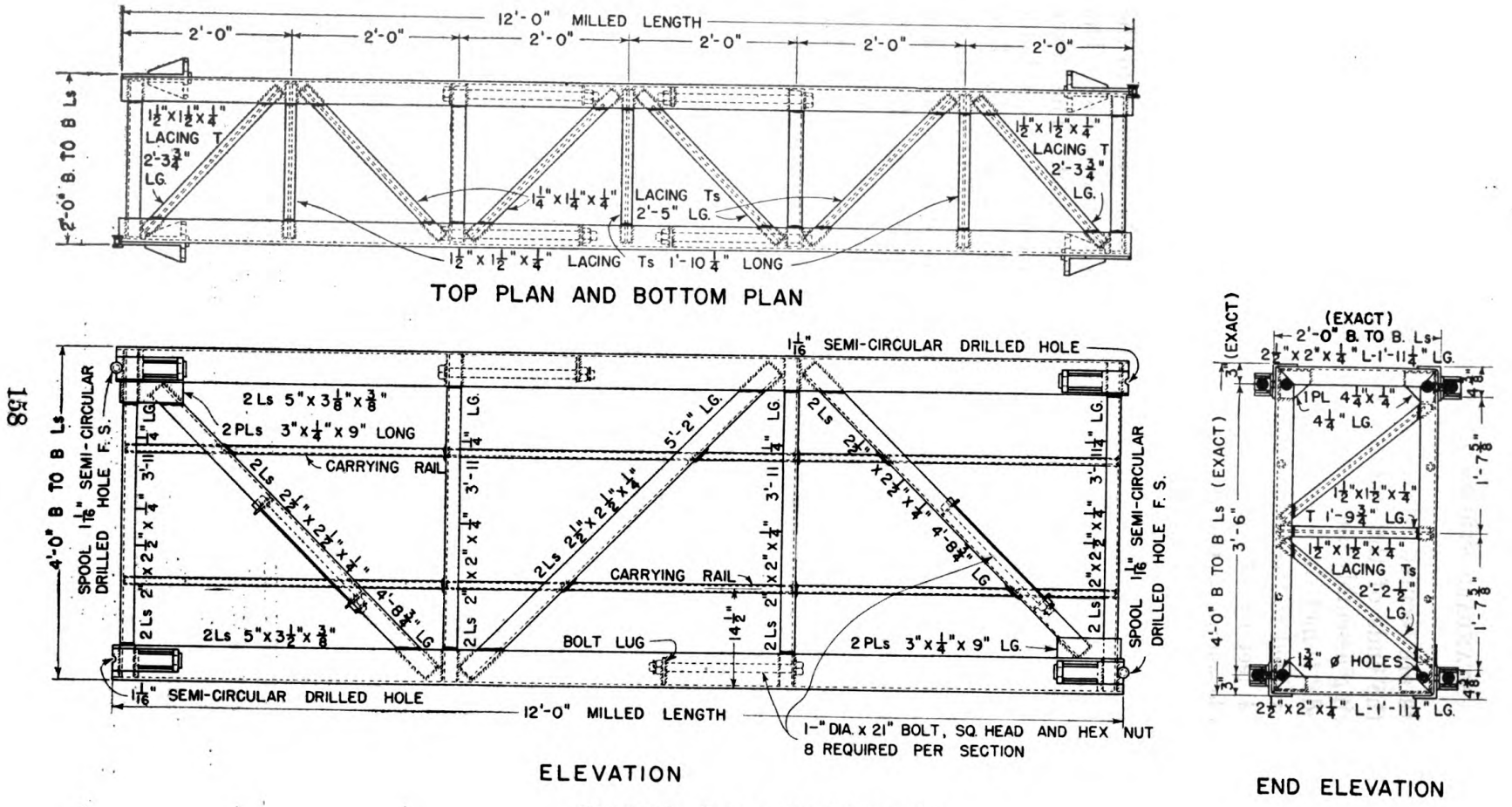


FIGURE 51.—Rectangular girder section.

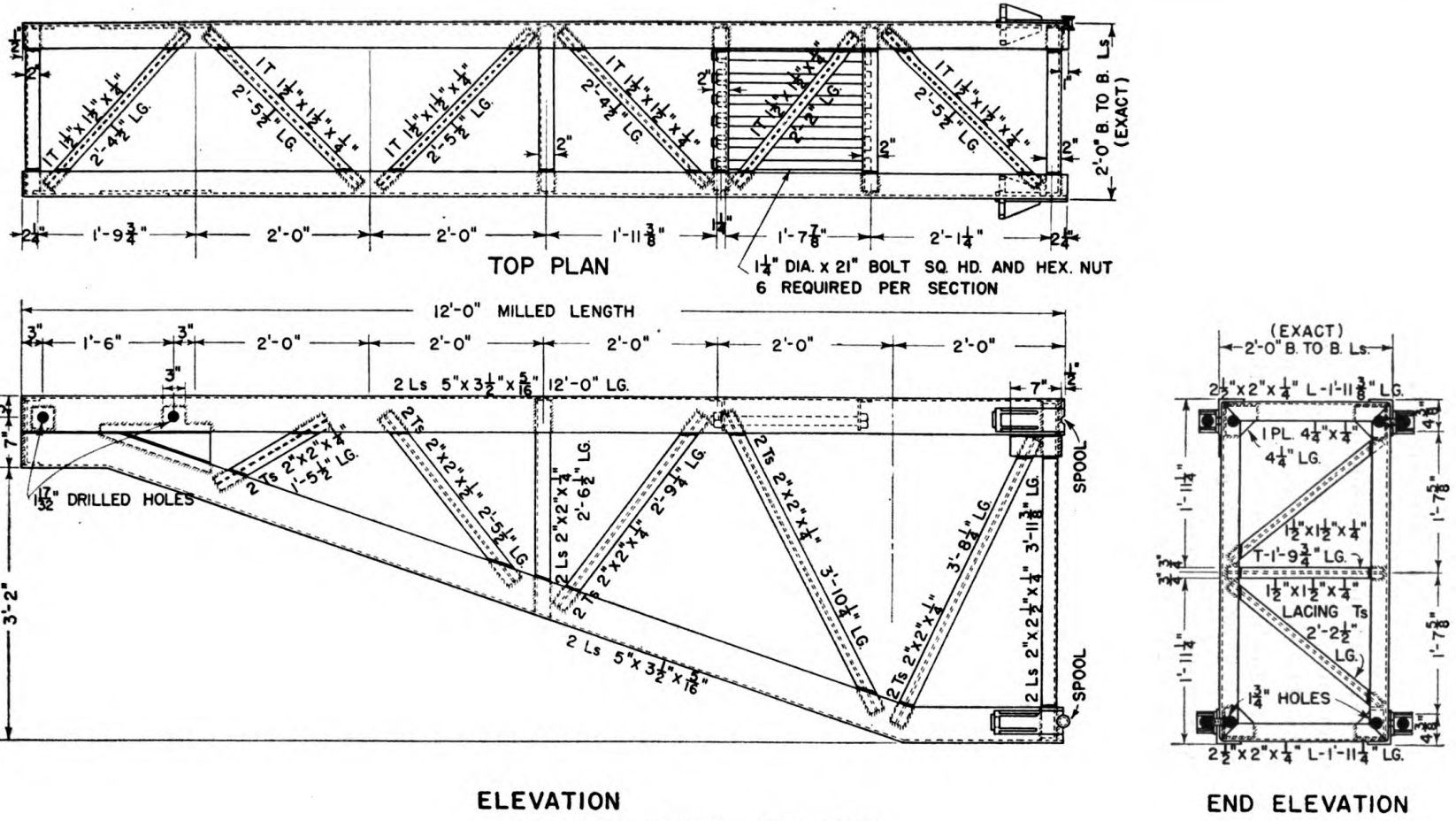


FIGURE 52.—Triangular girder section.

foot sections, connected in assembly by 4 vertical 1¼-inch pins locked with cotter pins. The complete unit weighs 840 pounds.

f. Jack.—The jack furnished with the equipment is used in certain situations in placing the girders on the sills. The tool is a single acting lever jack of the type generally used for rigging or wrecking. The load is raised or lowered on the downward stroke of the operating lever, which is simply a diamond pointed steel pinch bar about 2 feet long. The jack is 22 inches in collapsed over-all height and has a

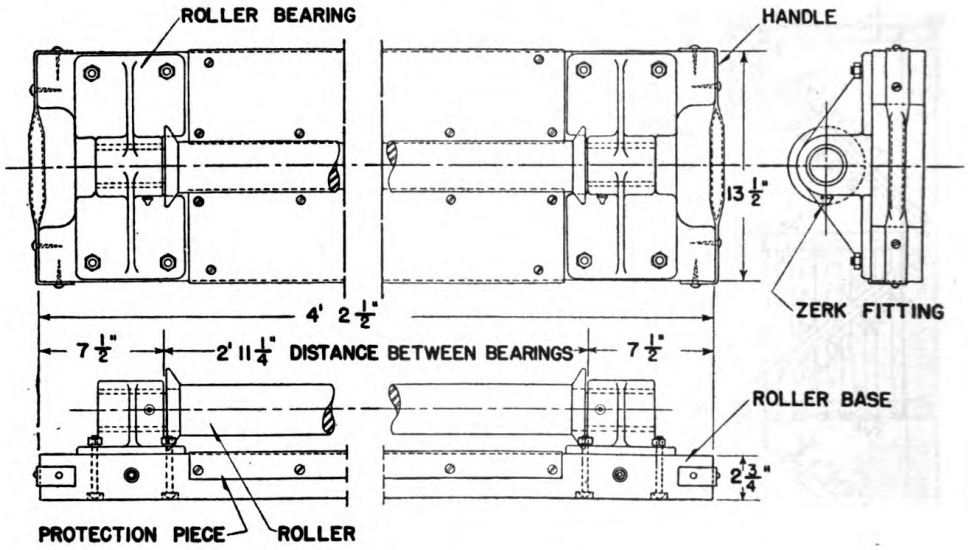


FIGURE 53.—Erection roller.

lift of 12 inches and a capacity of 15 tons. The jack is equipped with a ½-inch chain 5 feet long, with hook and ring ends for securing it to its load or base.

g. Lumber parts.—All lumber parts are of properly seasoned Douglas fir, of the grade known commercially as dense select structural. Two coats of paint are applied before issue; a priming coat of white lead and oil, tinted gray; and a finish coat of standard olive drab.

(1) *Deck planking.*—The deck planks are 12 feet long, dressed square edged to 2⅝ by 11½ inches (nominally 3 by 12 inches).

(2) *Siderails.*—The guard rails are 12 feet long, dressed square edged to 5½ by 5½ inches (nominally 6 by 6 inches).

(3) *Sills.*—The sills are 12 feet long dressed square edged to 5½ by 7½ inches (nominally 6 by 8 inches).

h. Siderail clamps.—The siderail clamps, used to hold the decking to the girders, are thrust screw clamps of C-shape. The lower jaw of the clamp is grooved to receive the lower edge of the top outside

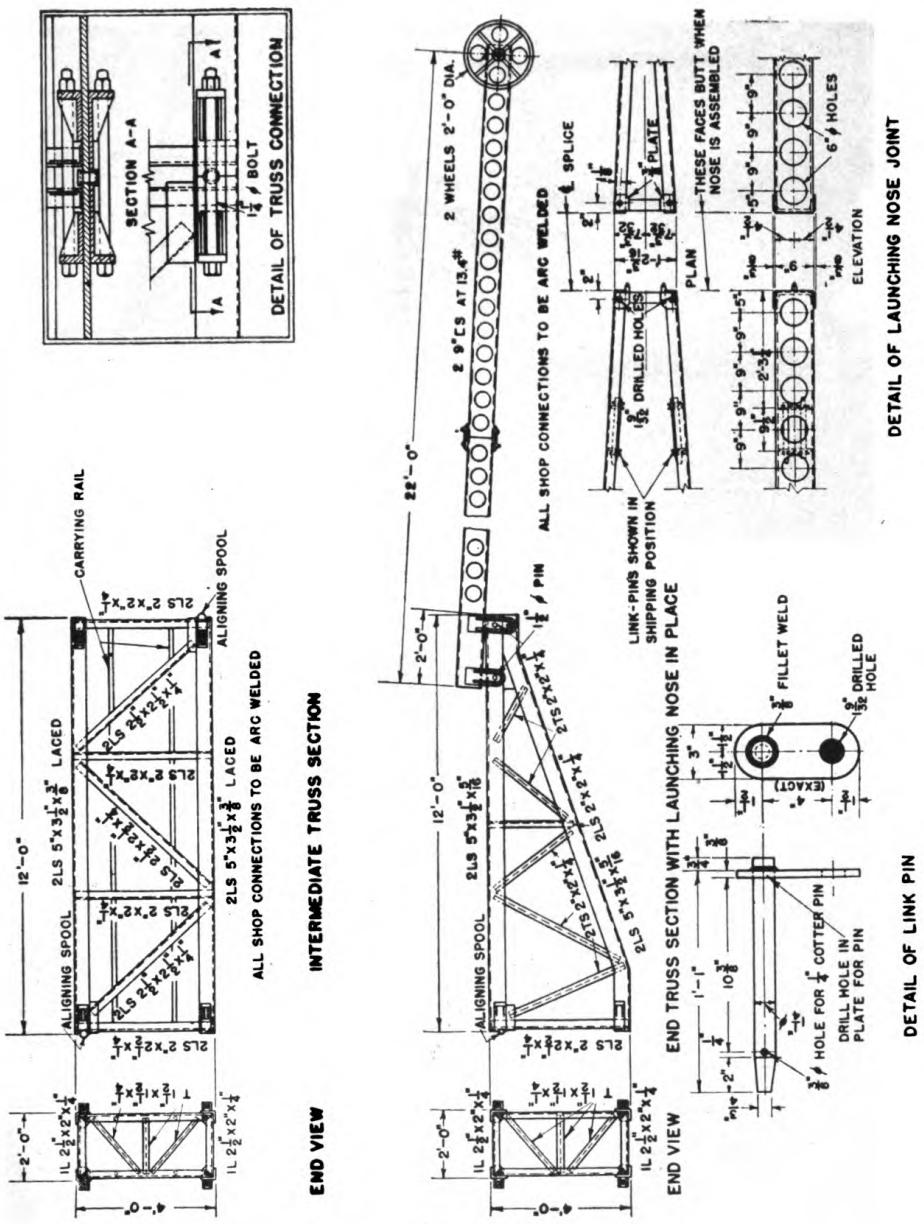


FIGURE 54.—Launching nose.

horizontal angle of the girder. An operating handle is permanently attached by a swivel to the head of the thrust screw.

i. Ramp girder.—Each ramp girder is made of two American standard 8- by 2¼-inch channels, 2 feet apart, back to back, joined and braced by a system of plates, angles, and light I-beams. Each main supporting channel is 12 feet long. Three-foot lengths at each end of the channels are reduced in depth by V-shaped longitudinal cut-outs, crimping, and continuous scarfed welds along the joints. The top

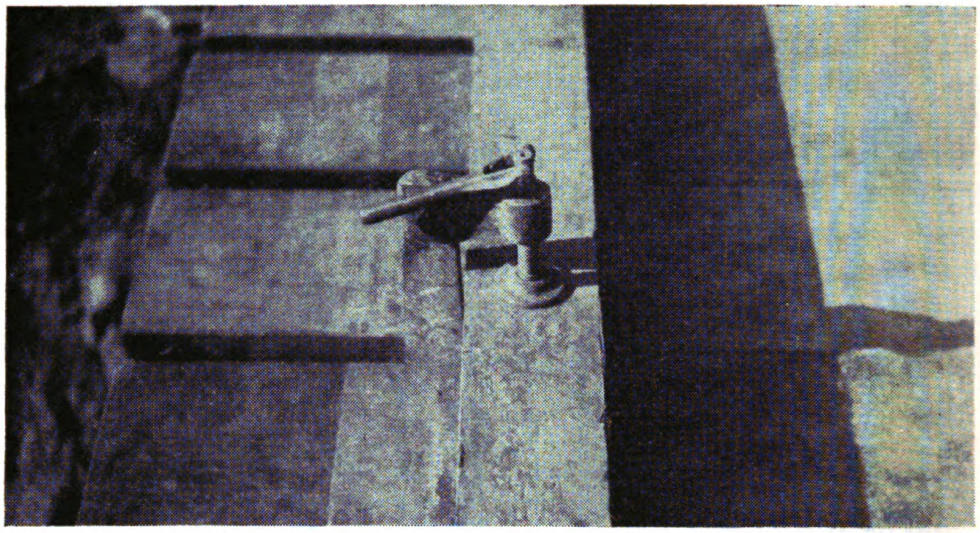


FIGURE 55.—Siderail clamp as viewed from above.

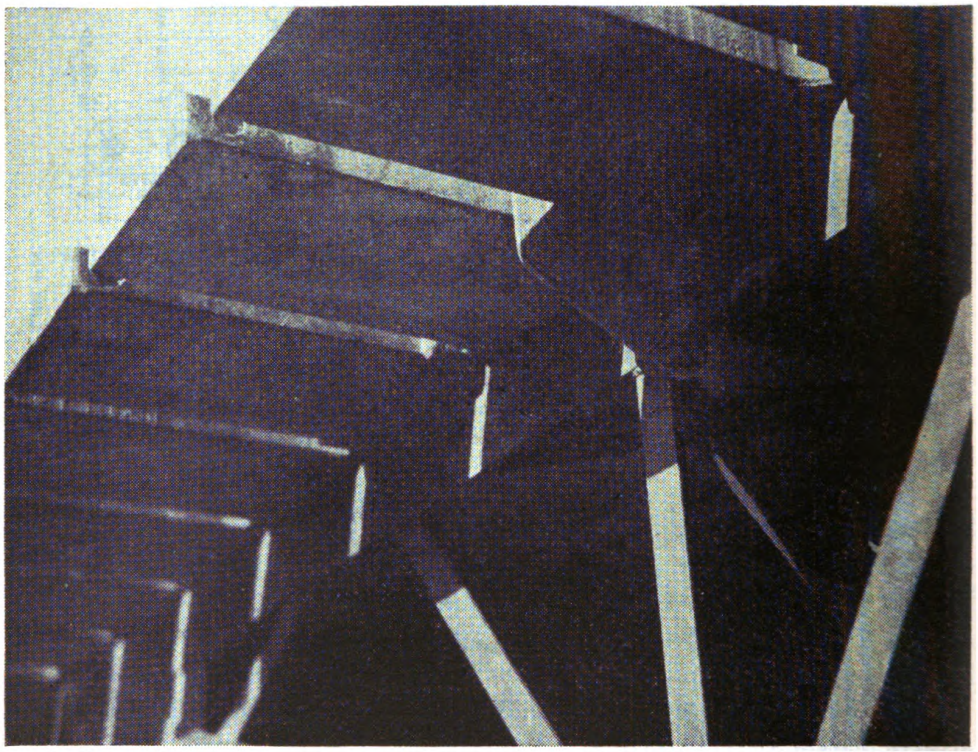
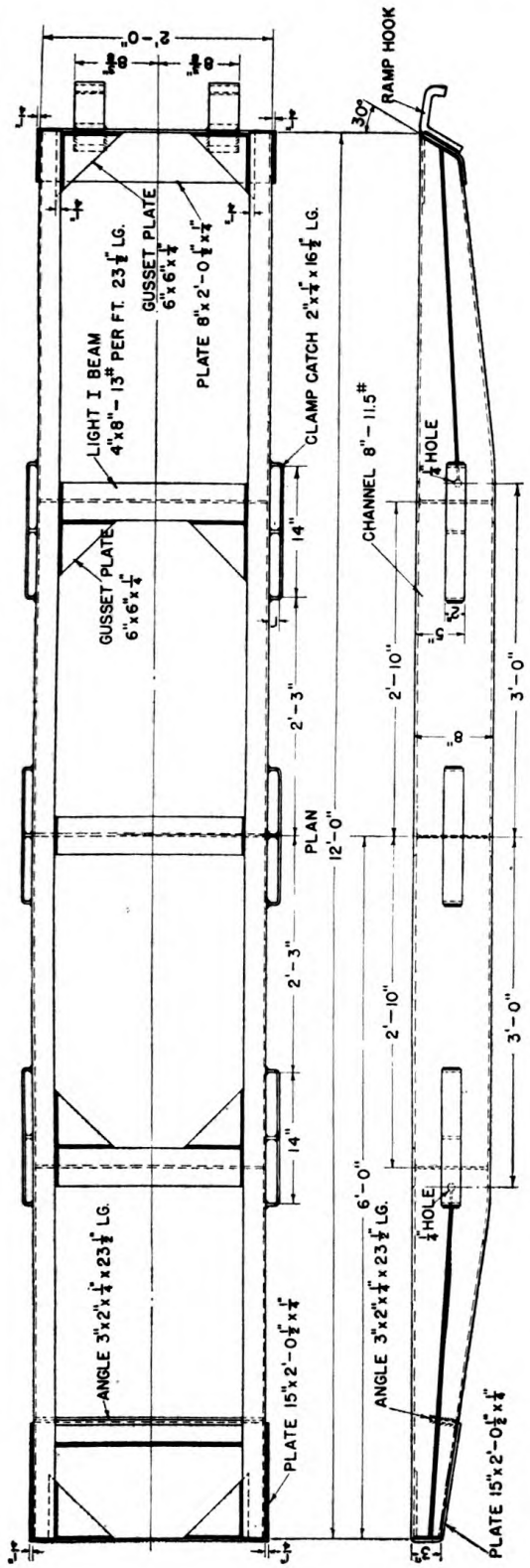
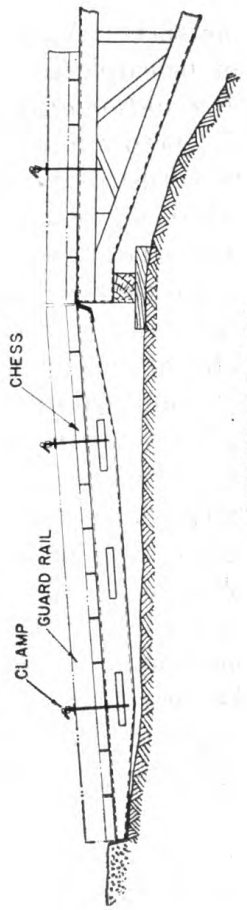


FIGURE 56.—Siderail clamp as viewed from below.

flange of the channel is maintained in line, but the bottom is thus made rectilinearly convex. The web depth at the end which is attached to the bridge proper is reduced to 4 inches and that at the approach end is reduced to 3 inches; two "ramp hooks" at the bridge end provide for attachment to the last section of the bridge girder. Three special





ERECTION OF RAMP

FIGURE 57.—Ramp girder.

clamp catches, each 14 inches long and projecting 1 inch outside the back, are welded to the outside of each main channel to provide points of attachment for the lower jaws of the siderail clamps. The ramp girder is made of the same alloy steel as the other structural elements of the bridge.

115. Care and storage of equipment.—*a. Handling.*—The steel elements of the bridge are rugged and of strong construction, but must nevertheless be handled with some care. The girder sections should not be carelessly unloaded from trucks so that they strike against hard objects. The timber parts of the bridge are all heavy and are not easily damaged. The bolts, clamps, rollers, blocks, wrenches, and jacks are essentially tools, and should be handled and used as such. All are of relatively heavy design, but they should neither be carelessly thrown about nor forced during operation.

b. Prevention of rust.—All structural steel parts are given two coats of paint before issue, the priming coat being a standard grade of red lead type rust prevention paint, and the second a commercial grade of olive drab oil paint. This protective covering must be maintained if rust is to be avoided. The olive drab paint should be renewed whenever inspection indicates it to be desirable; and any chipping, scaling, or disintegration of the paint which exposes the steel below should be corrected at once by the application of a rust prevention priming coat and a second coat of olive drab.

c. Timber parts.—Paint on the timber parts of the bridge should be renewed when necessary. Issue olive drab paint is satisfactory for the purpose. Cracked pieces which are likely to break under load, and other damaged parts, should be replaced.

d. Storage.—(1) The girder sections of the bridge may be stacked in any way desirable during storage, provided the lowermost section is placed upon a true and level surface, or is properly chocked up. Lumber parts should be piled or stacked in such a way as to prevent warping and allow the free circulation of air throughout the stacks. Covered storage space, while not absolutely necessary, should be provided whenever possible. When outdoor storage of the bridge parts cannot be avoided, the equipment should be covered by heavy canvas tarpaulins, which should be removed from time to time to allow for sunning and airing.

(2) Before being placed in storage for an appreciable period all parts of the bridge should be cleaned and inspected. All metal not covered by paint, such as threads and the machined parts of tools, should be covered with a thin film of oil or grease, and painted surfaces in poor condition should be touched up or repainted.

116. Transportation of equipment.—*a.* One complete, 72-foot unit of the bridge may be transported by 9 standard type engineer 1½-ton dump trucks as shown by the following loading schedule:

Truck number	Load	Total weight
		Pounds
1	2 ramp girders 2 rectangular girder sections 2 erection rollers	2, 930
2	ditto	2 930
3	1 end girder section 1 rectangular girder section 1 launching nose	2, 500
4	ditto	2, 500
5	2 end girder sections 16 siderails	3, 350
6	2 rectangular girder sections 2 sills Tools and supplies	3, 100
7	36 deck planks	3, 800
8	ditto	3, 800
9	ditto	3, 800

In an emergency, 8 trucks will suffice; the load of truck number 9 is distributed among all remaining trucks except numbers 5, 7, and 8, as bulk and weight limitations will best allow.

b. The unit may also be transported in five 2½-ton trucks (the transportation allotted the armored engineer squadron for this purpose) as follows:

Truck No.	Load	Total weight
		Pounds
1	2 end girder sections 1 launching nose 4 ramp girders 2 rectangular girders	5, 760
2	2 end girder section 2 erection rollers 2 rectangular girder sections 16 siderails	5, 770
3	2 erection rollers 1 launching nose 4 rectangular girder sections 2 sills	5, 840
4	54 deck planks	5, 725
5	ditto	5, 725

117. Site requirements.—*a.* The portable steel bridge may be erected at almost any site where the necessary span is not too great. The following site characteristics are desirable:

(1) Connection with, or proximity to, a road which will permit the transport of the bridge equipment to the point where the parts are to be assembled.

(2) A limited amount of work required in preparation of the approaches.

(3) Firm and stable banks.

(4) A far bank of a slope gentle enough to permit use of the launching nose, or of a nature which will permit erection of a temporary ramp to receive the wheels of the nose.

(5) A cleared space about 10 feet wide and twice the span in length and of fairly level surface near the abutment on the near shore, to permit assembly of the girders directly in line with their final position; such a space will often be supplied by the approach road if one has been prepared beforehand or already exists.

(6) Presence of some means for transporting men and tackle to the far bank, unless the crossing may be made on foot; an assault boat or small skiff will serve the purpose, a raft may be constructed, or possibly a tree may be felled across the stream.

(7) Sufficient bank height, if a stream is being crossed, to permit launching the girders without interference from swift currents or soft bottoms.

b. The nature of the banks will determine the choice of rectangular or triangular girder sections at the abutments. If the banks are steep and stable, the triangular sections may occasionally be omitted to advantage. However, it will often expedite launching to attach the triangular sections to the far ends of the girders so that the launching noses may be used. The end sections may be removed after the girders have been hauled across.

118. Organization of working parties.—*a.* The construction of the bridge is under the direct command of an officer, who supervises all operations.

b. The working party itself is constituted as follows:

Section	*Noncommissioned officers*	*Men*
Carrying	1	16
Bolting	1	14
Abutment	1	8
Totals	3	38

The bolting section is divided into 4 crews, 3 of four men each and 1 of two men. The 4-man crews place and secure the connecting bolts, while the 2-man crew removes the bolts from their carrying clips on the members of the girder sections.

c. The organization of the working party of 3 noncommissioned officers and 38 men as outlined above is the most efficient. However, in emergency the bridge may be erected with a crew of minimum strength of 1 noncommissioned officer and 16 men.

d. The combat platoon will be the unit ordinarily assigned to construct the bridge. However, a greater number can be used effectively if available. For example, two platoons will afford two full working parties. Except at sites presenting unusual difficulties not more than three platoons should be used.

e. None of the working schedules suggested above assigns men to work on the approaches or to handle traffic. When such work is necessary, additional men must be assigned as required and from whatever sources available.

119. Erection procedure.—*a. Unloading equipment.*—(1) The girder sections should be unloaded close to the final assembly positions in order to reduce manhandling. The sections may be easily unloaded from dump trucks by lowering one end of one section at a time and allowing it to slide slowly down and out as the truck moves ahead.

(2) The other and lighter parts need not be so carefully spotted when unloaded. Except for preserving a clear space for the assembly and launching of the girders, all parts should be unloaded and piled so as to be conveniently accessible to the carrying crews. It will be of particular advantage to have the deck planks and siderails stacked as near to the abutment as possible. Often the deck planking need not be unloaded until the laying of the decking is about to be started; the trucks may be backed on to the near end of the bridge, the planks removed and carried directly to their places.

b. Assembly of the girders.—(1) The girder sections are easily assembled on level ground simply by butting the sections and bolting them together. If the ground surface is slightly irregular, one section of a pair may be brought into position by a carrying crew while a bolting crew draws the two sections together. If the ground is very uneven, wood blocks should be used to chock the sections into alinement. Two lines of siderails may be laid 2 feet apart for a track on which to assemble the girder. However, the girder sections are not so heavy as to make assembly difficult even under the most adverse conditions.

(2) The operations involved in the assembly of the girders should ordinarily be performed in the following sequence:

(*a*) The first triangular end section is placed about 25 feet from the abutment by the carrying sections.

(*b*) The first rectangular interior section is placed in proper position by the carrying section.

(*c*) The first bolting crew bolts these first two sections together.

(*d*) While step (*c*) is being carried out, the carrying section places the second rectangular section.

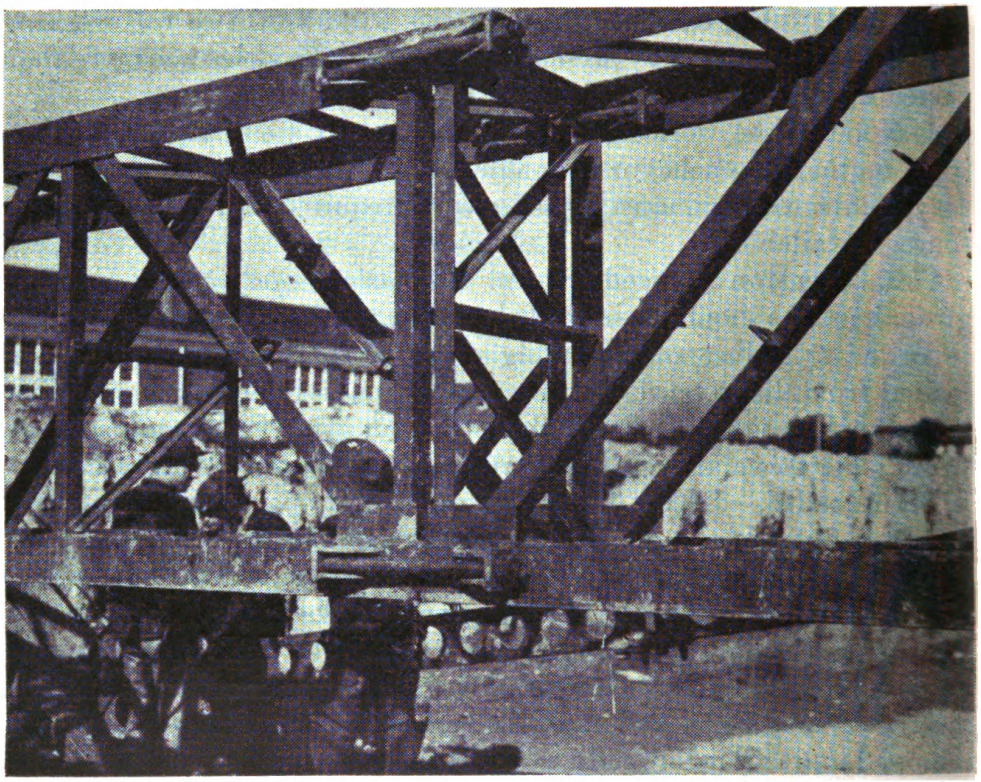


FIGURE 58.—Details of connection between girder sections.

(*e*) The second bolting crew then secures the second rectangular section to the first.

(*f*) The carrying section attaches the launching nose to the end section, rocks the assembled portion of the girder forward, and places an erection roller beneath the second interior section. Light lines should be attached to the handles on the base of the roller so that the roller may be moved with safety.

(*g*) The carrying section places the third interior section.

(*h*) The third bolting crew bolts the third interior section to the second.

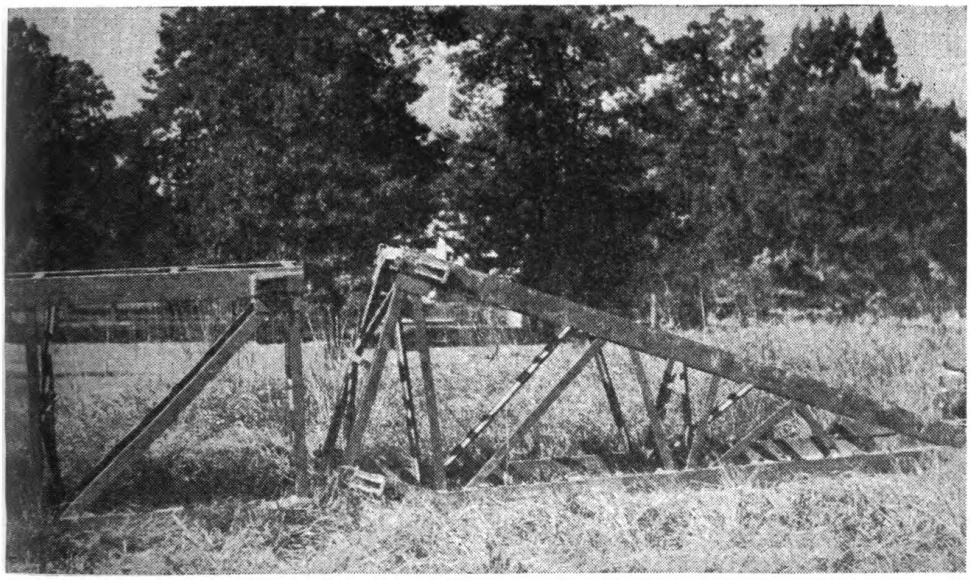


FIGURE 59.—Position of last rectangular and triangular sections just before connection.

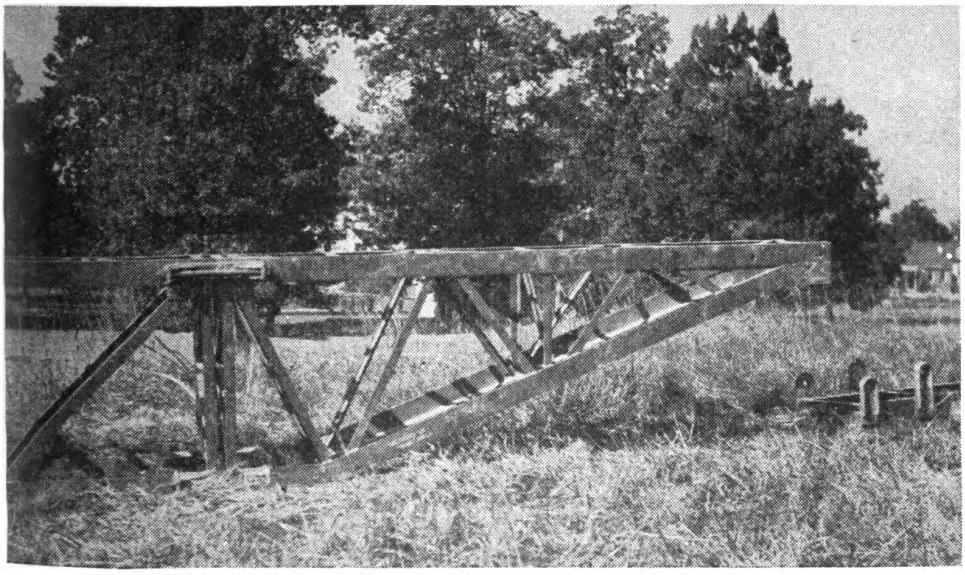


FIGURE 60.—Connection completed.

(*i*) Additional sections are erected in the same manner.

(*j*) Meanwhile, the fourth bolting crew of two men has been removing the bolts from their carrying clips on the section frames and giving them to the other bolting crews as needed. This crew has also placed the cotter pins behind the nuts after the sections have been drawn tightly together.

(3) If speed is essential, the two girders are assembled simultaneously, sections for each being placed and bolted alternately. This

method makes it possible for more men of the bolting crews to work at the same time and thus speeds up the critical operation of bolting.

(4) The girders should be assembled in such a position, and the erection rollers so placed, that the completed girders may be launched directly forward.

c. Preparation of the abutments.—(1) While the girders are being assembled, the abutment section cuts down the banks if necessary, places the sills, and reeves and lays out the tackle and prepares holdfasts on both banks for use in the launching operation. In firm soil, the 6- by 8-inch sills furnished with the bridge unit will properly support the bridge. However, if the banks are not stable, or are

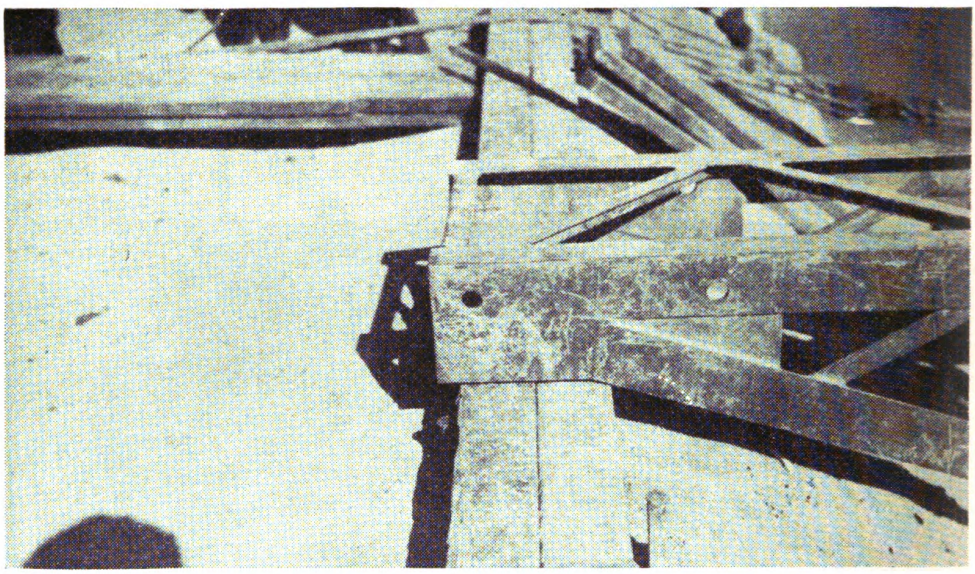


FIGURE 61.—Triangular girder section resting on improvised sill.

soft, it will be advisable to place the sill on a broader base of planks 2 or 3 inches thick, cut in 2- or 3-foot lengths and laid as mud shoes or planking parallel to the axis of the bridge. In any event, the sills should be anchored by stakes driven at their sides and ends, and earth or other material should be tamped around them.

(2) Since the girder sections are all exactly 12 feet long, the outside faces of the sills must be some multiple of 12 feet, less 2 feet, apart, depending on the clear span and the condition of the bank. The girders are designed to be supported by the 12-inch width horns of their triangular end sections or the ends of the rectangular sections. No attempt should be made to decrease the total span by setting the bank edges of the sills in greater distances than even with the ends of the girders.

(3) If the sills on opposite banks are not at the same elevation, so that the bridge will not be horizontal longitudinally, the abutment section should secure the girders, when they have been placed, either directly to the sills or to stakes or natural holdfasts in order to prevent creeping. The positions of the girders on the sills should be checked frequently, since if the girders—or particularly one girder—should slip off the sill at the higher end the results might be disastrous.

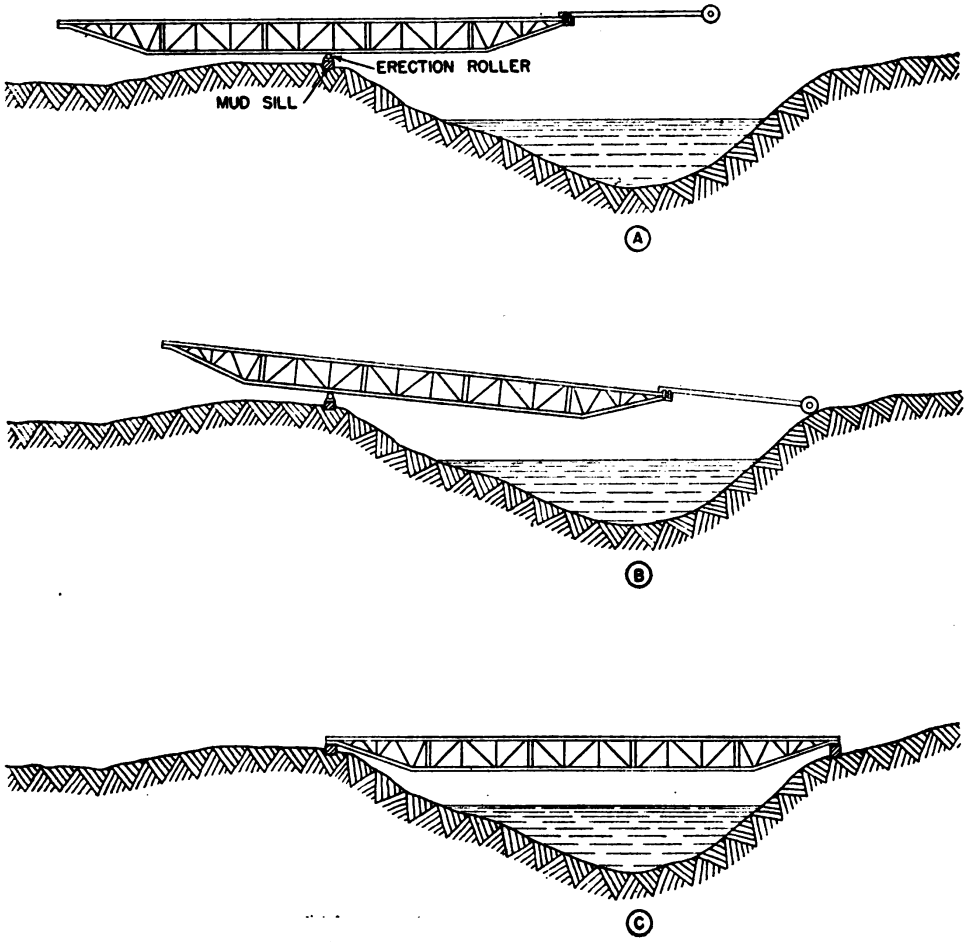


FIGURE 62.—Launching scheme, using nose.

(4) Although it may occasionally be necessary to erect the bridge so that it is higher at one end than the other, the tops of the two girders should always be in the same plane throughout and on level laterally. Therefore the abutment section should check the level of the sills to make certain that they are horizontal with respect to their long dimension. The bridge should not be skewed unless absolutely necessary; normally the girders should be of the same length, placed parallel to each other and perpendicular to the abutments.

d. Launching of the girders.—(1) *With end section and launching nose.*—The girder is pushed out on erection rollers by a crew of about 20 men working alongside the rear end. One roller is placed as noted in *b*(2)(*f*) above. A second should be placed close to the sill on the land side and somewhat above it, to facilitate dropping the end of the girder onto its seat. The triangular end section may be passed along this roller without difficulty, provided the bank below the sill is cut away if too flat to allow for the drop of the girder. The rope in the tackle connecting the rear end of the girder with a holdfast is paid out by two men. When the girder has been cantilevered out until it tips forward and the wheels of the launching nose strike the far bank the girder may be pushed on forward by the men on the near bank if the slope of the far bank is not steep; otherwise the girder must be hauled up by the far bank abutment crew by tackle attached to the rings on the launching nose. When the girder has been advanced until its far end is above its place on the sill, the near end should have reached a position either directly above or resting on its sill. If the far end is only 2 or 3 inches above its sill the girder may be dropped into place by removing the pins connecting the two parts of the launching nose beam. If the drop is greater (as will result from a steep bank behind the far abutment) the girder may be chocked with small blocks and the blocks knocked out one by one until the girder is seated, or the jacks furnished with the equipment may be used to effect the lowering. Small adjustments of the girder on the sill may be easily made with crowbars. Snubbing lines should be attached to either side of the end and center of the girder at the top, and then led to holdfasts on opposite sides. Small crews of one or two men handle these lines to prevent the girder from toppling sideways.

(2) *Without end section and launching nose.*—(*a*) When it is expected that the girders will be launched without the end sections and launching nose, one complete girder should be assembled directly behind the other and temporarily connected thereto. The first girder is then rolled into position, using the second and the weight of some of the men as a counterweight. With the first girder approximately in position, the second is unbolted therefrom and run out over it, supported on erection rollers. Two gin poles on either side are used to raise the second girder and lower it into place.

(*b*) If desired, both girders may be hauled directly into place by means of a gin pole on each bank.

(*c*) As already stated, time and labor may often be saved by temporary attachment of an end section and launching nose to the far

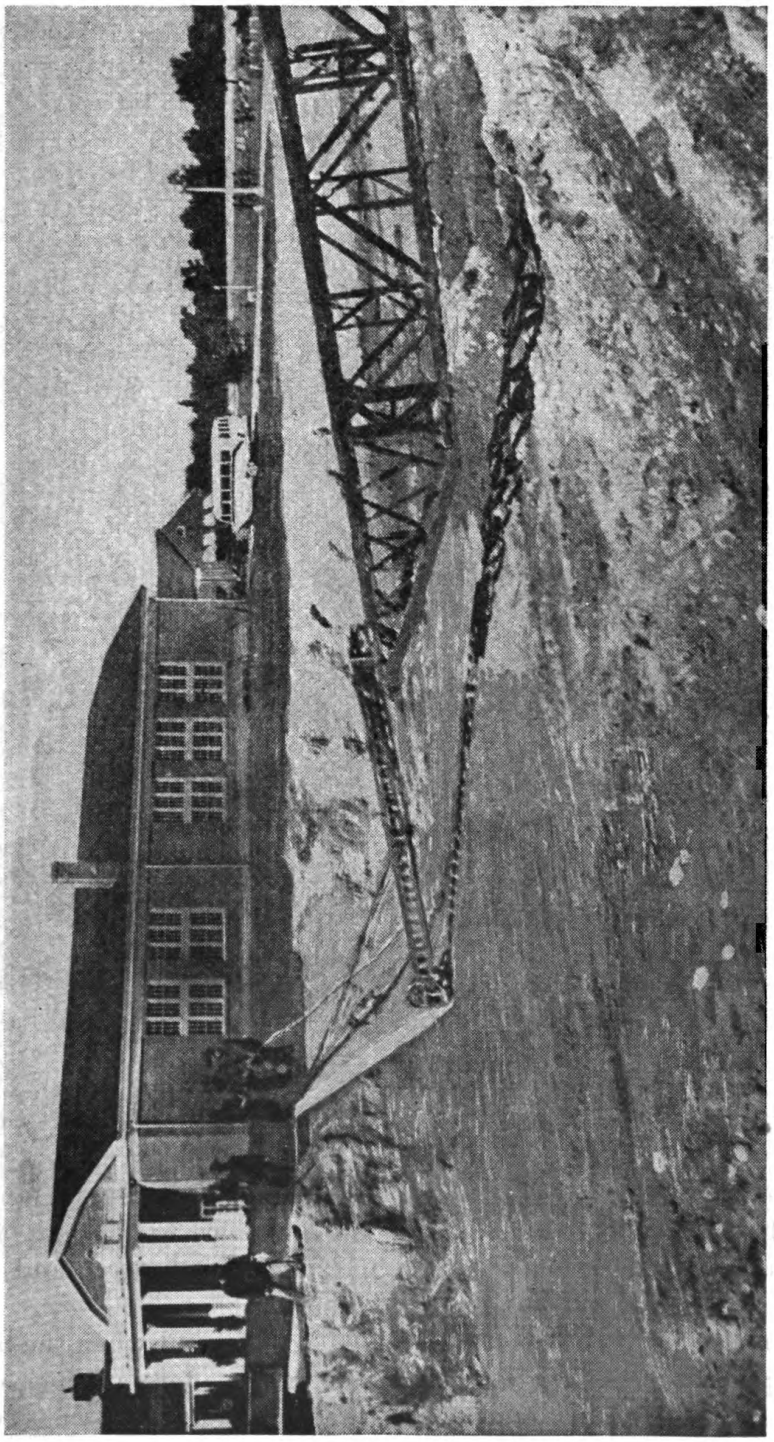


FIGURE 63.—Launching nose in use. Note ramp for nose on far bank.

ends of the girders which are ultimately to be used without end sections.

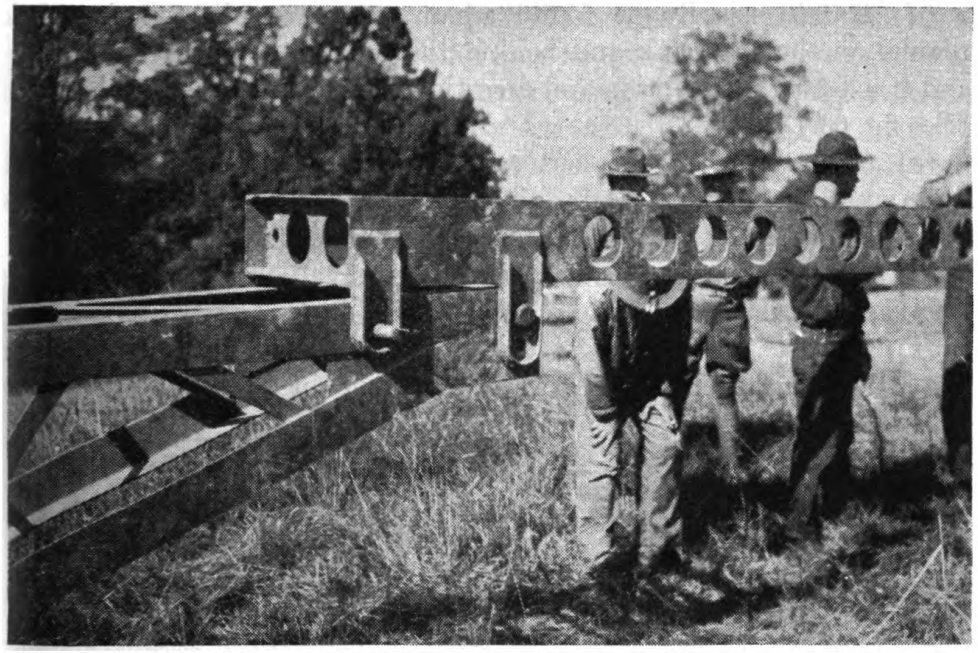
(3) *With end section but without launching nose.*—Occasionally it may be desirable or necessary to launch the girders without the launching noses, even though the end sections are to be used. Under such circumstances the girders are launched and placed with the aid of gin poles, as described above.

FIGURE 64.—Placing rectangular section on sill (triangular section not used).

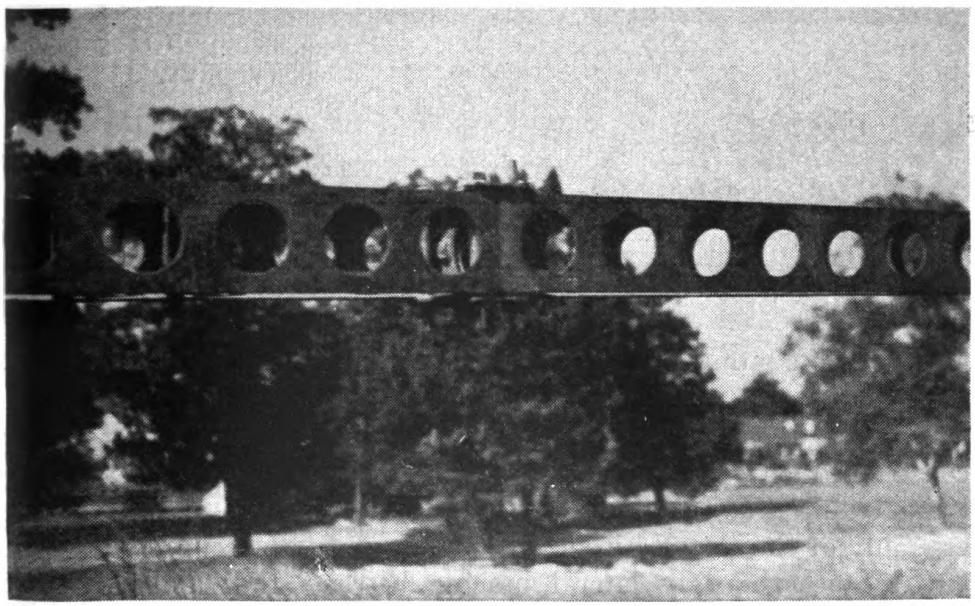
(4) *General.*—(*a*) Mechanical power equipment should be substituted for manhandling whenever possible in order to save both time and effort.

(*b*) No particular difficulties will be encountered in launching the girders by any of the methods outlined. However, the launching noses make the operation speedier and less complicated, and avoid the need for rigging one or two gin poles.

(*c*) Some difficulty in erection may be experienced when the bridge is to be placed across a stream at a site which offers a long sloping bank on the near side and a vertical or steep bank on the far side. Under such circumstances the tackle on the far bank must be rigged to lift the end of the girder almost vertically. It may on



① Between launching nose and end girder section.



② Between sections of launching nose.

FIGURE 65.—Connection details.

occasion even be desirable to attach a launching nose temporarily to the near end of the girder to afford some cantilever effect and partially counterbalance the weight ahead of the last near bank roller.

(*d*) It will usually be found advantageous to place a few deck planks on the far bank and behind the sill in the form of a ramp and track for the reception and direction of the launching nose wheels. (See fig. 63.)

(*e*) A gin pole of sufficient capacity may be readily improvised from available timber; a standing tree or a trestle post with chain hoist from the light ponton equipment may be used.

(*f*) If the girders are assembled successively, the entire bolting crew as well as the carrying crew is available for moving the girder into place, except that two to four men should be detailed to care for the rollers and a few to control the snubbing lines holding the girder

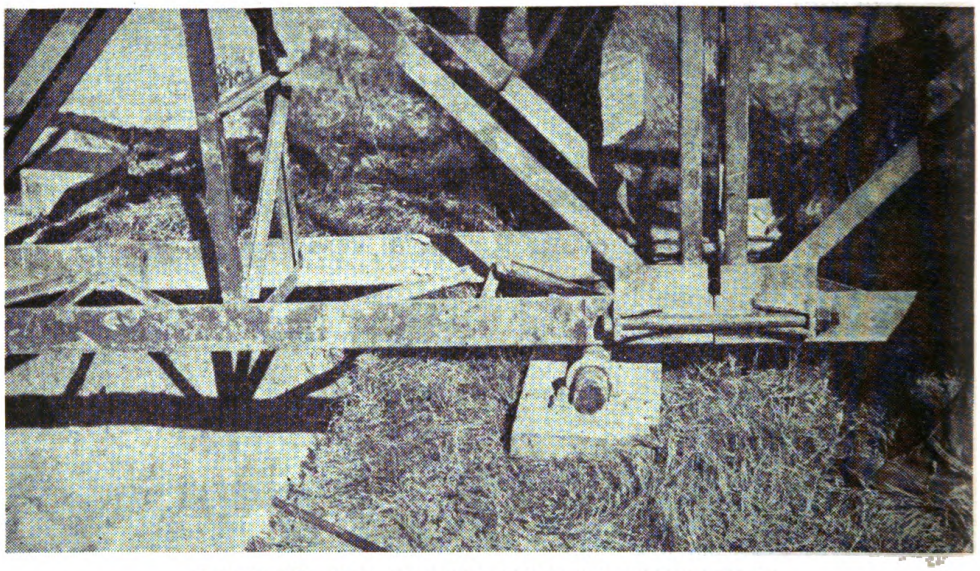


FIGURE 66.—Use of erection roller in launching girder.

erect. The abutment crew, divided between the two banks, pays out the holdfast line and hauls the launching nose into place on the far bank. If the girders are assembled simultaneously, the first girder constructed may be launched by the carrying section and two bolting crews while the remainder of the bolting section completes the assembly of the second girder.

(*g*) Since the only lateral bracing between the girders is that afforded by the clamped deck, it is desirable to use the end sections (which place the deck-carrying upper chords 10 inches above the sill instead of 4 feet above it) in order to reduce side sway under moving loads. The use of end sections is usually desirable also, to facilitate preparation of the abutments.

e. Placing the ramp girders.—As soon as the main girders are in position, the ramp girders are placed by the abutment crews. If

hand transport is difficult or impossible across the gap being bridged, the placing of the far bank ramp may be delayed until the bridge has been floored up to that point. Improvised sills under the land ends of the ramps may be necessary because of soft soil.

f. Placing the decking and siderails.—When the near bank ramp has been placed, the decking is laid. For this operation, the carrying section becomes a plank carrying and laying section and the bolting section places the side rails and secures them with clamps. The abutment section prepares the road-to-bridge connections at both ends, coils rope, and prepares tackle for loading.

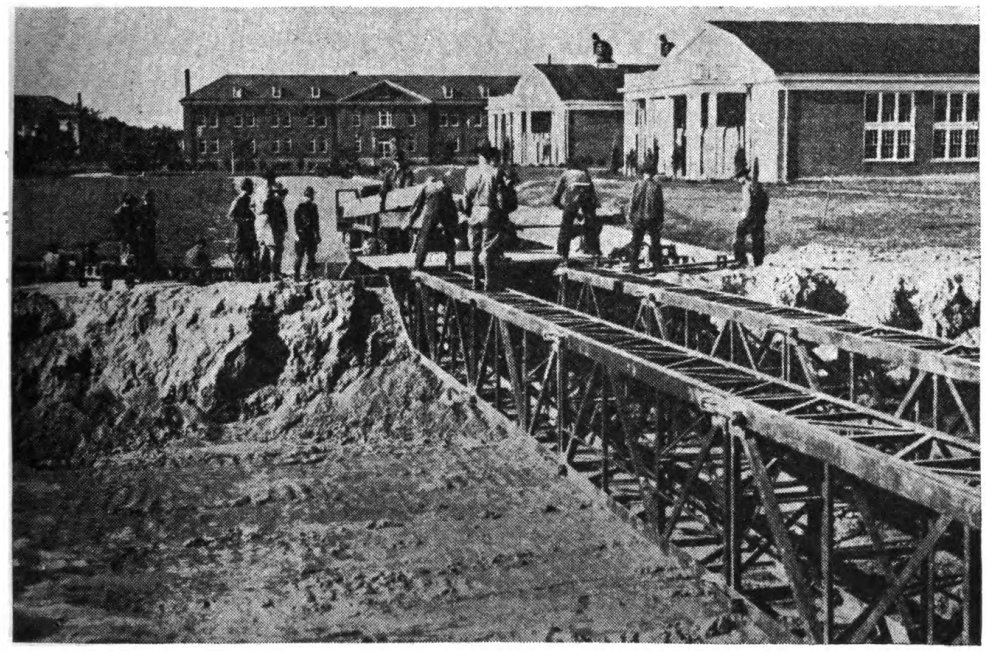


FIGURE 67.—Laying the decking.

120. Time required for the construction of bridge.—*a. Usual working party.*—The bridge may be constructed most efficiently with a working party of approximately one combat engineer platoon organized as in paragraph 118*b*. With such working sections and the use of launching noses and end sections, a 72-foot bridge may be erected in about 1 to 2 hours if no unusual work in preparation of the abutments is necessary and the equipment is in trucks at the site; as short a time as 30 minutes would be exceptional. Without end sections and launching noses the time required will be increased about 50 percent; during darkness about 2 to 3 hours will be required when the launching noses are used.

b. Small working party.—If the small working party of only 17 men be used, both carrying and bolting during assembly of the girders

must be done by the same men. The assembled girders must be pushed out by all men in the party, and then several men must cross to the far side to anchor and connect tackle, and pull the girders into place. Since few if any of the steps can be performed simultaneously, the times required for construction are at least double those with the full size crew.

c. Untrained working party.—The figures given above apply to trained personnel. Under normal daylight conditions the 72-foot bridge may be erected in about 2 to 3 hours by inexperienced men. In

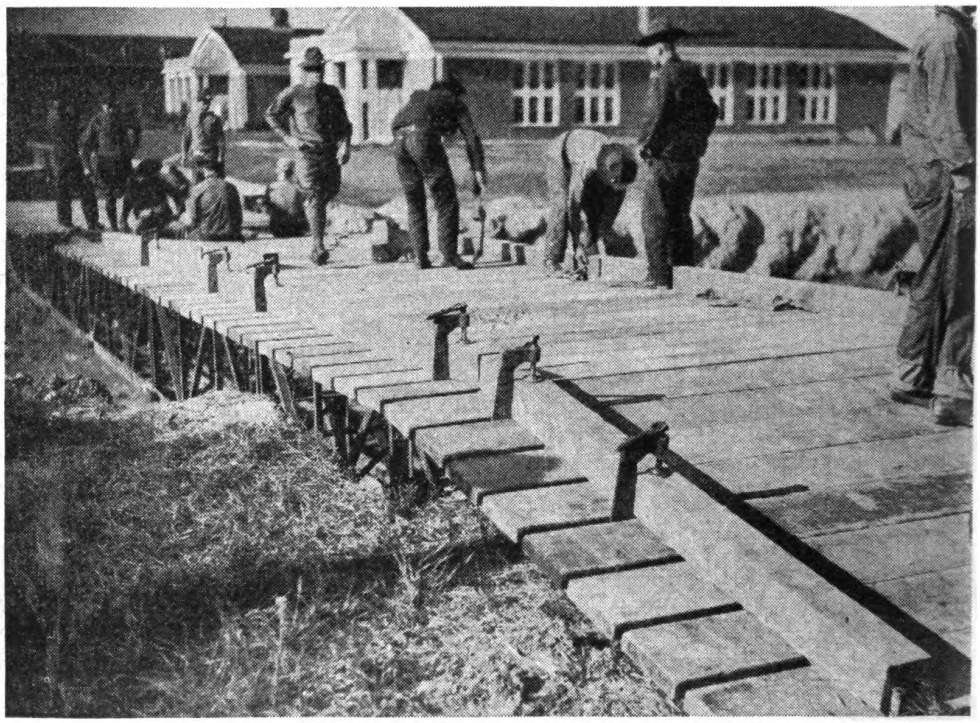


FIGURE 68.—Attaching siderails.

an actual test, an engineer combat platoon of trained men, inexperienced in the erection of this bridge and commanded by an inexperienced officer, erected a 72-foot bridge under unfavorable conditions in 2 hours and 30 minutes.

121. Dismantling bridge.—In general, the bridge is dismantled by a reversal of the procedure followed in erection. After the decking and ramps have been removed, the girders are hauled back on the near bank by the use of tackle. Usually the launching noses are not required, but occasionally the work may be expedited by using a launching nose on one bank or the other. Jacks will often have to be used in order to place the rollers. Often a gin pole on the near

bank, although not required in the launching, may be desirable. All parts of the equipment may be loaded into trucks by hand. Connecting bolts and nuts should be secured in the carrying clips.

SECTION II

H–20 CAPACITY

	Paragraph
Purpose of bridge	122
Features of design	123
Composition and assignment of equipment	124
Detailed description of equipment	125
Care and storage of equipment	126
Transportation of equipment	127
Site requirements	128
Organization of working parties	129
Erection procedure	130
Time required for construction of bridge	131
Dismantling bridge	132

122. Purpose of bridge.—*a.* The heavy portable steel bridge of H–20 capacity is intended to carry corps and army loads over spans not exceeding 125 feet, within both the combat and communications zones. Subject to this primary capacity requirement, the bridge has been designed in accordance with the usual criteria of military suitability.

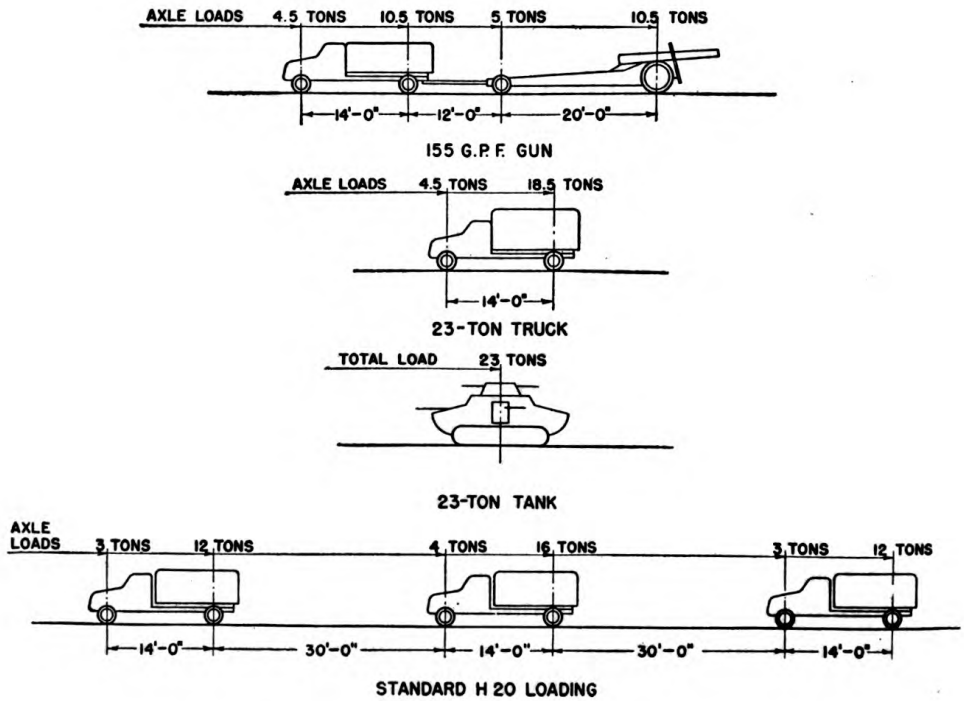
b. These criteria, with the set capacity, specify a bridge of a portable, easily erected, nonfloating type to carry loads similar to those for which the reinforced 10-ton ponton bridge is intended.

123. Features of design.—*a. Material and method of fabrication.*—The H–20 bridge is made of the same high tensile manganese steel, and is fabricated by the same welding methods, as the lighter H–10 bridge.

b. Main supporting members.—The principal load-carrying members are two sectional latticed box girders (or box trusses) of the deck type similar in fabrication to, but deeper than, those used in the light bridge. No sway bracing is used between the two girders of the constructed bridge, but some reduction of sway is afforded by the decking. The girders are laid 7 feet 4 inches center to center, and the clear roadway width inside the guard rails is 10 feet.

c. Capacity.—The bridge is designed to carry any of the "heavy loading" H–20 combinations shown in figure 70, which include the heaviest army loads, over a maximum clear span of 122½ feet. The bridge may be adapted to crossings of shorter lengths by reducing the number of sections in the girders, and to crossings of greater lengths

FIGURE 69.—H–20 portable steel bridge.



HEAVY LOADINGS

FIGURE 70.—Heavy or H–20 loadings.

by the introduction of cribs or timber bents at intervals to limit the clear spans to lengths not greater than those contemplated in the design. However, crossings exceeding the maximum single clear span length of the bridge will ordinarily be met by the construction of some other type of bridge.

124. Composition and assignment of equipment.—*a.* (1) *The bridge unit.*—A single unit of the equipment, permitting the construction of 125 feet of bridge, consists of the articles listed in table IV.

TABLE IV

Article	Overall dimensions	Unit weight	Number used (125-foot span)	Total weight (125-foot span)
		Pounds		*Pounds*
End girder section	2 feet by 6 feet by 12 feet 6 inches.	1, 240	4	4, 960
Intermediate girder section.	2 feet by 6 feet by 12 feet 6 inches.	1, 730	16	27, 680
Deck plank [1]	5 inches by 10 inches by 11 feet.	172	258	44, 380
Guard rail	6 inches by 6 inches by 12 feet 6 inches.	142	24	3, 408
Connecting bolt, with nut.	1½ inches by 25½ inches	14	152	2, 128
Carriage bolt (guard rail), with nut.	¾ inch by 14 inches	2	90	180
Carriage bolt (deck plank), with nut.	¾ inch by 18 inches	2½	80	200
Cut washer	2-inch diameter, 9 gage	9 per pound	180	20
Total weight of unit equipment.				82, 960

[1] Includes all timbers for the floor of the bridge, the backwall, the sills, and the stringers for the approach span, or ramp.

(2) One hundred forty-four connecting bolts are required to fasten the 20 girder sections in the 125-foot bridge (8 bolts at each complete section connection). Eight of these bolts, with nuts, are attached to each intermediate section and 6 to each end section, in carrying clips, thus providing 8 spares.

(3) The following tools, other than organizational equipment will be necessary for the erection of the bridge:

Article	Number
Block, steel, snatch, 12-inch for ⅝-inch wire rope	4
Block, steel, double, 8-inch, for 1-inch manila rope	2
Jack, hydraulic, 10-ton	2
Rope, manila, 1-inch, feet	600
Rope, wire, ⅝-inch, feet	1,000
Sling, rope, wire ⅝-inch, 6 feet	4
Wrench, monkey, 12-inch	8
Wrench, open end, 2¼-inch jaw	4
Wrench, open end, 1¼-inch jaw	8
Wrench, ratchet, for 1½-inch bolts, hexagonal head	8

NOTE.—Tackle and timber for the rigging of 2 gin poles or A-frames will often be necessary.

b. Issue.—This bridge will be stocked in engineer corps and army depots, and will be issued as needed. Issue for peacetime training purposes will be made only as specifically authorized.

125. Detailed description of equipment.—*a. Intermediate or rectangular girder section.*—Each rectangular girder section measures 2 feet by 6 feet by 12 feet 6 inches overall. The dimensions of the angle members are given in figure 71. The weight of the section is 1,730 pounds. The sections are connected during assembly of the girders as are those of the light bridge; connecting bolts, lugs, carrying clips, and alinement and shear lock spools are similar. The sections are reversible, end for end and top for bottom.

b. End or triangular girder section.—Each end girder section is 12 feet 6 inches long, 2 feet by 6 feet at the end to be attached to the interior sections, and 2 feet by 1 foot at the abutment end. The dimensions of the angle members are as given in figure 72. The lower surface of the abutment end, which rests against the sill of the bank seat, measures 2 feet by 1 foot 3 inches. The section weighs 1,240 pounds. The end section is attached to the first intermediate section by bolt and lug attachments identical with those connecting the interior sections. Carrying clips are provided for six connecting bolts.

c. Connecting bolts.—The connecting bolts are standard 1½-inch bolts, 25½ inches long, with square heads and hexagonal nuts.

d. Guard rail bolts.—Standard ¾-inch carriage bolts, 14 inches long, secure the guard rails to the planking. Three bolts are used for each rail section, one at each end and one at the center.

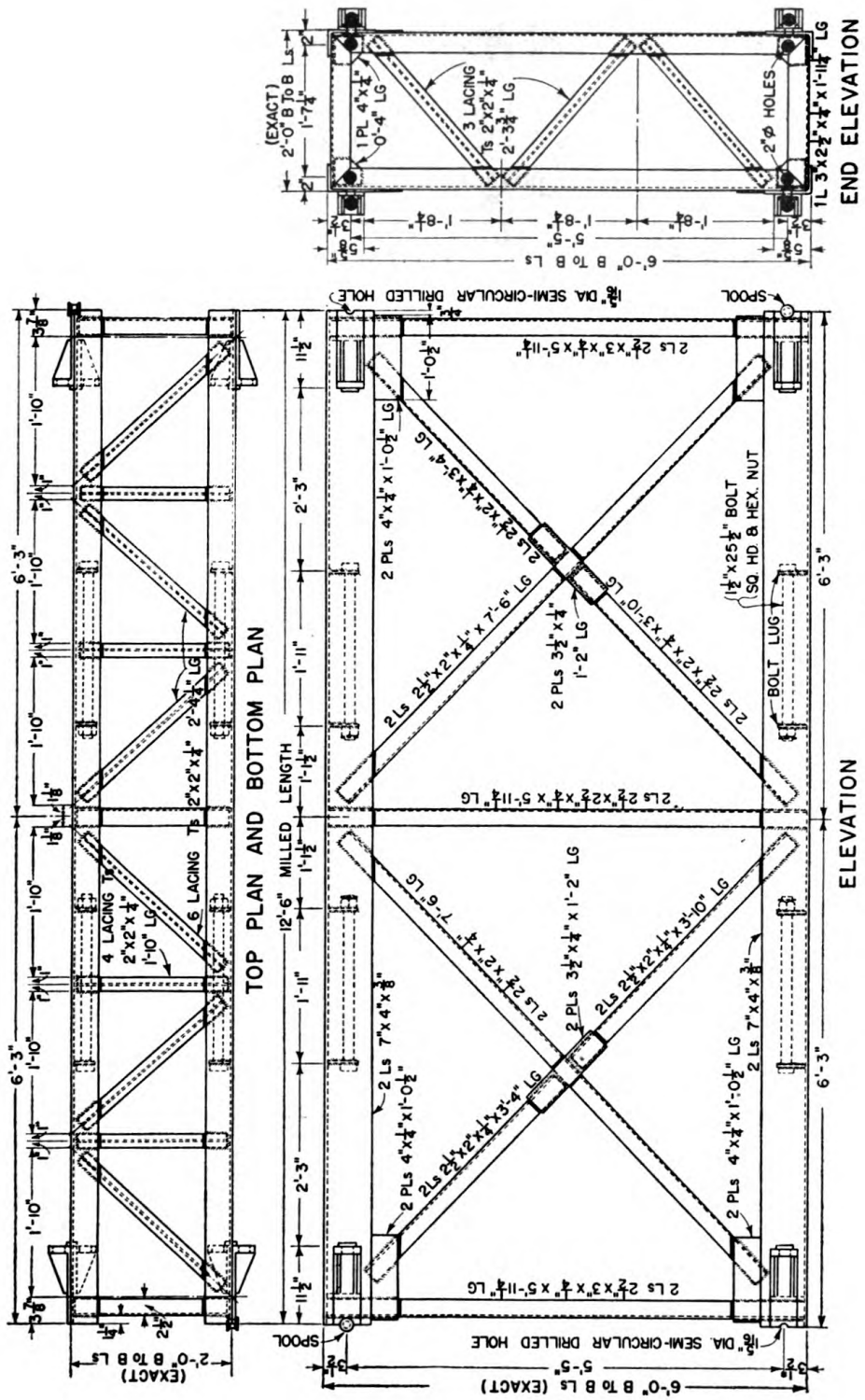


FIGURE 71.—Intermediate or rectangular girder section.

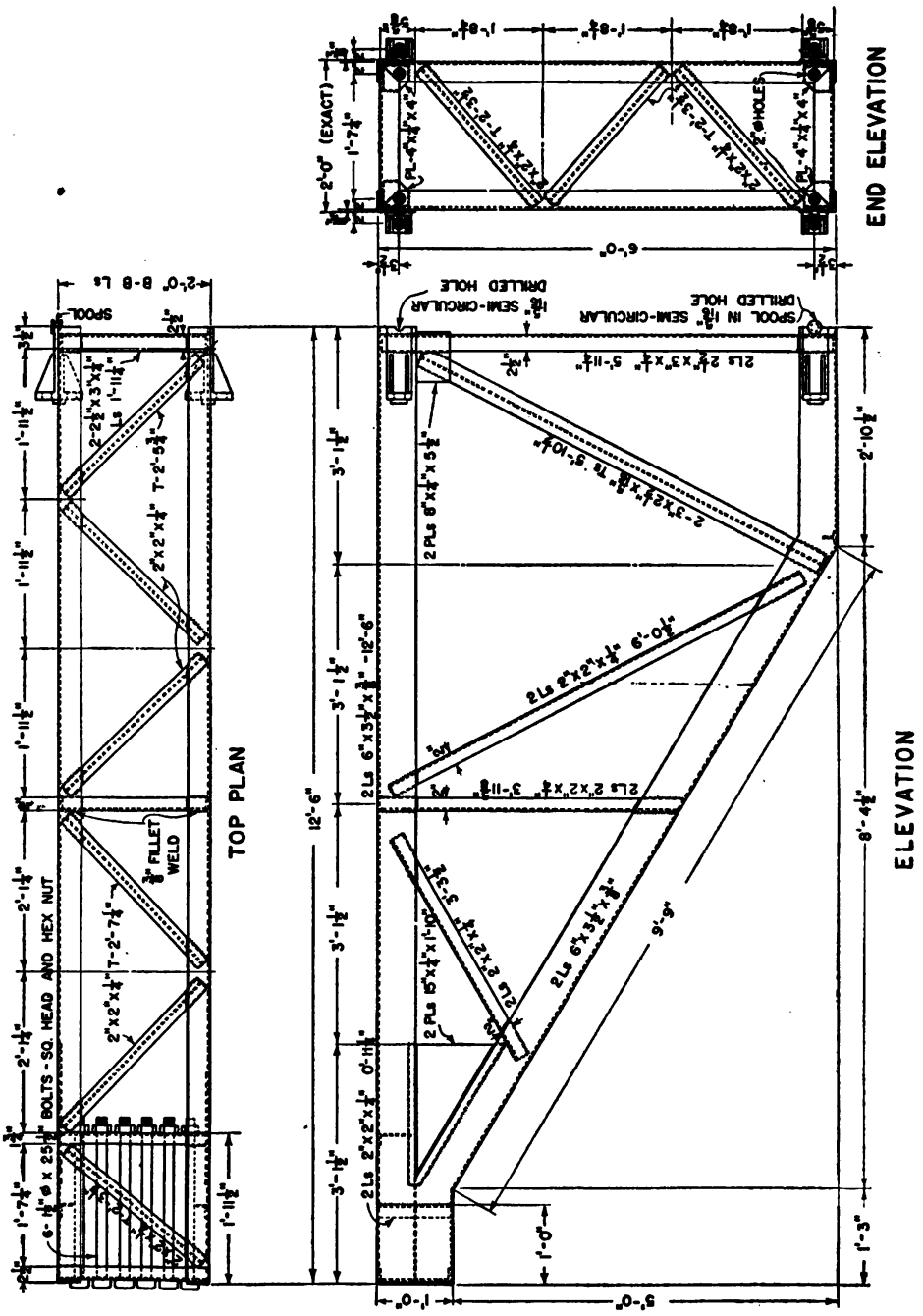


FIGURE 72.—End or triangular girder section.

e. Decking bolts.—Standard ¾-inch carriage bolts, 18 inches long, secure two deck planks per girder section to two planks (also deck planks) passed under the top chords of the girders to fasten the deck to the girders.

f. Lumber parts.—The lumber parts are of the same material (Douglas fir) and are painted in the same manner as the lumber parts of the light steel bridge.

(1) *Deck planking.*—The deck planks are dressed square edged to 4⅝ by 9½ inches (nominally 5 by 10 inches) and are 11 feet long.

(2) *Guard rails.*—The guard rails are dressed to 5½ by 5½ inches (nominally 6 by 6 inches) in section. No length is specified but 12

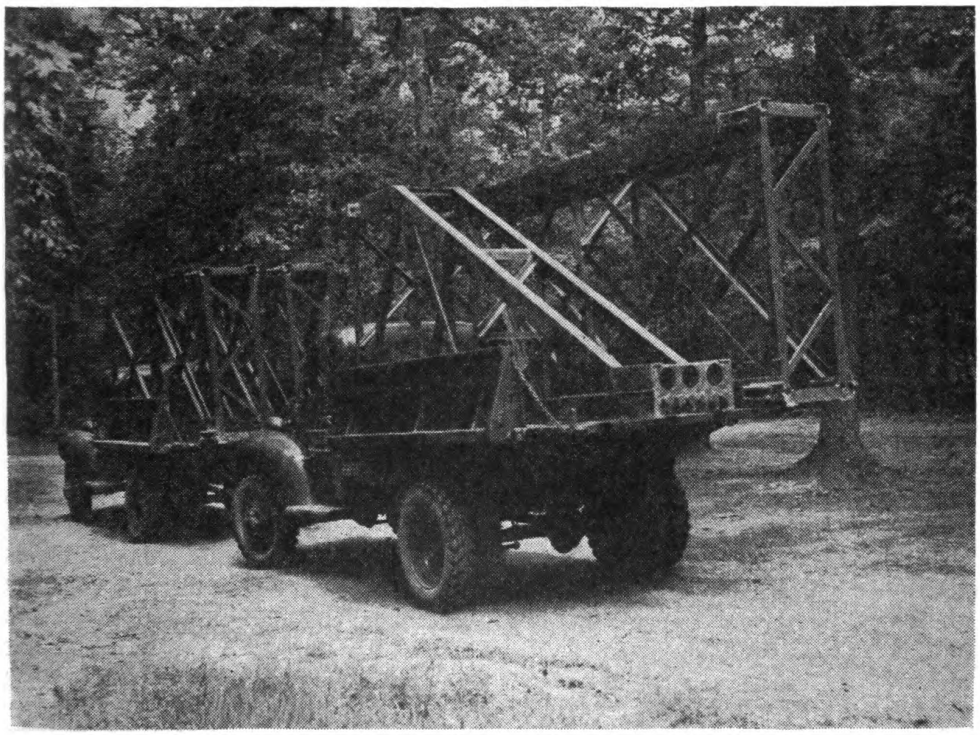


FIGURE 73.—Typical girder loads—1½-ton trucks.

feet or 12 feet 6 inches will probably be convenient for transport and use.

(3) *Stringers.*—Deck planks placed on edge are used as stringers in the approach ramps.

(4) *Lateral bracing.*—Deck planks placed under the top chord and bolted with 4 bolts to deck planking, furnish some lateral support for the bridge girders. (See fig. 76.) Consideration is being given to the substitution of one long or two short steel channels for each plank to save weight and facilitate assembly.

126. Care and storage of equipment.—The remarks of paragraph 115 on the care and storage of the light steel bridge equipment apply with equal force to the heavy bridge. Storage, maintenance,

and handling are all similar, except that tackle will often be found necessary or desirable in moving parts of the heavy bridge girders.

127. Transportation of equipment.—One complete bridge unit (125 feet) can be carried in twenty-four 1½-ton trucks with overloads of less than ½ ton. The use of heavy semitrailers is also being considered; seven would be required.

128. Site requirements.—In general, site requirements are the same for both the light and heavy steel bridges. Sites better adapted to the heavy ponton bridge than to the H-20 steel bridge will show the same characteristics as those sites more suitable to the 10-ton ponton bridge than to the H-10 steel bridge. A somewhat larger working space is required for the heavy bridge than for the light steel bridge, and level ground is even more desirable because of the greater weight of the girder sections.

129. Organization of working parties.—*a.* The construction of the bridge is under the supervision of an officer.

b. The working party is constituted as follows:

Section	Noncommissioned officer's	Men
Rigging No. 1	1	8
Rigging No. 2	1	8
Abutment No. 1	1	8
Abutment No. 2	1	8
Roller	1	6
Bolting	1	12
Tractor		2
Totals	6	52

130. Erection procedure.—*a. General.*—Because of the weight of sections, unloading and spotting for assembly should be effected by mechanical means whenever possible. The simplest installation for this purpose is a crane or a ginpole, A-frame, or shears, rigged to a tractor. Assembly can then proceed by addition of successive sections at the same site, using rollers to advance the assembled portion of the girder.

b. Detailed girder assembly.—(1) (*a*) Rigging section No. 1, aided as necessary by the bolting section, prepares the mechanical set-up by means of which sections will be unloaded and placed in position, at the assembly site.

(*b*) The roller section places rollers, leveling each to guard against overturning of the girder and alining all rollers at a uniform elevation or on a constant slope. Two lines of guardrails will assist in this.

(*c*) Abutment section No. 1 prepares the near abutment.

(*d*) Rigging section No. 2 prepares the gin pole, A-frame, or shears for use at the far abutment.

(*e*) Abutment section No. 2 prepares the far abutment.

(2) Rigging section No. 1 takes over unloading operations. The first truck backs into position, the rectangular section is placed on the

FIGURE 74.—Placing second girder. (Note gin pole in foreground, guide lines on girder, wire rope leading across ravine to tractor in background, and crane used for unloading sections.)

rollers, and the end section is then placed in its proper relative position. Successive girder sections are handled as assembly proceeds.

(3) The bolting section divides into three parts. A four-man crew removes the bolts from their clips, a second four-man crew places and tightens outside bolts, and a third four-man crew follows with inside bolts, advancing with the girder if necessary.

c. Launching girder.—(1) (*a*) Rigging section No. 1, assisted by roller section, makes fast the tractor or handbrake line to the near

end of the girder and attaches three manila rope lines, two as side guide lines to prevent overturning and the third as a back safety tag line.

(*b*) Rigging section No. 2 makes fast the far tractor line to the far end of the girder.

(2) Power is applied on the far end of the girder to draw the girder into position.

(3) Abutment sections jack or pinch girder into final position.

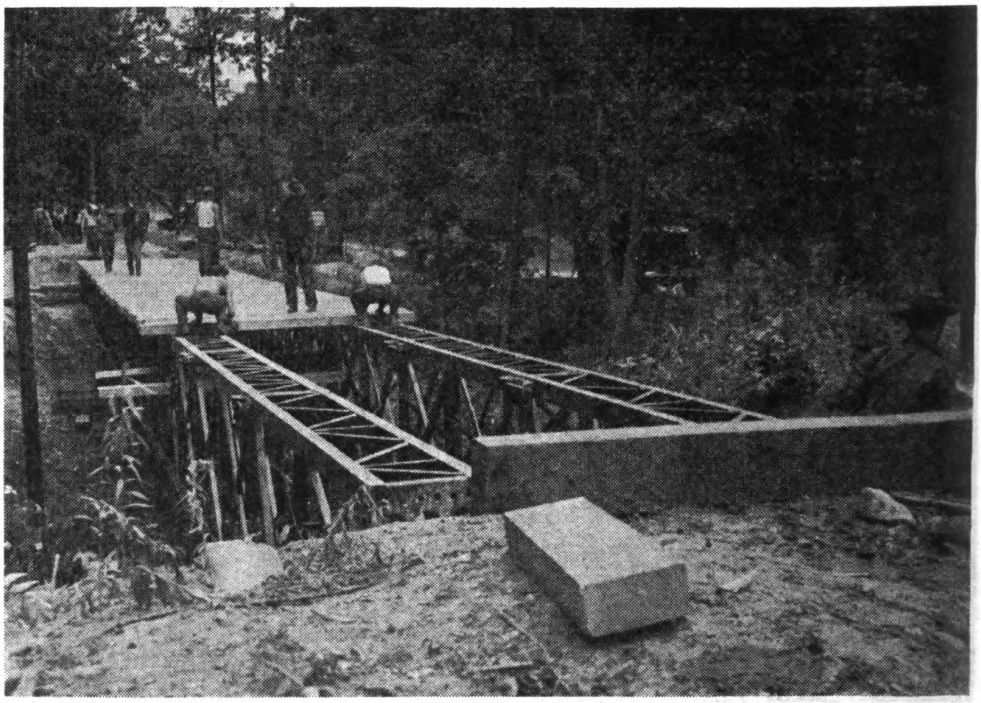


FIGURE 75.—Laying the decking.

d. Decking.—As soon as the two girders are in final position the entire detail is reorganized to place the decking, which, because of its weight, must be spotted close to the bridge. The reorganization is—

Section	Noncommissioned office's	Men
Chess placing		2
Lateral braces placing and securing	1	8
Guard rail placing and securing	1	8
Carrying and approaches	Remainder	Remainder

131. Time required for construction of bridge.—*a. Trained personnel.*—At a favorable site, experienced personnel, organized as described above, can erect this bridge, exclusive of approaches, in

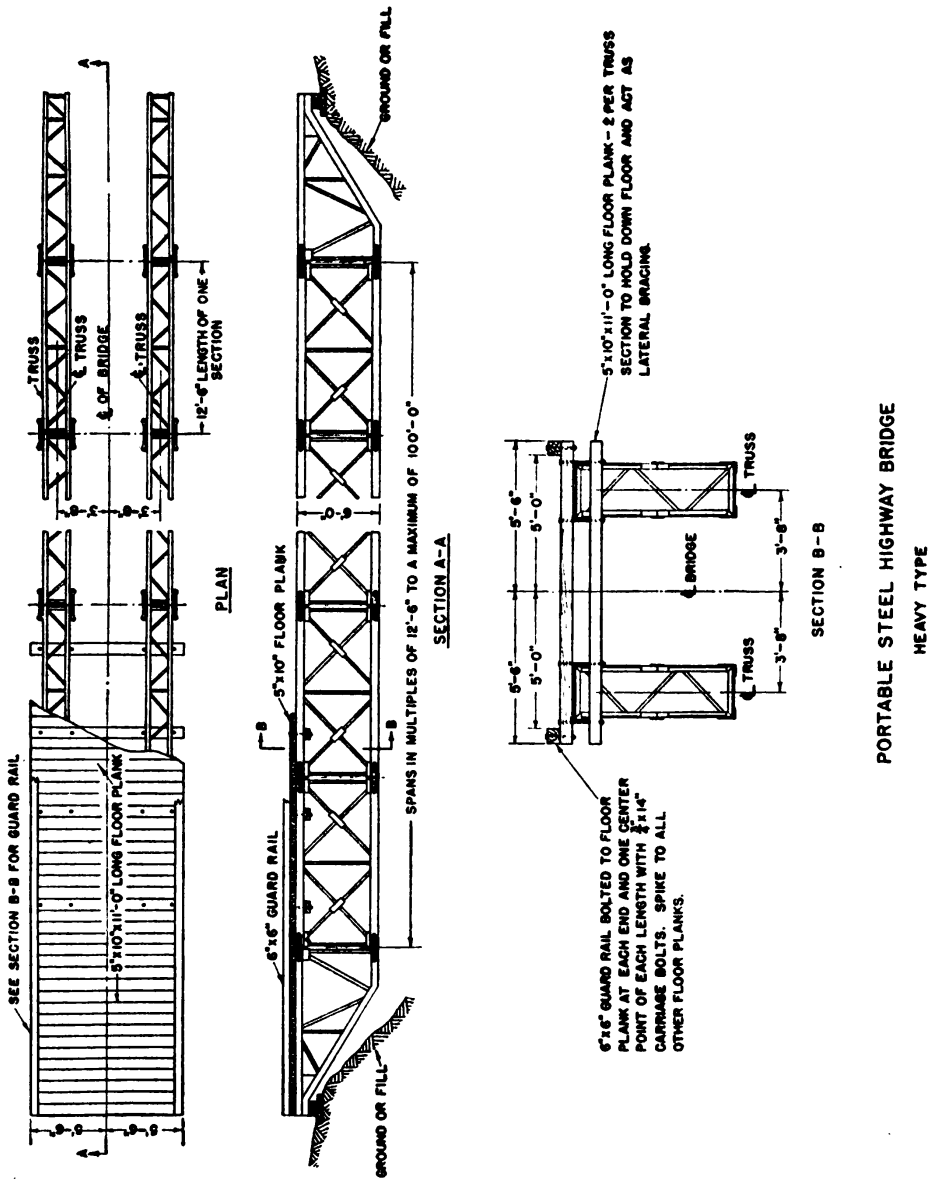


FIGURE 76.—H–20 portable steel bridge.

4 to 5 hours. About one hour can be saved by the use of a crane in the assembly.

b. Inexperienced personnel.—Personnel unfamiliar with the equipment and rigging necessary would probably require 8 to 10 hours to install the bridge.

132. Dismantling bridge.—In general, the bridge is dismantled by the reversal of the erection procedure. The instructions in paragraph 121 on the dismantling of the light bridge apply to the H–20 bridge, with minor deviations arising from the differences between the two units.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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