FM 4-198

WAR DEPARTMENT FIELD MANUAL

ANTIAIRCRAFT ARTILLERY

BARRAGE BALLOON REFERENCE DATA

WAR DEPARTMENT • 30 OCTOBER 1943

RESTRICTED

FM 4–198
•C 1

ANTIAIRCRAFT ARTILLERY FIELD MANUAL

BARRAGE BALLOON REFERENCE DATA

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 8 December 1943.

FM 4–198, 30 October 1943, is changed as follows:

(See page 2 for *Figure 31—Method of measuring weigh-off.*)

•The individual item in this change will be cut apart and pasted over the specific illustration affected.

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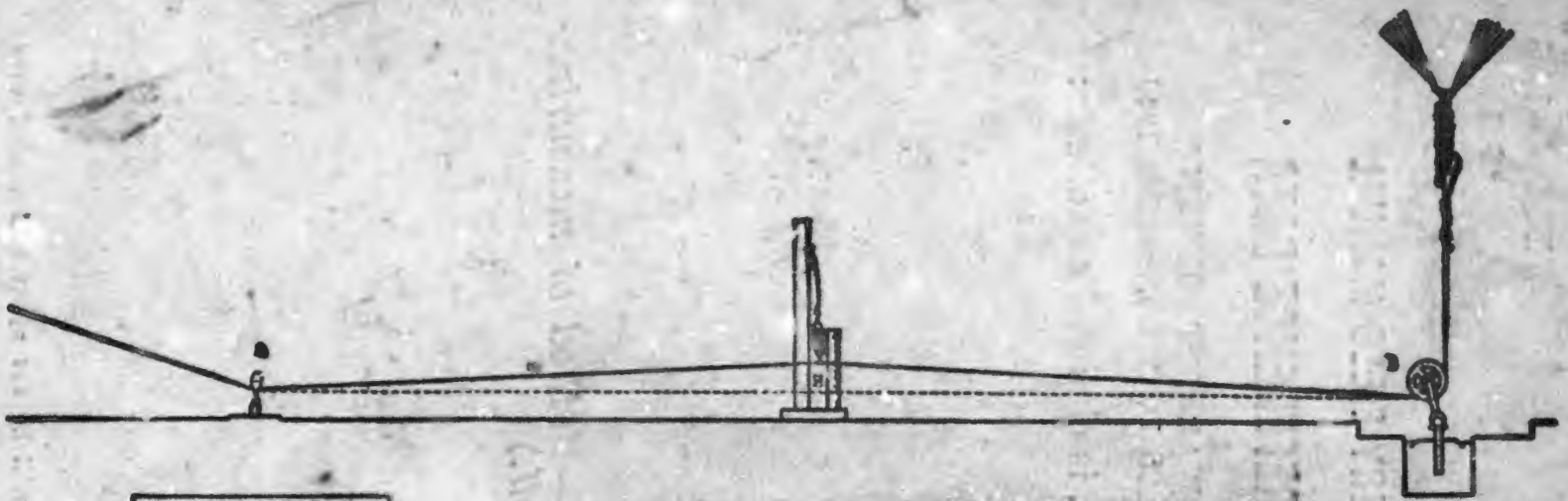

Distance A to B	Cable To Be Raised (H)
36'	10 3/4"
37'	11"
38'	11 1/4"
39'	11 3/4"
40'	12"
45'	13 1/2"
50'	15"
60'	18"

1. THE ADJOINING TABLE GIVES THE REQUIRED HEIGHT TO WHICH THE CABLE IS TO BE RAISED ACCORDING TO THE DISTANCE BETWEEN A AND B.

2. IN EACH CASE, THE READING ON THE SPRING BALANCE IS TO BE MULTIPLIED BY 10 TO GIVE THE NET LIFT OF THE BALLOON.

3. RESULTS WILL ONLY BE CORRECT IF READINGS ARE TAKEN IN CALM AIR. IN ANY LIGHT WIND READING SHOULD BE TAKEN AT MOMENT WHEN WIND DROPS.

EXAMPLE. A TO B IS 36 FT. CABLE IS RAISED 10 3/4" FROM ITS NORMAL POSITION, THEN, IF READING ON SPRING BALANCE IS, SAY, 26 LBS. 26 x 10 = 260 LBS = NET LIFT OF BALLOON.

Figure 31. Method of measuring weigh-off.

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

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

[A. G. 300.7 (17 Dec 43).] (C 1, 28 Dec 43.)
2
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WAR DEPARTMENT · 30 OCTOBER 1943

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON, 1943

WAR DEPARTMENT,
WASHINGTON 25, D. C., 30 October 1943.

War Department Field Manual 4–198, Antiaircraft Artillery, Barrage Balloon, Reference Data, is published for the information and guidance of all concerned.

[A. G. 300.7 (28 Jun 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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

DISTRIBUTION:

IBn and H 44(5); IC 44(25).

(For explanation of symbols see FM 21–6.)

TABLE OF CONTENTS

Chapter 1

GENERAL

1. PURPOSE The purpose of this manual is to furnish barrage balloon personnel a compact source of data for ready reference.

2. REFERENCES Field and Technical Manuals dealing with barrage balloons are listed below.

FM No.	Title
4–181	Employment of barrage balloons.
4–182	Technique.
4–183	Barrage control.
4–184	Barrage balloon site installations.
4–187	Service of the balloon and balloon equipment, LA.
4–188	Service of the balloon and balloon equipment, VLA.
4–191	Service of cable armament.
4–193	Gas generation, use, purification, and service of the hydrogen generator.
4–196	Rigging and fabric repair.
4–198	Reference data.

TM No.	Title
4–241	Meteorology for antiaircraft balloon units.

3. CHARACTERISTICS OF BALLOONS The characteristics of balloons are given in table I. All figures are approximate and may vary with individual balloons.

TABLE I—CHARACTERISTICS OF BALLOONS

Characteristic	Unit	Mk. VII	B-7	B-6	Mk. VI	M1
Length over-all (including fins)	Feet	64	64	69½	35	35
Length of envelope	Feet	62¾	62¾	68½	33½	33½
Maximum diameter of envelope	Feet	25¼	25¼	27	11⅜	14¾
Maximum height from bottom of rudder	Feet	31¾	31¾	35	14⅜	17
Maximum height of balloon above junction of foot ropes	Feet	40½	40½	44½	21⅛	23
Volume of envelope (design)	Cu. ft.	19,150	19,150	23,500	2,700	3,100
Volume of ballonet	Cu. ft.	6,000	6,000	7,900	None	None
Gas volume (including stretch)	Cu. ft.	20,000	20,000	24,000	3,000	3,300
Basic gas volume	Cu. ft.	17,200	17,200	20,000	2,300	2,900
Basic ballonet volume	Cu. ft.	2,800	2,800	4,000	None	None
Cylinders of gas required to inflate (average)	Each	90	90	105	13	16
Dead weight of balloon	Pounds	500	625	765	110	126
Altitude in still air	Feet	5,000	4,500	5,000	2,000	2,000

Chapter 2

BALLOON SITE ARRANGEMENT AND ANCHORAGES

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4. ARRANGEMENT A typical arrangement of LA balloon site components is shown in figures 1 to 3, inclusive.

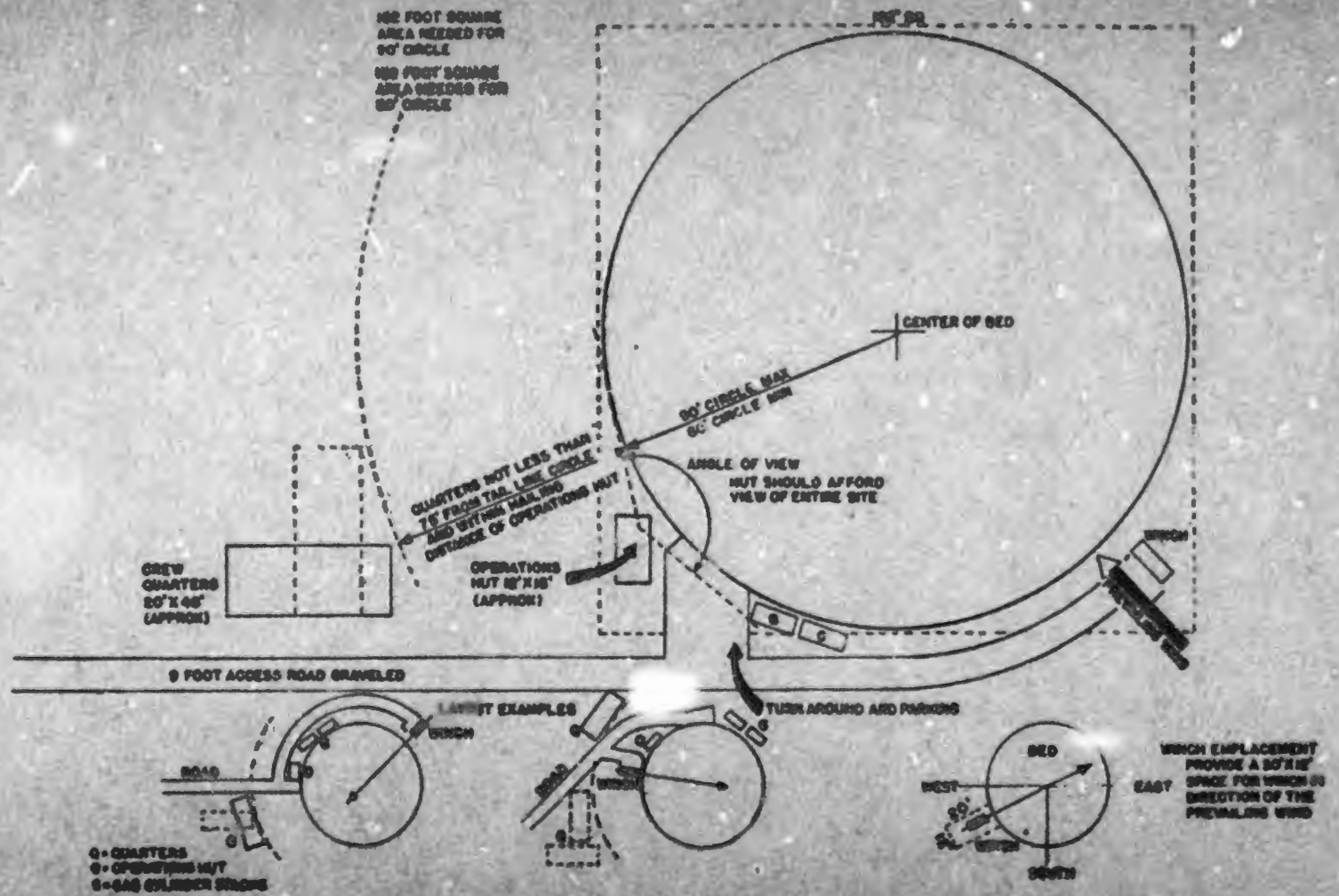

Figure 1. Lay-out of site

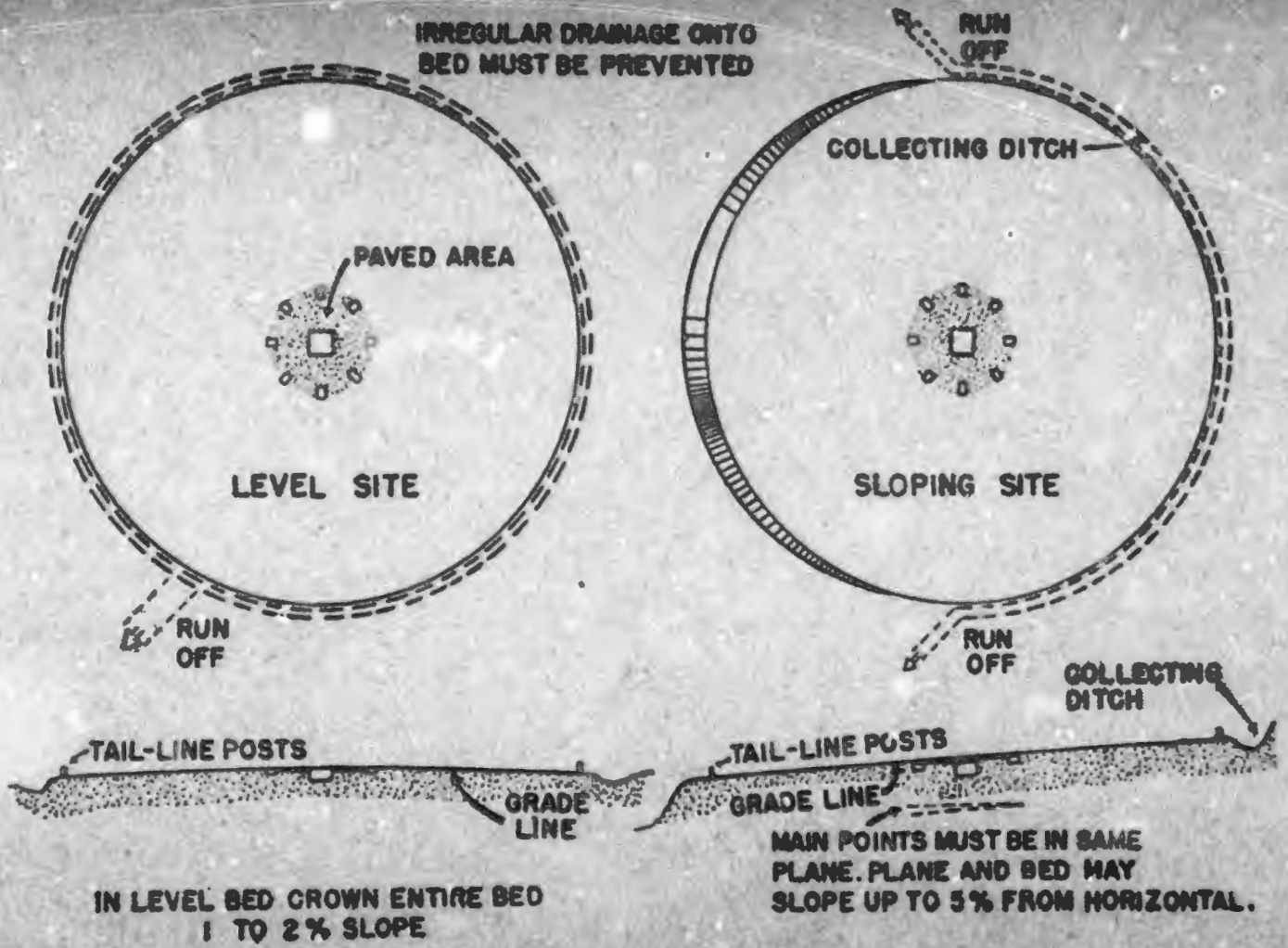

Figure 2. Site drainage

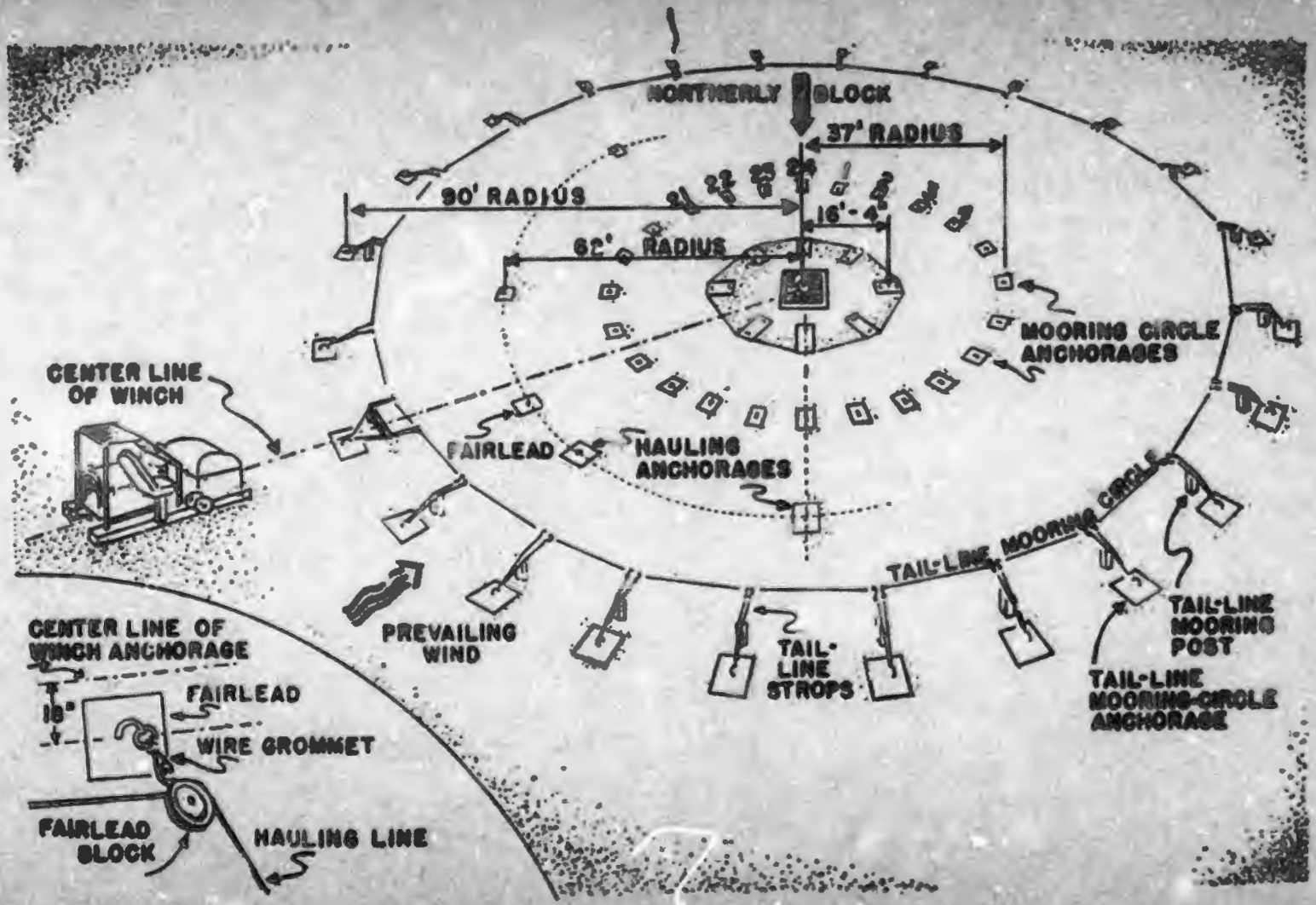

Figure 3. Lay-out of anchorages

5. CONCRETE ANCHORAGES Construction of concrete anchorages for LA balloon sites is shown in figures 4 to 6, inclusive. For information on concrete, see appendix VII.

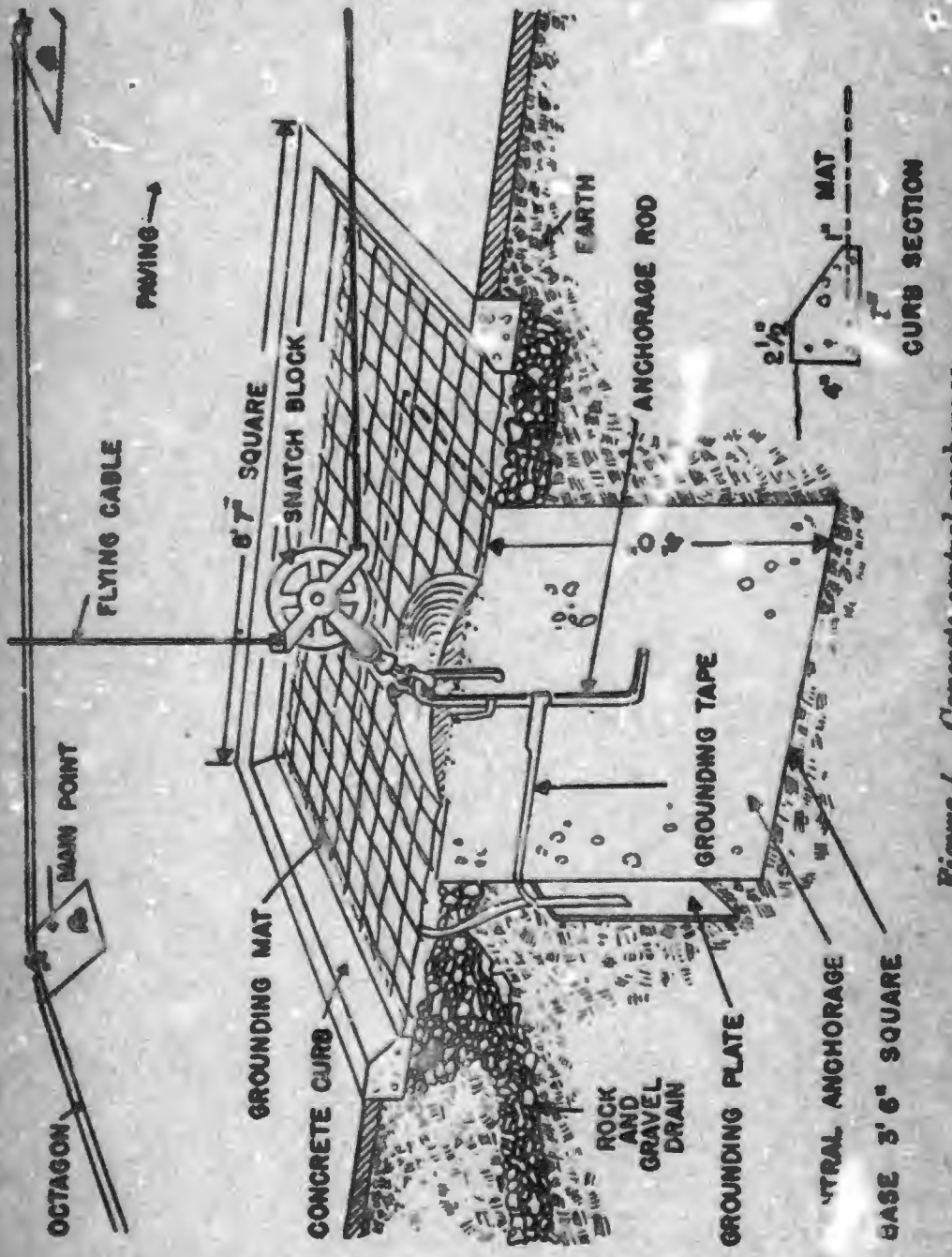

Figure 4. Concrete central anchorage

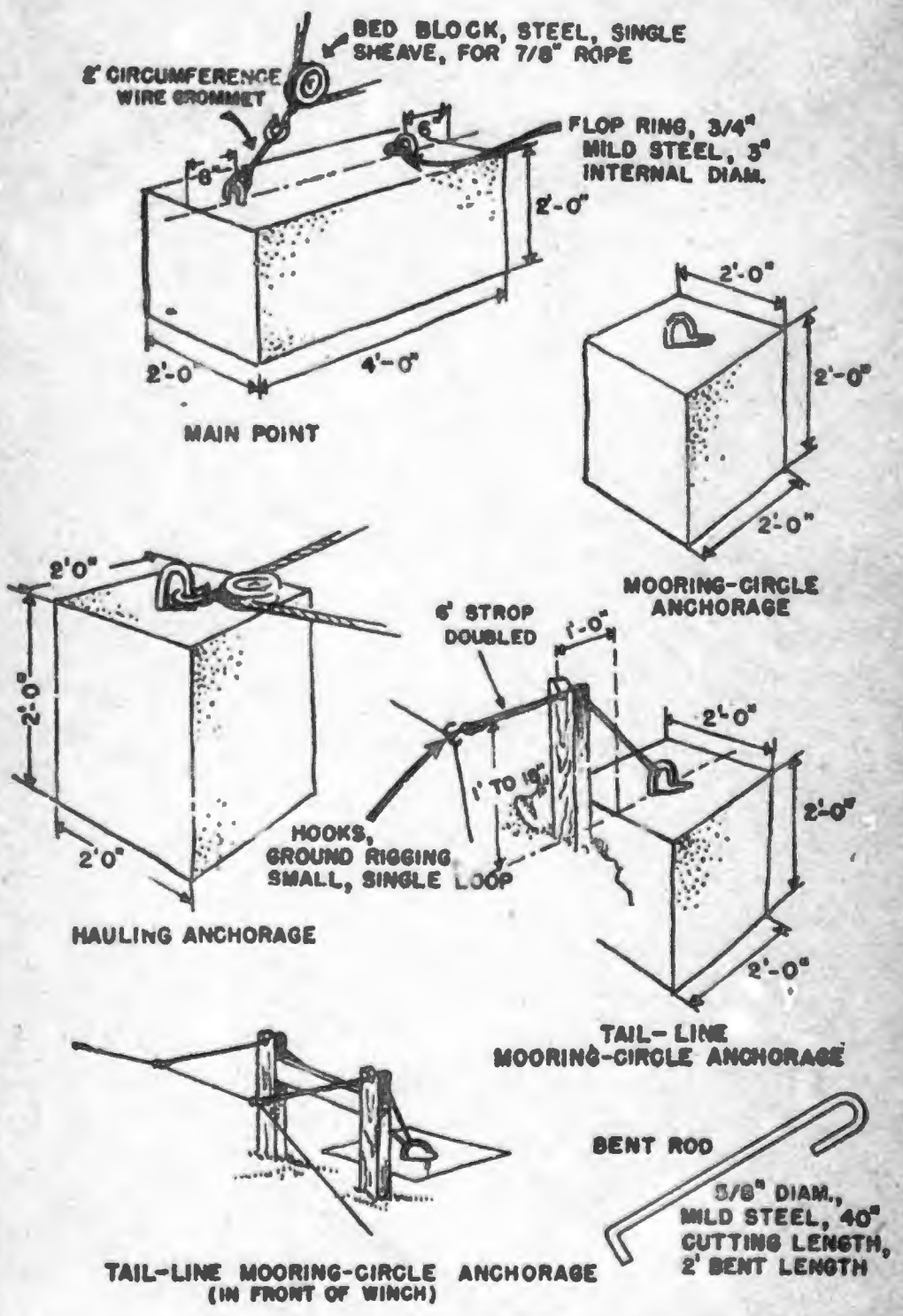

Figure 5. Main-point, mooring-circle, hauling, and tail-line mooring-circle anchorages

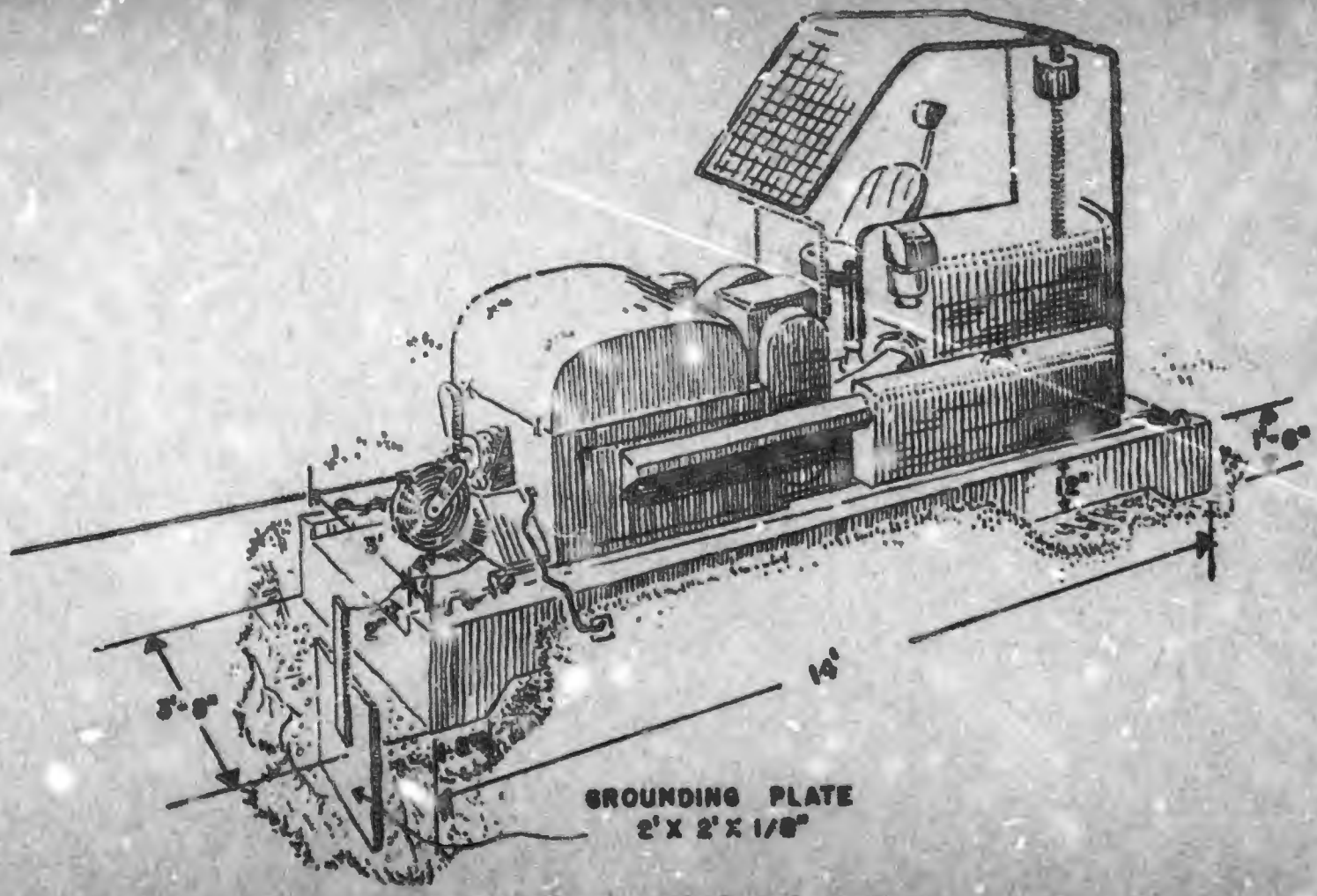

Figure 6. Concrete winch anchorage

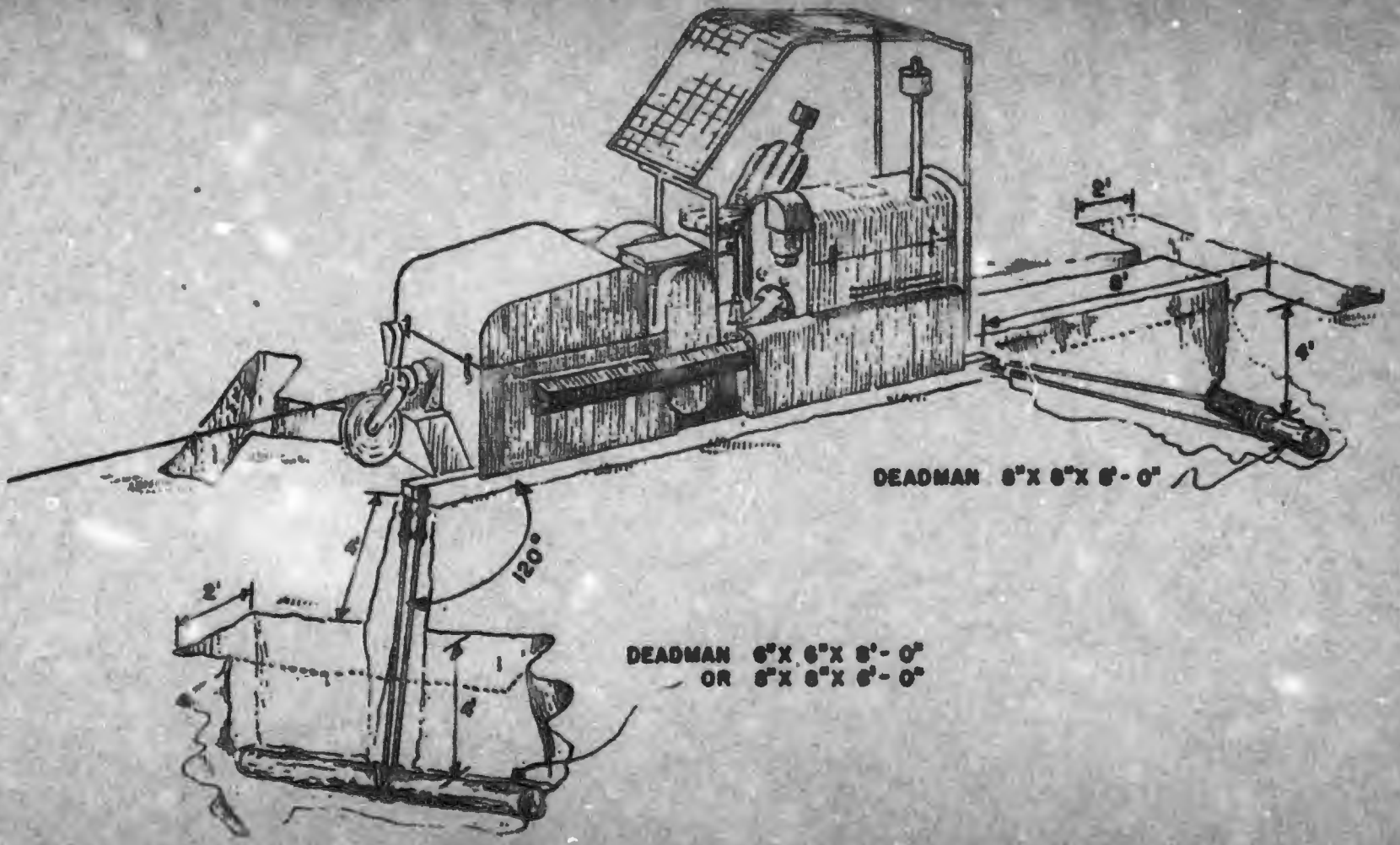

Figure 7. Deadman winch anchorages

6. DEADMAN ANCHORAGES *a. General* It may sometimes be necessary to use deadman anchorages instead of concrete. Methods for determining the length, size, and depth of a deadman are outlined below. Use of deadmen for the winch and central anchorages is illustrated in figures 7 and 8.

b. Length In order to insure that the deadman selected will not fail in bending, test by the following formulas:

(1) Round log: $$L = \frac{1600\,d^3}{P}$$

(2) Rectangular timber: $$L = \frac{2667\,bh^2}{P}$$

where L = Maximum allowable length of log or timber.
d = Diameter of log (inches).
P = Pull (pounds).
b = Base of rectangular timber (inches).
h = Height of rectangular timber (inches).

c. Holding power.

TABLE II—HOLDING POWER OF DEADMAN[1]

Resistance to anchor pull in pounds per square foot of anchor face for various declinations of pull[2]

Depth (feet)	1/0 (vertical)	1/1	1/2	1/3	1/4
1	70	110	150	160	175
1½	150	250	320	360	390
2	290	410	580	650	700
3	600	950	1,300	1,450	1,500
4	1,050	1,750	2,100	2,600	2,700
5	1,700	2,800	3,600	4,000	4,100
6	2,400	3,800	5,100	5,800	6,000
7	3,200	5,100	7,000	8,000	8,400

[1] Table is based on dry, loamy earth. For wet earth, the holding values must be multiplied by the following factors:

Wet hard gravel	0.9
Wet river clay	0.5
Wet river sand	0.5

[2] The declination of pull is the ratio of vertical and horizontal distances from deadman to point of pull. For example, if the deadman is buried 4 feet deep, 8 feet to the rear of a winch, the declination is 1/2.

d. Application of table II to winch anchorages Logs 8 feet long and 8 inches in diameter are to be used as deadmen to anchor a winch and offset a total pull of 7,600 pounds (breaking strength of M2 flying cable). Declinations of pull of 1/2 for the rear deadman anchorage and of 1/1 for the front deadman anchorages are to be used. How far from the winch and at what depth should the deadmen be buried?

(1) Compute the number of square feet of anchor face, which is the length of the anchor (8 feet) multiplied by its diameter (8 inches, or .66 feet):

$$8 \times .66 = 5.28 \text{ square feet}$$

(2) Determine the pull per square foot of anchor face, which is the total pull (7,600 pounds) divided by the number of square feet of anchor face (5.28 square feet):

$$\frac{7,600}{5.28} = 1,437 \text{ pounds}$$

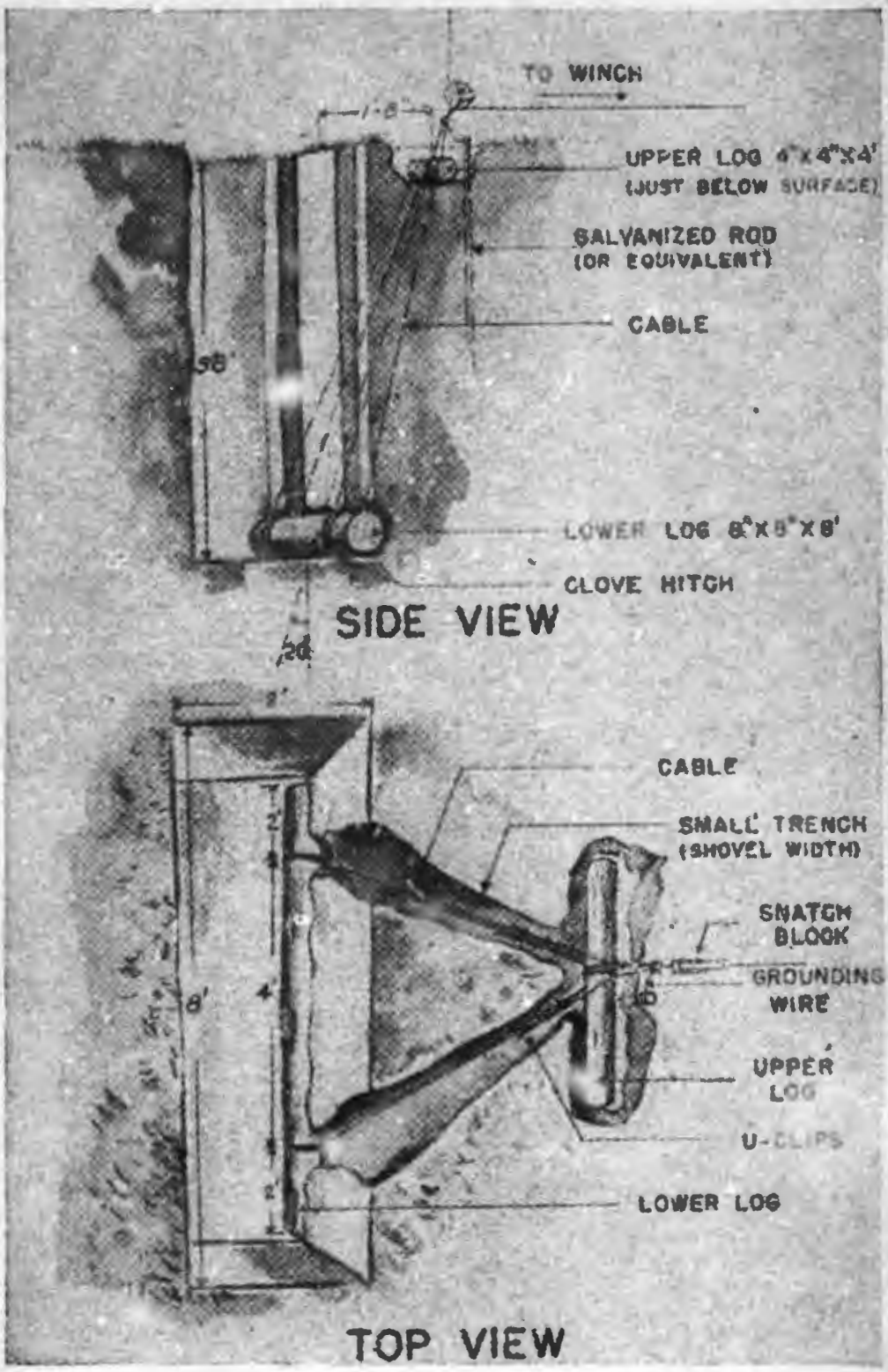

Figure 8. Deadman central anchorage

(3) Refer to the appropriate column in table II and determine the depth to which the deadman must be buried. Table II shows that the rear deadman anchorage must be buried to a depth of 4 feet to resist a pull of 1,437 pounds per square foot of anchor face at a declination of 1/2. Each front deadman anchorage must be buried to a depth of 4 feet to resist a pull of 1,437 pounds per square foot of anchor face at a declination of 1/1.

e. Application of table II to central anchorage The application of table II to a central anchorage is the same as that for winch anchorages, except that a pull of 15,200 pounds (twice the breaking strength of the M2 cable) and a declination of 1/.4 are used. It is not necessary to calculate the size of the upper deadman (fig. 8) since the only purpose of this deadman is to prevent the anchor cable from shifting.

7. PROTECTIVE MEASURES Measures for the protection of the winch are illustrated in figure 9. Fox holes for personnel should be distributed around the site.

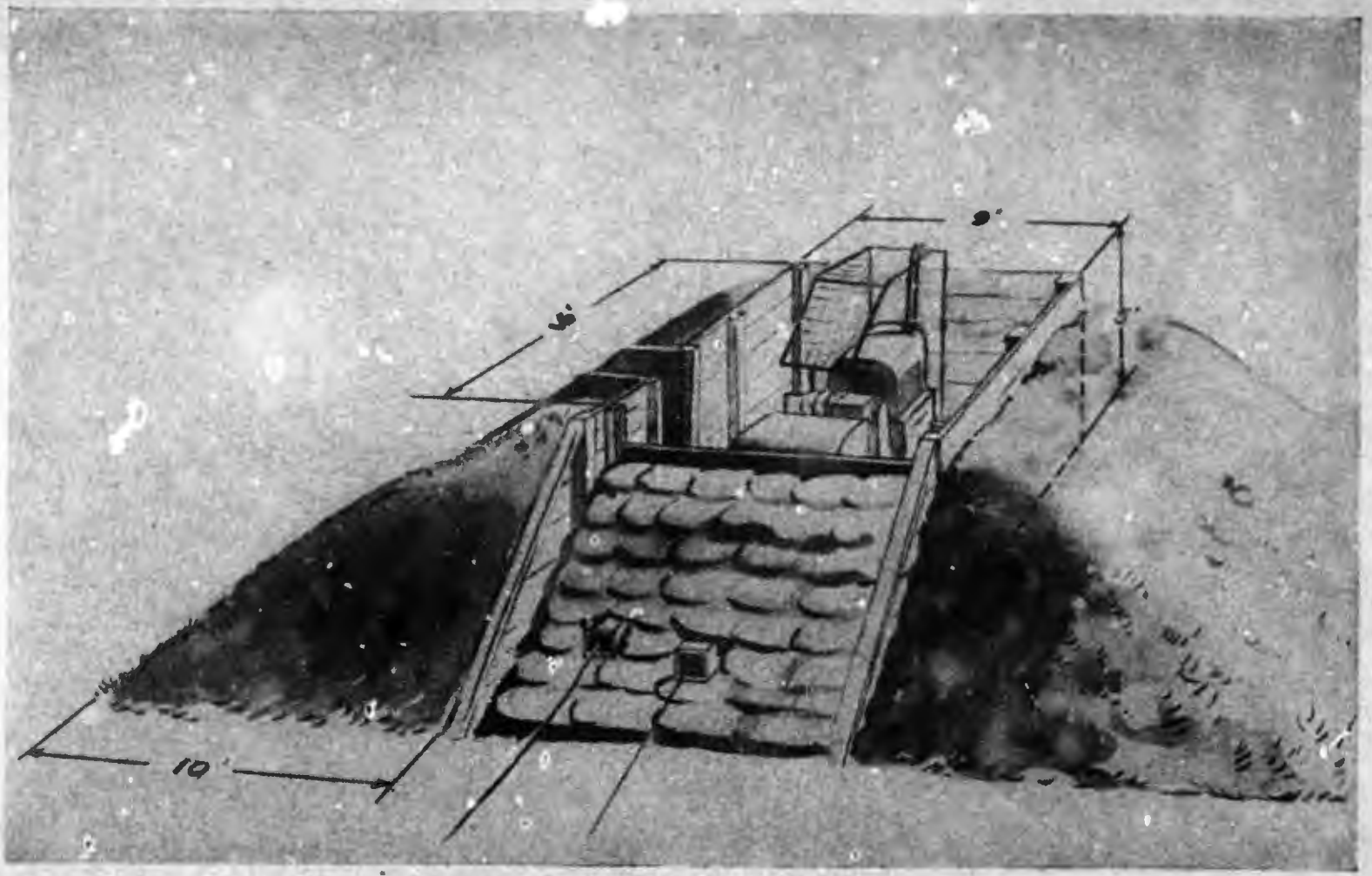

Figure 9. Winch barricade

Chapter 3

BALLOON MOORING

8. BEDDING DOWN LA BALLOONS The method of bedding down LA balloons and the equipment necessary for this operation are shown in figures 10 to 15, inclusive.

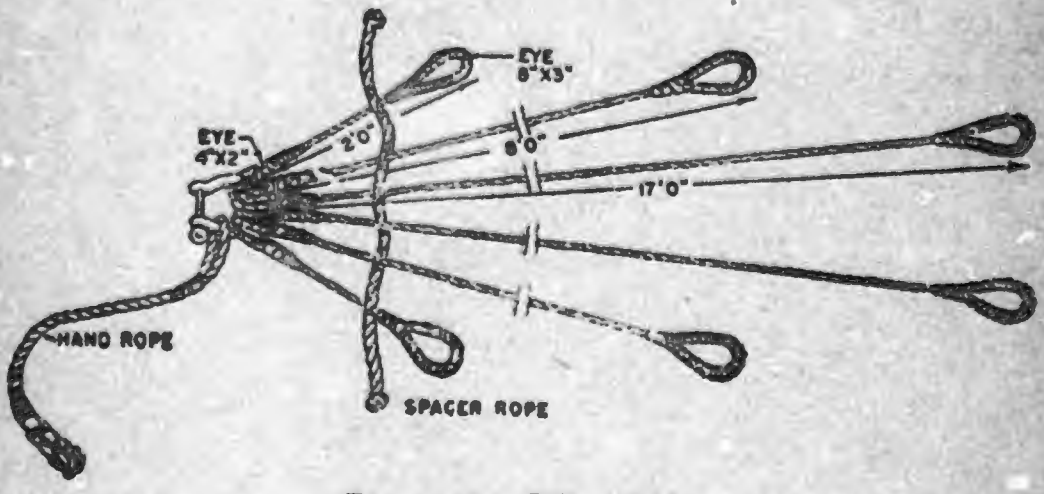

Figure 10. Wire spider

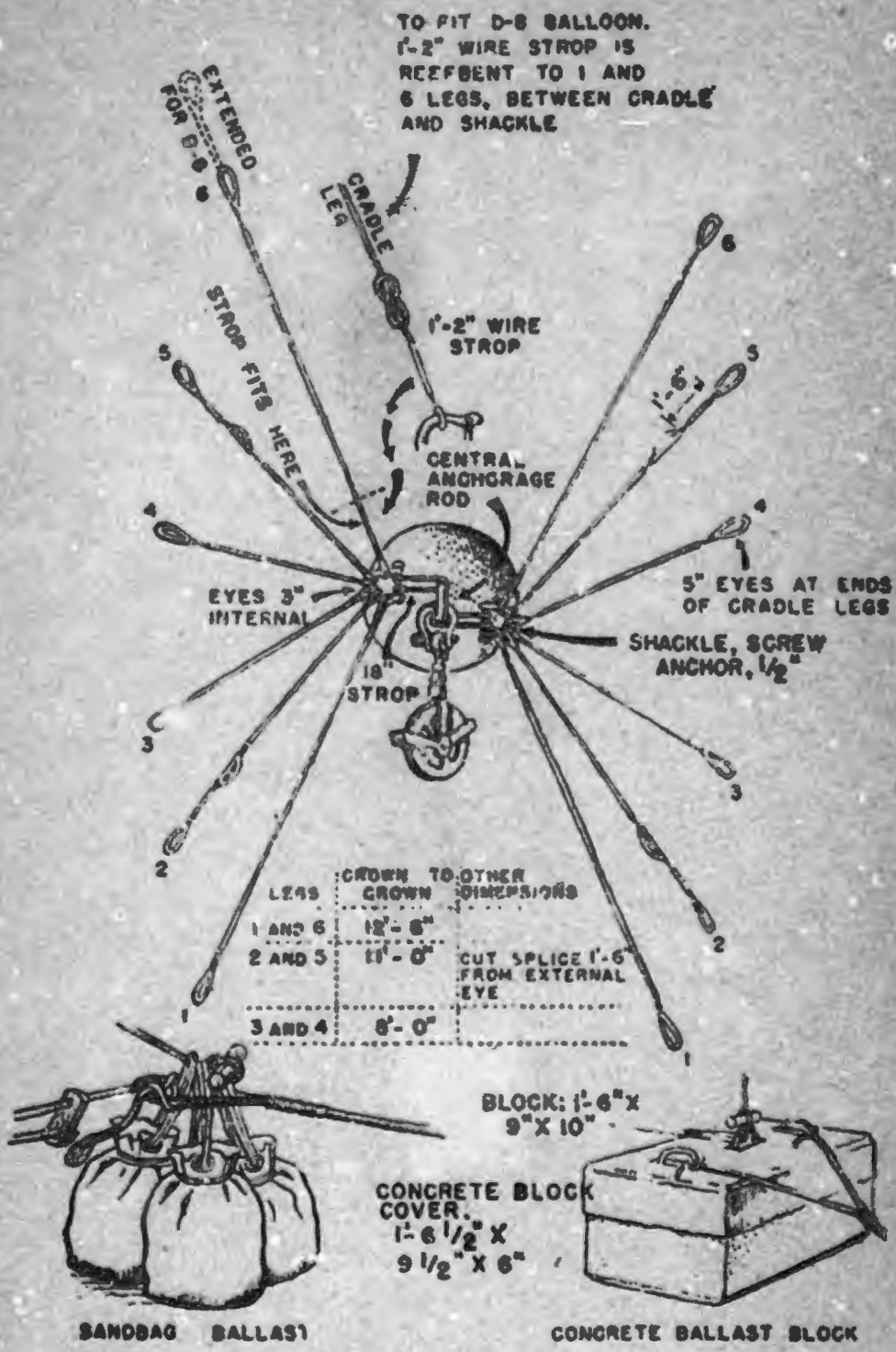

Figure 11. Cradle

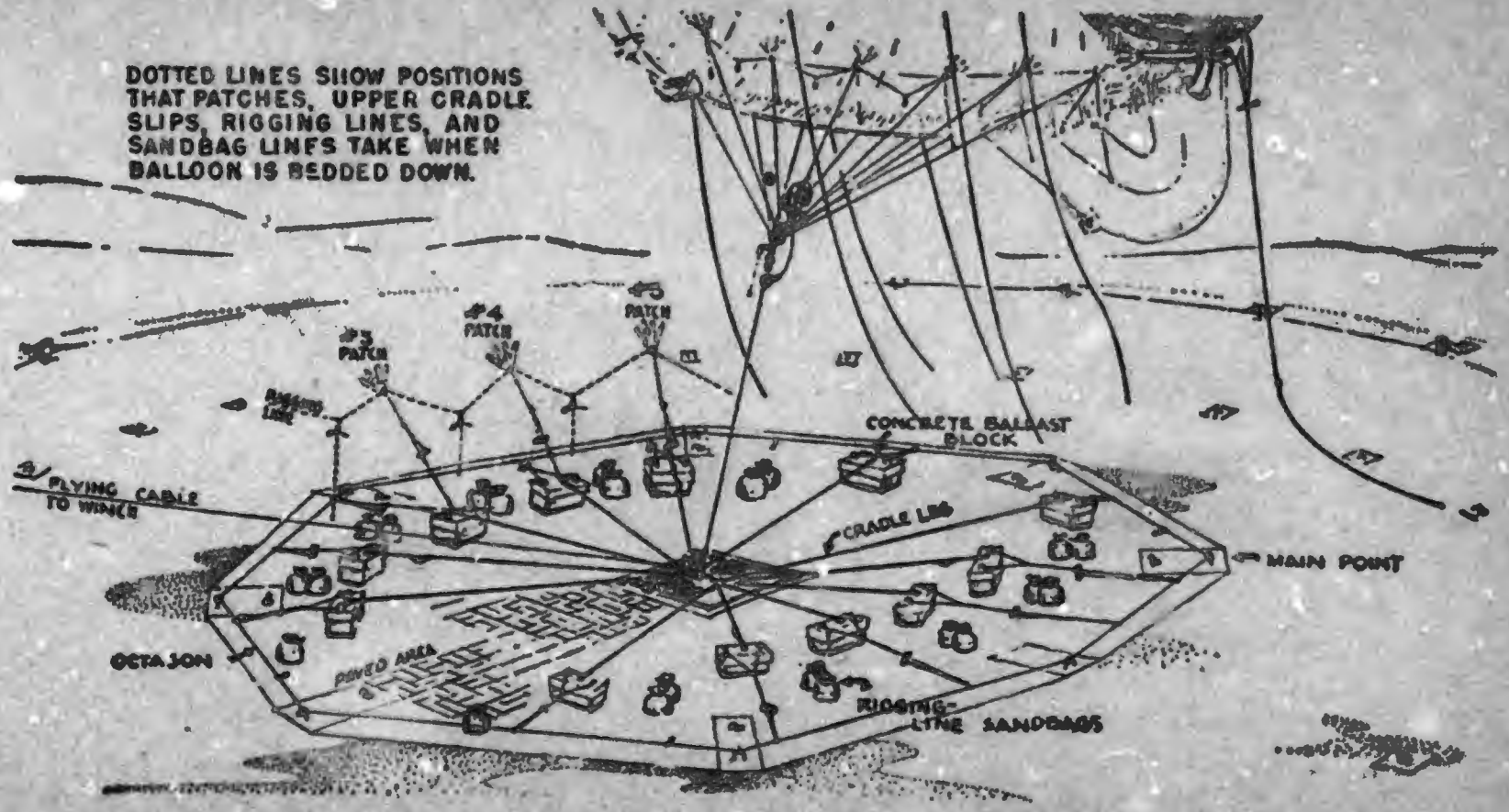

Figure 12. Cradle bed prepared for balloon

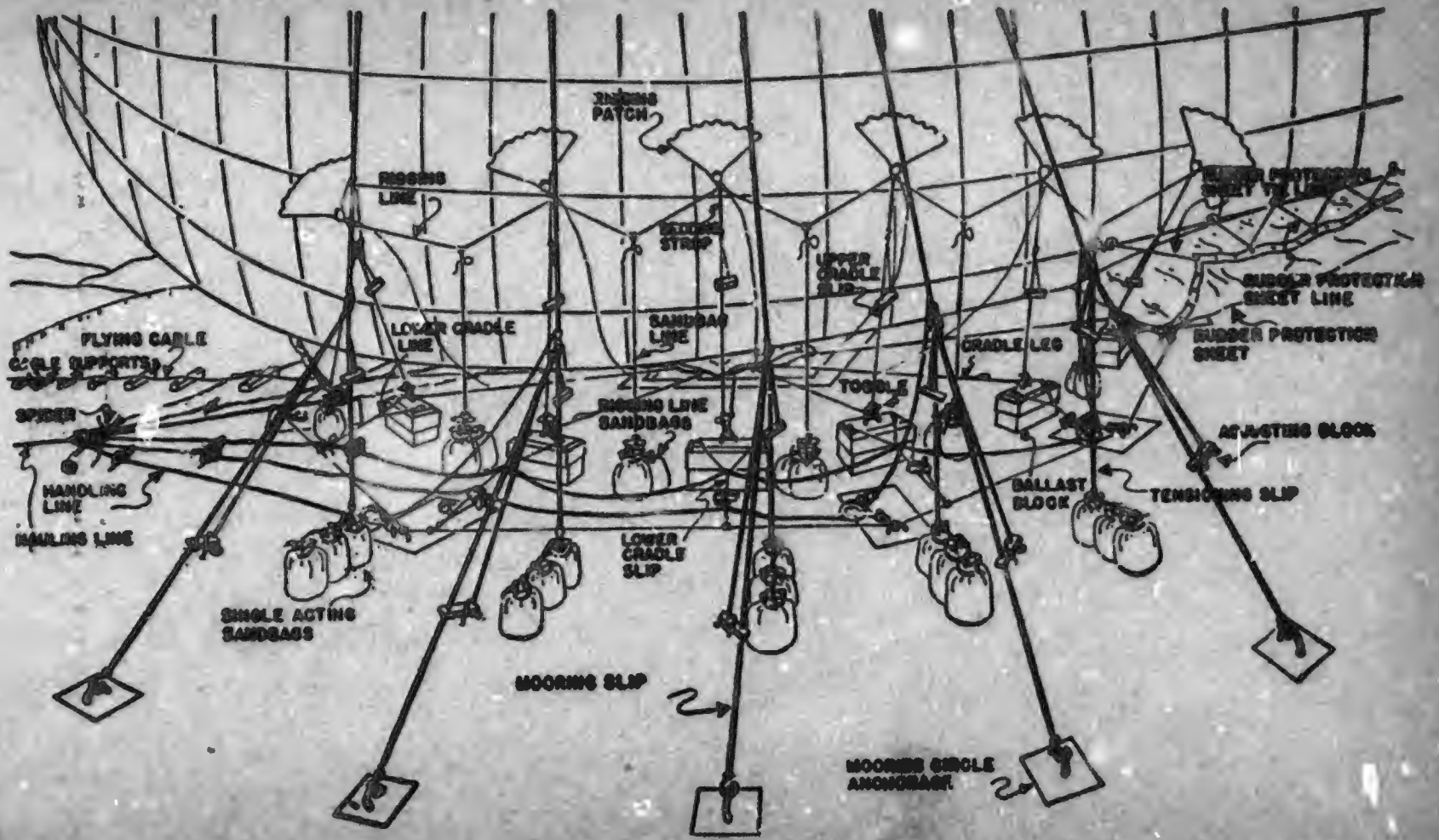

Figure 13. Balloon bedded dur

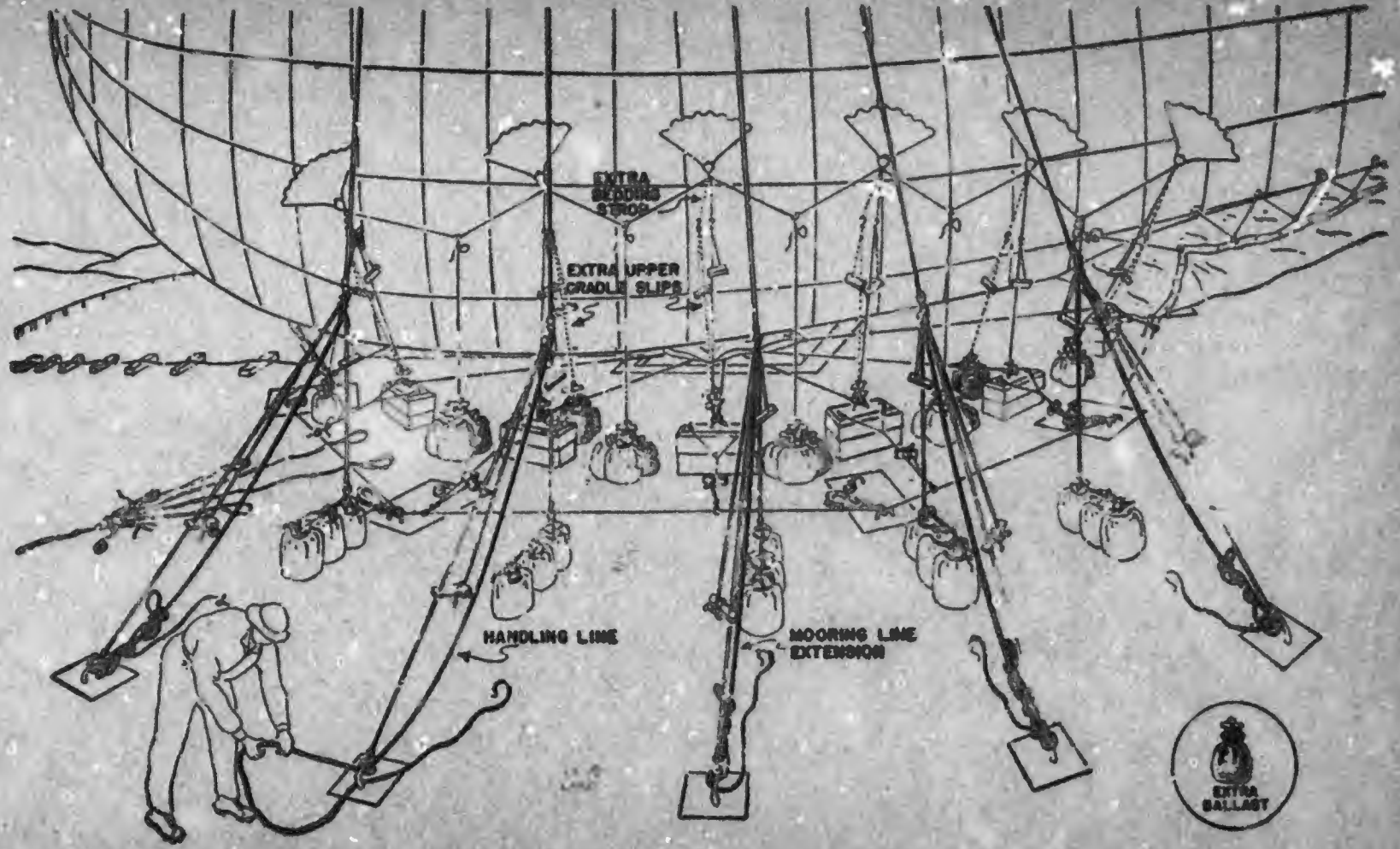

Figure 14. Storm precautions

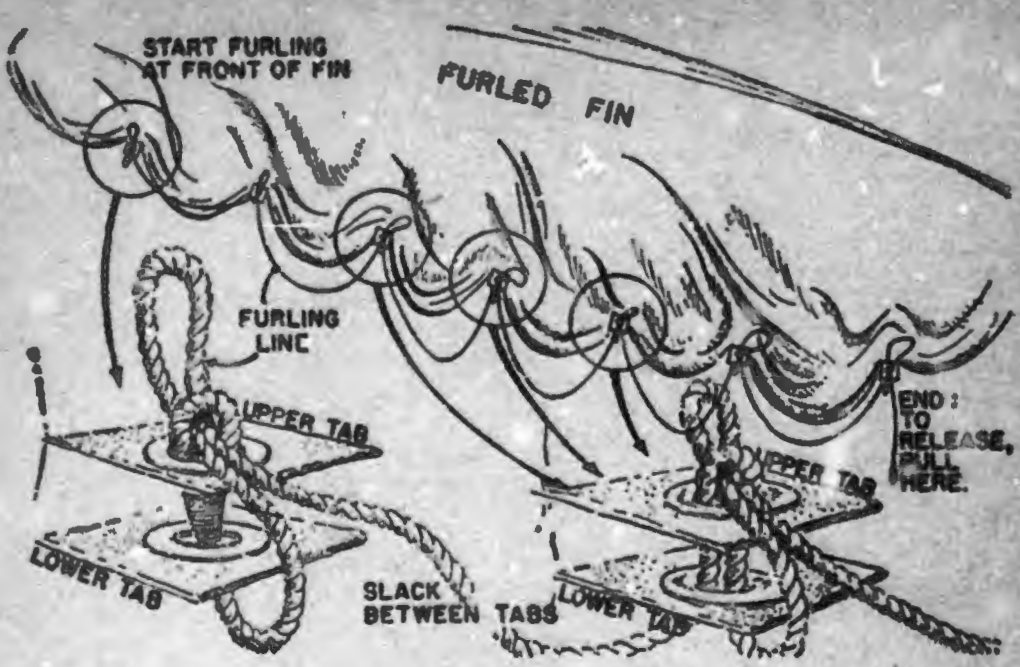

Figure 15. Furling fins

9. TAIL-LINE MOORING The equipment necessary for tail-line mooring LA balloons is shown in figures 16 to 18, inclusive.

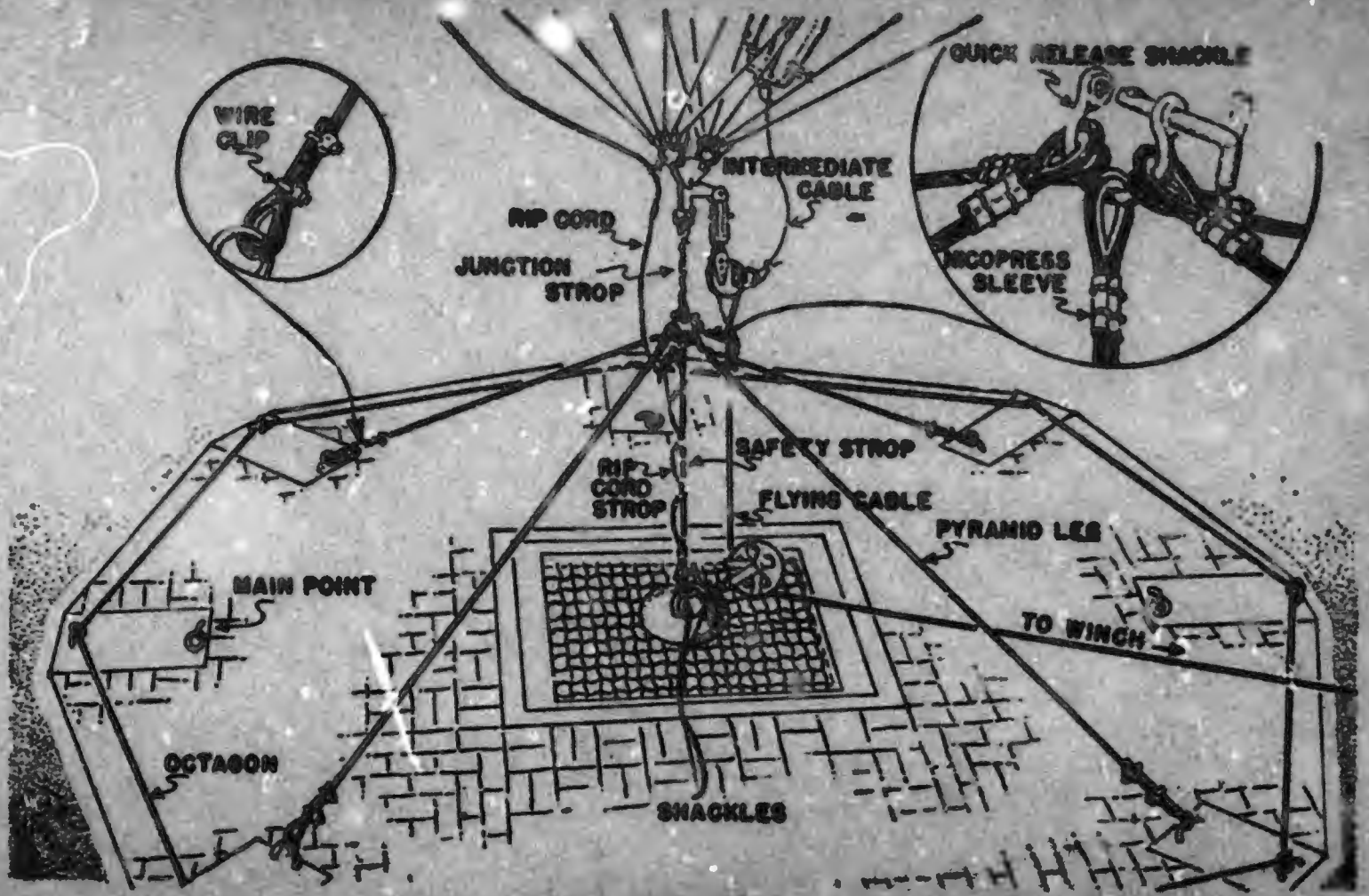

Figure 16. Pyramid

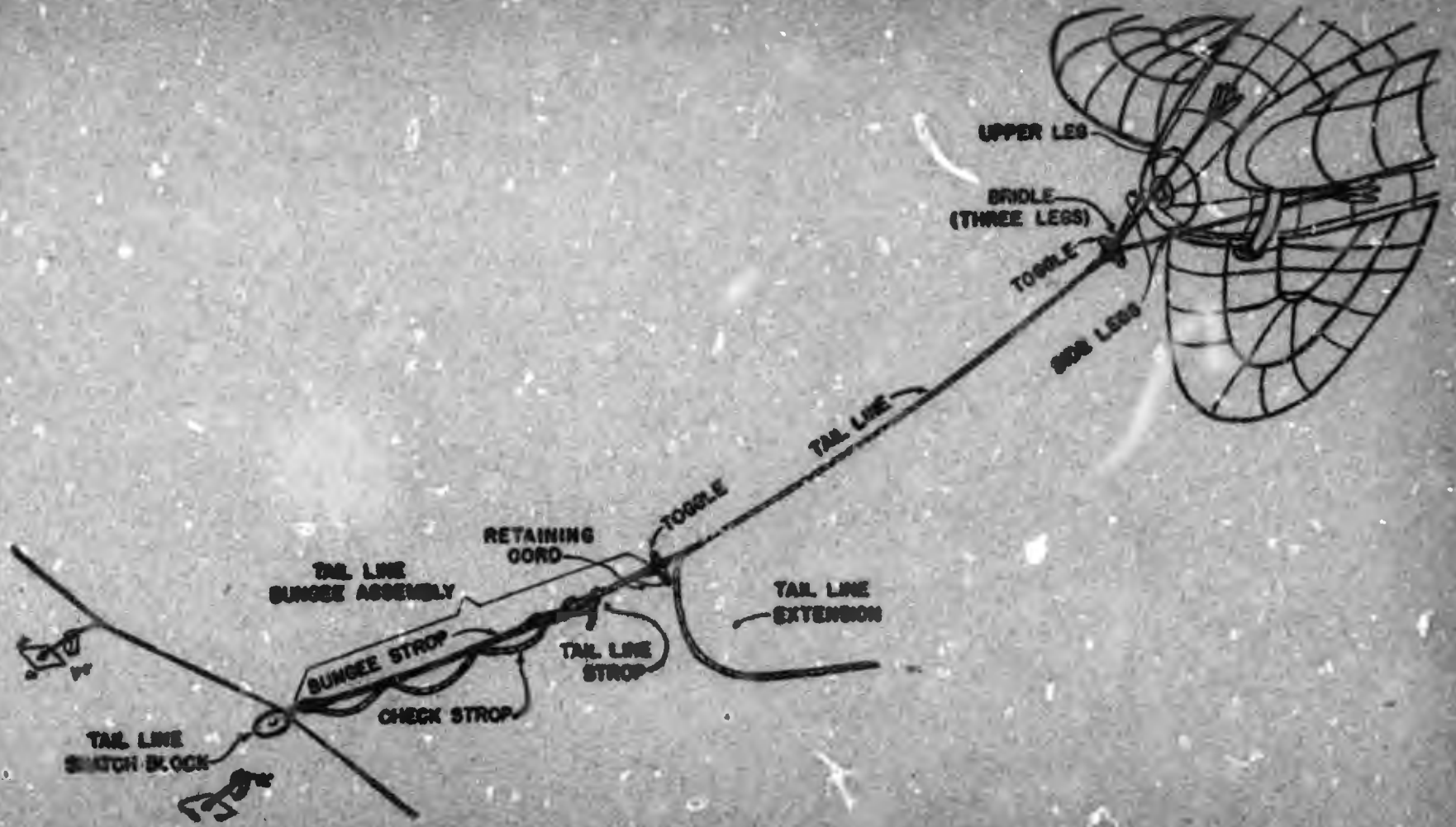

Figure 17. Tail-line rigging

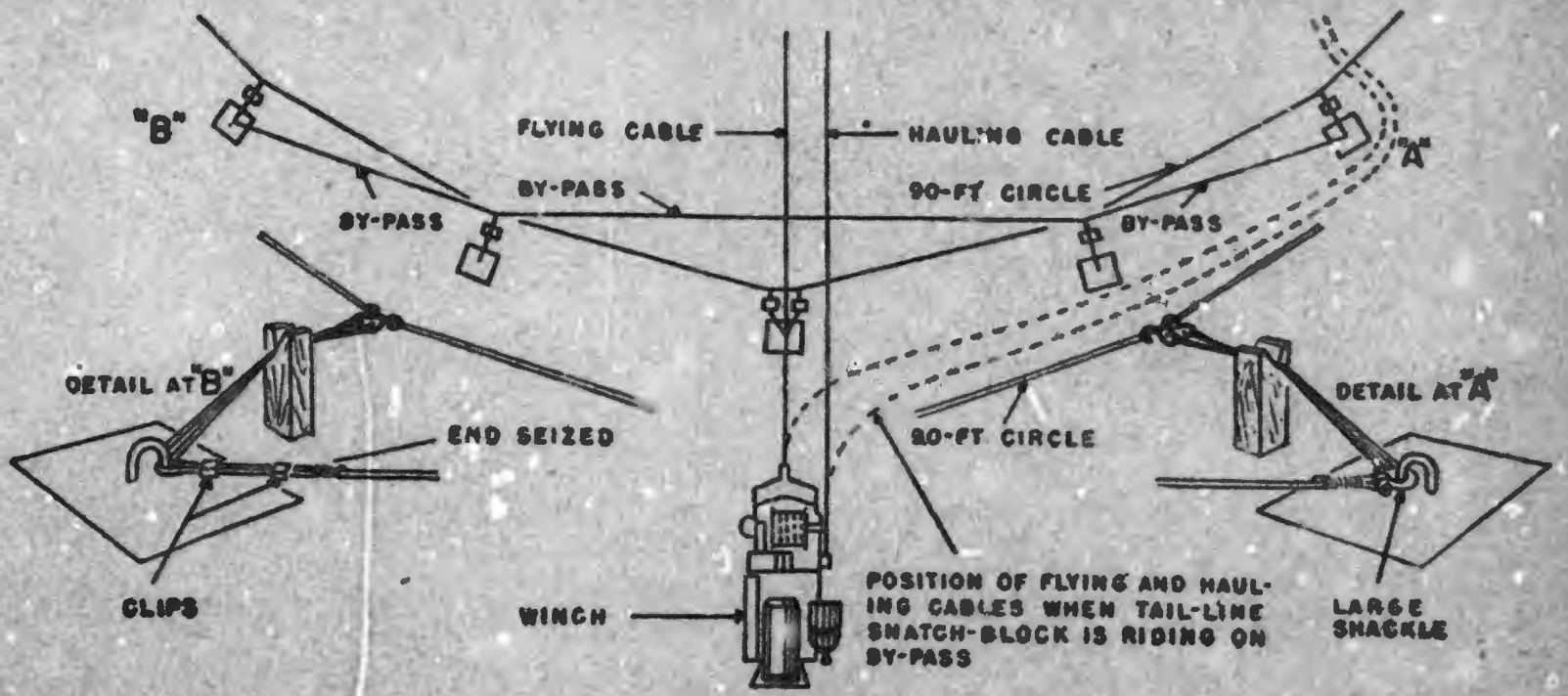

Figure 18. Tail-line bypass

10. MIDSHIP MOORING The method of mooring LA balloons at midship mooring and the equipment necessary for this operation are shown in figures 19 and 20.

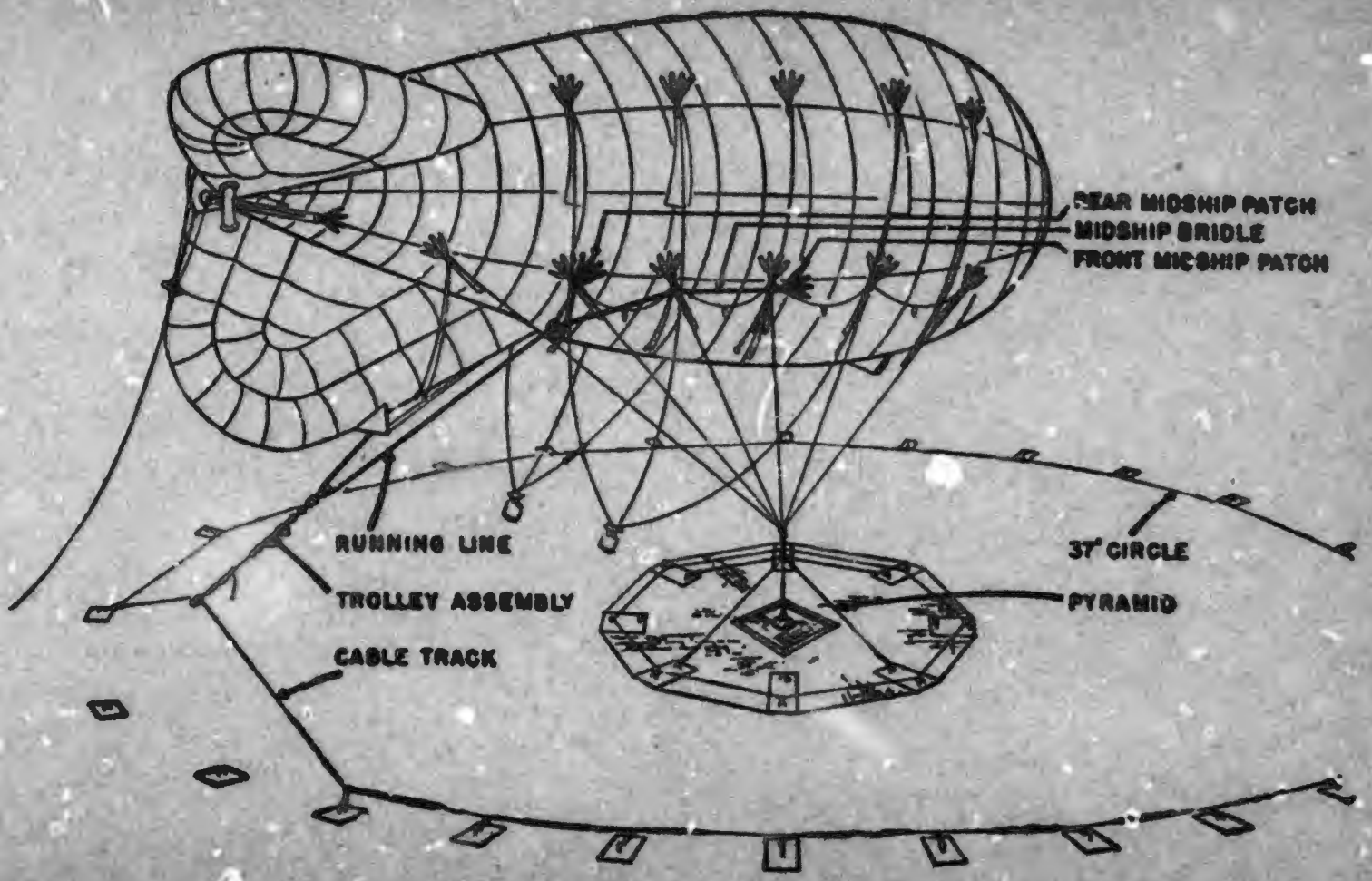

Figure 19. Balloon at midship mooring

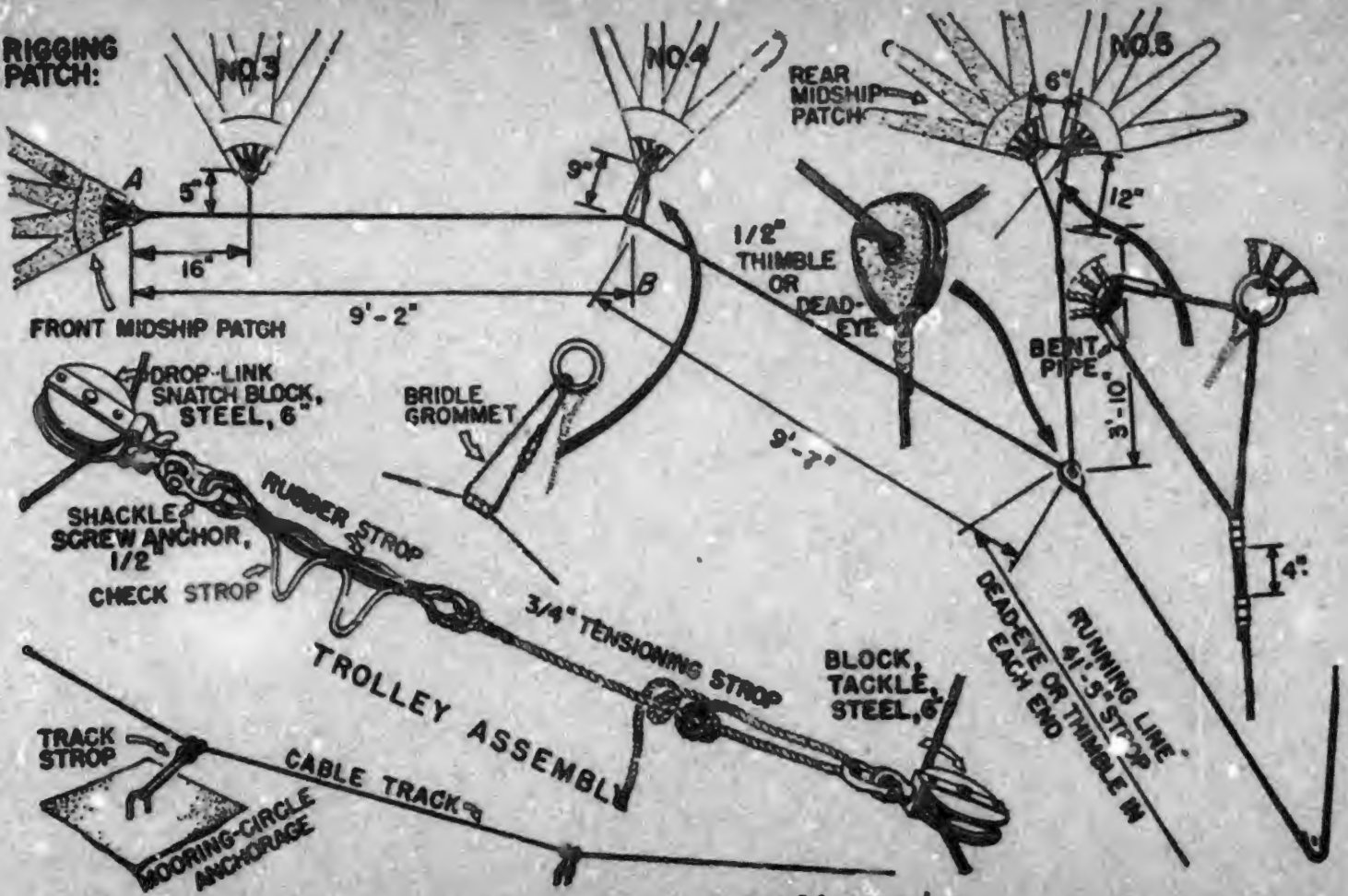

Figure 20. Details of midship mooring

Chapter 4

RIGGING AND BED INSTALLATIONS

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11. ITEMS, MATERIALS, AND DIMENSIONS (LA BALLOONS) *a. General* Table III shows the items, materials, and dimensions of rigging and bed installations for LA balloons.

b. Methods of mooring Some of the items listed in table III are required for all methods of mooring; other items are required for only certain methods. The items required for various methods are indicated in the appropriate column of table III as follows:

Tail-line mooring	I
Mooring-circle close-haul	II
Midship mooring	III

c. Categories of equipment Balloon and ground rigging materials for LA balloons may be divided into four categories:

(1) *Category A* Items issued ready for use (see current T/E's).

(2) *Category B* Materials issued in bulk which must be made into usable assemblies by the using troops.

(3) *Category C* Materials not issued as units or in bulk,

but provided by the local district engineer or made from salvage materials by the using troops.

(4) *Category D* Items issued with the balloon, which may have to be constructed or replaced.

d. Rope sizes Rope sizes given in table III are for Manila rope, unless otherwise indicated. Other rope of equivalent strength may be used.

e. Cutting lengths Cutting lengths of cable given in table III are for nicopress sleeve splices. If nicopress sleeves are not used, increase cutting lengths given by 6½ inches for each hand splice.

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)

Item	Method of mooring	Category	Quantity per assembly or unit	Quantity per site	Cable min. size (inches)	Manila rope size (inches)	Guiding length Mk. VII B-7	Guiding length B-4	Finished length Mk. VII B-7	Finished length B-4
Anchorage, central, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Block, snatch, British-type	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Concrete, for anchorage block	....	C	50 cu. ft.	50 cu. ft.	....	....	....	....	....	....
Concrete, for curb	....	C	5 cu. ft.	5 cu. ft.	....	....	....	....	....	....
Cushion, 4 ft. by 4 ft. by 4 in.	....	C	1 ea.	1 ea.	....	....	....	....	....	....
Mat, expanded metal, 8 ft. by 8 ft., 3 in. mesh, 15½ lb. per sq. yd. (or No. 8 wire)	....	C	1 ea.	1 ea.	....	....	....	....	....	....
Plate, grounding, zinc-coated iron, 2 ft. by 2 ft. by ⅛ in.	....	C	1 ea.	1 ea.	....	....	....	....	....	....
Rod, bent, 1⅛ in. diam., mild steel, cutting length 5 ft., bent length 3 ft. 5 in.	....	C	1 ea.	1 ea.	....	....	....	....	....	....
Shackle, screw anchor, ⅝-in.	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Tape, grounding, zinc-coated iron, 1 in. by ⅛ in.	....	C	5 ft. 8 in.	5 ft. 8 in.	....	....	....	....	....	....
Anchorage, hauling, assembly	I, II, III	....	....	5 ea.	....	....	....	....	....	....
Block, tackle, steel, single sheave, for ½ in. rope	....	B	....	2 ea.	....	....	....	....	....	....
Concrete	....	C	8 cu. ft.	40 cu. ft.	....	....	....	....	....	....
Grommet, wire, 2 ft. circumference, assembly	....	....	1 ea.	5 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	2 ft. 2 in.	11 ft.	7/32	....	....	....	....	....
Sleeve, nicopress	....	B	1 ea.	5 ea.	....	....	....	....	....	....
Ring, flop, 3 in. internal diam., ⅝ in. section	....	C	1 ea.	5 ea.	....	....	....	....	....	....
Rod, bent, ⅝ in. diam., mild steel, cutting length 40 in., bent length 34 in.	....	C	1 ea.	5 ea.	....	....	....	....	....	....

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of mooring	Category	Quantity per assembly or unit	Quantity per site	Cable min. size (inches)	Manila rope size (inches)	Cutting length		Finished length	
							Mk. VII B–7	B–6	Mk. VII B–7	B–6
Anchorage, main point, assembly	I, II, III	....	....	8 ea.	....	....	....	....	....	....
Block, tackle, steel, single sheave, for ½ in. rope	....	B	1 ea.	8 ea.	....	....	....	....	....	....
Concrete	....	C	16 cu.ft.	128 cu.ft.	....	....	....	....	....	....
Grommet, wire 2 ft. circumference, assembly	....	....	1 ea.	8 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	2 ft. 2 in.	18 ft.	7/32	....	....	....	....	....
Sleeve, nicopress	....	B	1 ea.	8 ea.	....	....	....	....	....	....
Ring, flop, 3 in. internal diam., ¾ in. section	....	C	2 ea.	16 ea.	....	....	....	....	....	....
Rod, bent, ⅝ in. diam., mild steel, cutting length 40 in., bent length 24 in.	....	C	2 ea.	16 ea.	....	....	....	....	....	....
Anchorage, mooring-circle, assembly	I, II, III	....	....	24 ea.	....	....	....	....	....	....
Concrete	....	C	8 cu.ft.	192 cu.ft.	....	....	....	....	....	....
Rod, bent, ⅝ in. diam., mild steel, cutting length 40 in., bent length 24 in.	....	C	1 ea.	24 ea.	....	....	....	....	....	....
Anchorage, tail-line mooring-circle, assembly	I	....	....	24 ea.	....	....	....	....	....	....
Concrete	....	C	8 cu.ft.	192 cu.ft.	....	....	....	....	....	....
Rod, bent, ⅝ in. diam., mild steel, cutting length 40 in., bent length 24 in.	....	C	1 ea.	24 ea.	....	....	....	....	....	....

Anchorage, winch, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	12 ft.	12 ft.	....	....	....	....	....	....
Clip, wire rope, steel	....	B	8 ea.	8 ea.	....	....	....	....	....	....
Concrete	....	C	63 cu.ft.	63 cu.ft.	....	....	....	....	....	....
Plate, grounding, zinc-coated iron, 2 by 2 ft. by ⅛ in.	....	C	1 ea.	1 ea.	....	....	....	....	....	....
Rod, bent, ⅝ in. diam., mild steel, cutting length 40 in., bent length 24 in.	....	C	4 ea.	4 ea.	....	....	....	....	....	....
Tape, grounding, zinc-coated iron, 1 by ⅛ in.	....	C	5 ft.8 in.	5 ft.8 in.	....	....	....	....	....	....
Bag, handling-line, assembly	I, III	....	....	2 ea.	....	....	....	....	....	....
Bag, 12 in. diam., 18 in. deep	....	C	1 ea.	2 ea.	....	....	....	....	....	....
Rope	....	B	10 ft.	20 ft.	....	¼	....	....	....	....
Block, ballast, assembly	I, II, III	....	....	12 ea.	....	....	....	....	....	....
Concrete	....	C	94 cu.ft.	11.3 cu.ft.	....	....	....	....	....	....
Loop, cable	....	B	3 ea.	36 ea.	7/32	....	1 ft.8 in.	1 ft.8 in.	....	....
Bridle, ballast-block	I, II, III	B	....	12 ea.	....	⅜	3 ft.4 in.	3 ft.4 in.	....	....
Bridle, midship, assembly	III	....	....	2 ea.	....	....	....	....	....	....
Cable, flying, salvage	....	B	....	....	7/32	....	25 ft.	25 ft.	....	....
Sleeve, nicopress	....	B	3 ea.	6 ea.	....	....	....	....	....	....
Tube, patch, iron pipe, galvanized, ⅜ in. diam., 6 in. long	....	C	1 ea.	2 ea.	....	....	....	....	....	....
Grommet, assembly	....	....	1 ea.	2 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	1 ft.8 in.	3 ft.4 in.	7/32	....	....	....	....	....
Sleeve, nicopress	....	B	2 ea.	4 ea.	....	....	....	....	....	....
Bridle, tail-line, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Leg, short (spliced around toggle)	....	D	1 ea.	1 ea.	....	⅝	13 ft.6 in.	12 ft.10 in.	10 ft.6 in.	9 ft.10 in.
Leg, long (spliced around toggle)	....	D	2 ea.	2 ea.	....	⅝	16 ft.5 in.	15 ft.10 in.	13 ft.5 in.	12 ft.10 in.
Toggle, wooden, round, 1½ in. diam., 9 in. long, round groove, 1 in. wide, ¼ in. deep, center	....	D	1 ea.	1 ea.	....	....	....	....	....	....

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of mooring	Category	Quantity per assembly or unit	Quantity per ship	Cable min. size (inches)	Manila rope size (inches)	Cutting length		Finished length	
							Mk. VII B–7	B–4	Mk. VII B–7	B–4
Bungee assembly	I	....	....	1 ea.	....	....	....	....	....	....
Block, snatch, tail-line	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Cord, retaining, No. 72 seine twine	....	B	3 ft.	3 ft.	....	....	....	....	....	....
Shackle, screw anchor, ¾ in.	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Strop, bungee, assembly (thimbled eye each end)	....	....	1 ea.	1 ea.	....	....	....	....	....	....
Cord, rubber, 5/16 in. (folded 10 times)	....	B	....	....	....	....	41 ft.	41 ft.	4 ft.	4 ft.
Thimble, wire rope, galvanized, for 1 in. rope	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Strop, check (3 in. eye each end)	....	B	1 ea.	1 ea.	....	½	7 ft. 6 in.	7 ft. 6 in.	6 ft.	6 ft.
Strop, tail-line (8 in. eye one end)	....	B	1 ea.	1 ea.	....	¾	16 ft. 7 in.	16 ft. 7 in.	15 ft.	15 ft.
Toggle, wooden, round, 1½ in. diam., 14 in. long	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Cable, hauling, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	200 ft.	200 ft.	7/32	....	....	....	....	....
Thimble, wire rope, galvanized, for 1 in. rope	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Sleeve, nicopress	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Cable, octagon, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	113 ft.	113 ft.	7/32	....	....	....	....	....
Clip, wire rope, steel	....	B	3 ea.	3 ea.	....	....	....	....	....	....
Cable, tail-line mooring-circle, assembly	I	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	570 ft.	570 ft.	7/32	....	....	....	....	....
Clip, wire rope, steel	....	B	3 ea.	3 ea.	....	....	....	....	....	....

Cord, rip, 3/8 in. sisal rope	....	D	...	....	....	....	66 ft.6 in.	75 ft.7 in.	65 ft.11 in.	75 ft.
Cord, rudder air-scoop restraining, No. 72 seine twine	....	D	....	....	....	....	38 ft.6 in.	31 ft.6 in.	....	....
Cover, ballast-block (1 ft. 6½ by 9½ by 6 in., made from salvaged sandbags)	I, II, III	C	....	12 ea.	....	....	....	....	....	....
Cradle assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Legs 1 and 6 (5 in. eye outer end, 3 in. eye inner end)	....	B	4 ea.	4 ea.	7/32	....	13 ft.6 in.	13 ft.6 in.	12 ft.6 in.	12 ft.6 in.
Legs 2 and 5 (eyes same as in legs 1 and 6)	....	B	4 ea.	4 ea.	7/32	....	12 ft.	12 ft.	11 ft.	11 ft.
Legs 3 and 4 (eyes same as in legs 1 and 6)	....	B	4 ea.	4 ea.	7/32	....	9 ft.	9 ft.	8 ft.	8 ft.
Sleeve, nicopress	....	B	44 ea.	44 ea.	....	....	....	....	....	....
Straight cut-splice (legs 2 and 5, 1 ft. 6 in. from outer eye)	....	B	4 ea.	4 ea.	7/32	....	11 in.	11 in.	....	....
Strop, extra for D-8 (3 in. eye each end)	....	B	4 ea.	4 ea.	7/32	....	....	2 ft.1 in.	....	1 ft.2 in.
Strop, inner (3 in. eye each end)	....	B	2 ea.	2 ea.	7/32	....	2 ft.4 in.	2 ft.4 in.	1 ft.6 in.	1 ft.6 in.
Extension, mooring-line (5 in. eye one end)	I, II, III	D	...	4 ea.	....	5/8	26 ft.4½ in.	31 ft.4½ in.	25 ft.	30 ft.
Extension, tail-line (spliced to tail line), 3/4 in. cotton rope	I, II, III	B	...	1 ea.	....	....	25 ft.8 in.	25 ft.8 in.	25 ft.	25 ft.
Grapple, ballast block, assembly	I, II, III	....	....	4 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	4 ea.	....	....	....	....	....	....
Rope (hook spliced in one end; toggle in other end)	....	B	2 ft.6 in.	10 ft.	....	3/4	....	....	....	....
Toggle, wooden, round, 1¼ in. diam., 4 in. long, 3/8 in. round groove, center	....	B	1 ea.	4 ea.	....	....	....	....	....	....

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of mooring	Subcategory	Quantity per assembly or unit	Quantity per ship	Cable min. size (inches)	Manila rope size (inches)	Cutting length		Finished length	
							Mk. VII B-7	B-6	Mk. VII B-7	B-6
Handy-billy, assembly	I	....	....	1 ea.	....	....	....	....	....	....
Block, tackle, steel, double sheave, for ½ in. rope	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Block, tackle, steel, single sheave for ½ in. rope	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Rope	....	B	25 ft.	25 ft.	....	3/8	....	....	....	....
Line, fin-furling (1 in. eye each end), No. 72 seine twine	I, II, III	B	....	2 ea.	....	....	38 ft.	38 ft.	....	....
Line, gas-valve operating	....	D	....	....	....	....	64 ft.7 in.	69 ft.7 3/8 in.	61 ft.11 in.	66 ft.11 3/8 in.
Line, handling, lower part (5 in. eye one end)	....	D	....	....	....	5/8	51 ft.7 in.	39 ft.1 in	50 ft.	37 ft.6 in.
Line, handling, upper part, assembly (5 in. eye each end, looped cut-splice 1 ft. 6 in. from crown of lower eye)	....	....	....	....	....	....	....	....	....	....
Rope	....	D	....	....	....	1/2	18 ft.4 1/2 in.	19 ft.4 1/2 in.	15 ft.6 in.	16 ft.6 in.
Rope (for looped cut-splice)	....	D	1 ea.	....	....	5/8	9 in.	9 in.	....	....
Line, lower cradle (3 in. eye one end)	I, II, III	B	....	4 ea.	....	3/8	6 ft.10 in.	6 ft.10 in.	6 ft.	6 in.
Line, mooring, assembly (5 in. eye each end, looped cut-splice 1 ft. 6 in. from crown of lower eye)	....	....	....	....	....	....	....	....	....	....
Rope	....	D	....	....	....	1/2	18 ft.4 1/2 in.	19 ft.4 1/2 in.	15 ft.6 in.	16 ft.6 in.
Rope (for looped cut-splice)	....	D	1 ea.	....	....	5/8	9 in.	9 in.	....	....
Line, rigging	....	D	....	....	....	5/16	35 ft.	70 ft.	....	....

Line, rudder-protection-sheet	I, II, III	B	....	2 ea.	....	¼	28 ft.	30 ft.	....	....
Line, running, assembly (thimbled eye each end)	III	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	....	....	7/32	....	40 ft.	42 ft.	39 ft. 6 in.	41 ft. 5 in.
Sleeve, nicopress	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Thimble, wire rope, galvanized, for ½ in. rope	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Line, running nose (3 in. eye one end), ½ in. cotton rope	I, II, III	B	....	1 ea.	....	....	28 ft.	26 ft.	25 ft.	26 ft.
Line, sandbag, assembly	I, II, III	....	....	12 ea.	....	....	....	....	....	....
Rope (spliced around toggle)	....	B	1 ea.	12 ea.	....	⅜	7 ft. 10 in.	7 ft. 10 in.	7 ft.	7 ft.
Toggle, wooden, round, 1¼ in. diam., 4 in. long, ⅜ in. round groove, center	....	B	1 ea.	12 ea.	....	....	....	....	....	....
Line, tail (5 in. eye one end, 3 in. eye other end)	....	D	....	1 ea.	....	⅝	28 ft. 1 in.	30 ft. 7 in.	28 ft. 6 in.	28 ft.
Paving material (sufficient to pave area from central anchorage curb to outer edge of main points)	I, II, III	C	....	....	....	....	....	....	....	....
Post, tail-line, 2 by 4 in., 2½ ft. long	I	C	....	25 ea.	....	....	....	....	....	....
Pyramid assembly	I, III	....	....	1 ea.	....	....	....	....	....	....
Leg, assembly	....	....	4 ea.	4 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	19 ft.	76 ft.	7/32	....	....	....	....	....
Clip, wire rope, steel	....	B	2 ea.	8 ea.	....	....	....	....	....	....
Sleeve, nicopress	....	B	1 ea.	4 ea.	....	....	....	....	....	....
Thimble, wire rope, galvanized, for ¼ in. rope	....	B	2 ea.	8 ea.	....	....	....	....	....	....
Shackle, quick-release	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Shackle, screw anchor, ¾ in.	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Strop, reinforcing (8 in. eye each end)	....	B	1 ea.	1 ea.	7/32	....	32 ft.	32 ft.	29 ft.	29 ft.
Strop, rip-cord (3 in. eye each end)	....	B	1 ea.	1 ea.	....	⅜	7 ft. 6 in.	7 ft. 6 in.	5 ft. 6 in.	5 ft. 6 in.

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of mooring	Category	Quantity per assembly or set	Quantity per ship	Cable min. size (inches)	Manila rope size (inches)	Cutting length		Finished length	
							Mk. VII B–7	B–8	Mk. VII B–7	B–8
Pyramid assembly—Continued										
Strop, safety, assembly (thimbled eye each end)	....	....	1 ea.	1 ea.	....	....	....	....	....	....
Cable, flying salvaged	....	B	....	....	7/32	....	12 ft. 5 in.	12 ft. 5 in.	5 ft. 10 in.	5 ft. 10 in.
Sleeve, nicopress	....	B	3 ea.	3 ea.	....	....	....	....	....	....
Thimble, wire rope, galvanized, for ⅜ in. rope	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Rope, foot, assembly	....	....	....	....	....	....	....	....	....	....
No. 1	....	D	....	....	5/32	....	....	....	27 ft. 3 in.	27 ft. 9 in.
No. 2	....	D	....	....	5/32	....	....	....	25 ft. 1 in.	26 ft. 3½ in.
No. 3	....	D	....	....	5/32	....	....	....	23 ft. 8 in.	25 ft. 5½ in.
No. 4	....	D	....	....	5/32	....	....	....	24 ft. 4 in.	26 ft. 5½ in.
No. 5	....	D	....	....	5/32	....	....	....	26 ft. 6 in.	29 ft. 6½ in.
No. 6	....	D	....	....	5/32	....	....	....	32 ft. 4 in.	35 ft. 6½ in.
Sleeve, nicopress	....	B	3 ea.	....	....	....	....	....	....	....
Rope, hauling, assembly (thimbled eye one end)	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Block, tackle, steel, double sheave, for ⅜ in. rope	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Rope	....	B	200 ft.	200 ft.	....	¾	....	....	....	....
Thimble, wire rope, galvanized, for 1 in. rope	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Sheet, rudder-protection, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Cloth, 26 by 8 ft.	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	16 ea.	16 ea.	....	....	....	....	....	....
Twine, seine, No. 72	....	B	44 fs.	44 ft.	....	....	....	....	....	....

Slip, lower cradle, assembly (8 in. eye in one end, other end rigged with adjusting block with hook in bight)	I, II, III	....	....	8 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	8 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	8 ea.	....	....	....	....	....	....
Rope	....	B	1 ea.	8 ea.	....	⅜	9 ft. 8 in.	9 ft. 8 in.	9 ft.	9 ft.
Slip, mooring, assembly (large hook spliced in outer end, other end rigged with adjusting block with small hook in bight)	I, II, III	....	....	11 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	11 ea.	....	....	....	....	....	....
Hook, ground rigging, large, single loop	....	B	1 ea.	11 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	11 ea.	....	....	....	....	....	....
Rope	....	B	1 ea.	11 ea.	....	⅝	25 ft. 8 in.	25 ft. 8 in.	25 ft.	25 ft.
Slip, running tensioning, assembly (hook spliced in one end, other end rigged with adjusting block with hook in bight)	II	....	....	1 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Rope	....	B	....	....	....	½	37 ft.	37 ft.	36 ft.	36 ft.
Slip, snubber, assembly (rigged with adjusting block with hook in bight)	II	....	....	2 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	2 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	2 ea.	....	....	....	....	....	....
Rope	....	B	12 ft.	24 ft.	....	⅝	....	....	....	....
Slip, tensioning, assembly (rigged with adjusting block with hook in bight)	I, II, III	....	....	10 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	10 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	10 ea.	....	....	....	....	....	....
Rope	....	B	12 ft.	120 ft.	....	⅜	....	....	....	....

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of securing	Category	Quantity per assembly or unit	Quantity per ship	Cable min. size (inches)	Manila rope size (inches)	Cutting length: Mk. VII B-7	Cutting length: B-4	Finished length: Mk. VII B-7	Finished length: B-4
Slip, upper cradle, assembly (toggle spliced in one end, other end rigged with adjusting block with hook in bight)	I, II, III	....	....	24 ea.	....	....	....	....	....	....
Block, adjusting, wooden, 3-hole	....	B	1 ea.	24 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	24 ea.	....	....	....	....	....	....
Rope	....	B	1 ea.	24 ea.	....	½	9 ft. 10 in.	9 ft. 10 in.	9 ft.	9 ft.
Toggle, wooden, round, 1⅛ in. diam., 4 in. long, ⅝ in. round groove, center	....	B	1 ea.	24 ea.	....	....	....	....	....	....
Spider, sandbag, assembly	II	....	....	2 ea.	....	....	....	....	....	....
Leg, assembly (toggle spliced in each end)	....	....	....	....	....	....	....	....	....	....
Long	....	B	1 ea.	2 ea.	....	½	5 ft. 2 in.	5 ft. 2 in.	4 ft.	4 ft.
Short	....	B	1 ea.	2 ea.	....	½	4 ft. 2 in.	4 ft. 2 in.	3 ft.	3 ft.
Toggle, wooden, round, 1⅛ in. diam., 4 in. long, ⅝ in. round groove, center	....	B	2 ea.	8 ea.	....	....	....	....	....	....
Spider, wire, assembly	I, II, III	....	....	1 ea.	....	....	....	....	....	....
Leg, assembly (8 in. eye in outer end, 4 in. eye in inner end)	....	....	....	....	....	....	....	....	....	....
1 and 6	....	B	2 ea.	2 ea.	3/16	....	3 ft. 5½ in.	3 ft. 5½ in.	2 ft.	2 ft.
2 and 5	....	B	2 ea.	2 ea.	3/16	....	9 ft. 5½ in.	9 ft. 5½ in.	8 ft.	8 ft.
3 and 4	....	B	2 ea.	2 ea.	3/16	....	18 ft. 5½ in.	18 ft. 5½ in.	17 ft.	17 ft.
Sleeve, nicopress	....	B	7 ea.	12 ea.	....	....	....	....	....	....
Rope, hand (3 in. eye one end)	....	B	1 ea.	1 ea.	....	½	4 ft.	4 ft.	3 ft.	3 ft.
Rope, spacer	....	B	3 ft.	3 ft.	....	½	....	....	....	....
Shackle, screw anchor, ⅝ in.	....	B	1 ea.	1 ea.	....	....	....	....	....	....

Strop, bedding (5 in. eye both ends)	I, II, III	....	....	24 ea.	....	....	....	....	....	....
Nos. 1–4	....	B	....	16 ea.	....	3/4	4 ft. 5 in.	4 ft. 5 in.	2 ft. 6 in.	2 ft. 6 in.
No. 5	....	BB	....	4 ea.	....	5/8	5 ft. 8 in.	6 ft. 11 in.	3 ft. 9 in.	5 ft.
No. 6	....	B	....	4 ea.	....	5/8	7 ft. 11 in.	9 ft. 11 in.	6 ft.	8 ft.
Strop, tail-line mooring-circle, assembly (hook spliced in each end)	I	....	....	25 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	1 ea.	25 ea.	7/32	....	6 ft. 10 in.	6 ft. 10 in.	6 ft.	6 ft.
Hook, ground rigging, small, single loop	....	B	2 ea.	50 ea.	....	....	....	....	....	....
Sleeve, nicopress	....	B	2 ea.	50 ea.	....	....	....	....	....	....
Strop, junction, bell-crank, assembly (thimbled eye each end)	....	....	....	....	....	....	....	....	....	....
Cable, flying, salvaged	....	D	....	....	7/32	....	4 ft. 3 in.	4 ft. 3 in.	1 ft. 9 in.	1 ft. 9 in.
Sleeve, nicopress	....	D	3 ea.	....	....	....	....	....	....	....
Thimble, wire rope, galvanized, for 1/2 in. rope	....	D	2 ea.	....	....	....	....	....	....	....
Strop, junction, British-type, assembly (one end seized around triangular plate, 4 in. eye in other end, hand splicing)	....	....	....	....	....	....	....	....	....	....
Cable, flying, salvaged	....	D	....	....	7/32	....	5 ft. 11 in.	5 ft. 11 in.	1 ft. 9 in.	1 ft. 9 in.
Plate, triangular	....	D	1 ea.	....	....	....	....	....	....	....
Strop, snubber, assembly (toggle spliced in one end, hook spliced in other end)	II	....	....	2 ea.	....	....	....	....	....	....
Hook, ground rigging, small, single loop	....	B	1 ea.	2 ea.	....	....	....	....	....	....
Rope	....	B	1 ea.	2 ea.	....	5/8	2 ft.	2 ft.	9 in.	9 in.
Toggle, wooden, round, 1 1/4 in. diam., 4 in. long, 5/8 in. round groove, center	....	B	1 ea.	2 ea.	....	....	....	....	....	....
Strop, track, assembly (hook spliced in each end)	II	....	....	24 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	1 ea.	24 ea.	7/32	....	2 ft.	2 ft.	1 ft. 6 in.	1 ft. 6 in.
Hook, ground rigging, small, single loop	....	B	2 ea.	48 ea.	....	....	....	....	....	....
Sleeve, nicopress	....	B	2 ea.	48 ea.	....	....	....	....	....	....

TABLE III—RIGGING AND BED INSTALLATIONS (LA BALLOONS)—Continued

Item	Method of mooring	Category	Quantity per assembly or unit	Quantity per ship	Cable min. dia. (inches)	Manila rope min. dia. (inches)	Cutting length		Finished length	
							Mk. VII B–7	B–4	Mk. VII B–7	B–4
Strop, transverse, assembly (8 in. eye each end, straight cut-splice 5 ft. from each end)	II	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	....	....	7/32	....	26 ft. 11 in.	26 ft. 11 in.	26 ft.	26 ft.
Cable, flying, salvaged (for cut-splice)	....	B	2 ea.	2 ea.	7/32	....	10 in.	10 in.	....	....
Sleeve, nicopress	....	B	6 ea.	6 ea.	....	....	....	....	....	....
Support, cable, wooden (4 by 4 by 16 in.)	I, II, III	C	12 ea.	....	....	....	....	....	....	....
Track, cable, assembly	III	....	....	1 ea.	....	....	....	....	....	....
Cable, flying, salvaged	....	B	229 ft.	229 ft.	7/32	....	....	....	....	....
Clip, wire rope, steel	....	B	3 ea.	3 ea.	....	....	....	....	....	....
Trolley, midship, assembly	III	....	....	1 ea.	....	....	....	....	....	....
Block, snatch, steel, 6 in. drop link	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Block, tackle, steel, 6 in.	....	B	1 ea.	1 ea.	....	....	....	....	....	....
Shackle, screw-anchor, ½ in.	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Strop, check (4 in. eye each end)	....	B	1 ea.	1 ea.	....	½	5 ft. 2 in.	5 ft. 2 in.	3 ft. 4 in.	3 ft. 4 in.
Strop, rubber, assembly (thimbled eye each end)	....	....	1 ea.	1 ea.	....	....	....	....	....	....
Cord, rubber, 5/16 in. (folded 14 times)	....	B	....	....	....	....	29 ft.	29 ft.	2 ft.	2 ft.
Thimble, wire rope, galvanized, for 1 in. rope	....	B	2 ea.	2 ea.	....	....	....	....	....	....
Strop, tensioning (4 in. eye one end)	....	B	1 ea.	1 ea.	.	¾	7 ft. 11 in.	7 ft. 11 in.	7 ft.	7 ft.

12. ITEMS, MATERIALS, AND DIMENSIONS (VLA BALLOONS) *a. General* Table IV shows the items, materials, and dimensions of rigging and bed installations for VLA balloons.

b. Tandem flying The mooring equipment in table IV is listed on the basis of one balloon per site. For tandem flying, mooring equipment for two balloons will be needed on each site.

TABLE IV—RIGGING AND BED INSTALLATIONS (VLA BALLOONS)

Item	Quantity per unit or assembly	Quantity per ship	Cable size (inches)	Rope size (inches)	Cutting length	Finished length
Bed, eight-way, assembly	....	1 ea.	....	....	....	....
Anchor, guy	12 ea.	12 ea.	....	....	....	....
Cable, LA flying, salvaged	390 ft.	390 ft.	7/32	....	....	....
Clips, wire rope	3 ea.	3 ea.	....	....	....	....
Bed, two-way, assembly	....	1 ea.	....	....	....	....
Anchor, guy	6 ea.	6 ea.	....	....	....	....
Cable, LA flying, salvaged	100 ft.	100 ft.	7/32	....	....	....
Clip, wire rope	3 ea.	3 ea.	....	....	....	....
Extension, handling-line (for lower tandem-flown balloon)	....	....	....	....	....	....
Front (3 in. eye one end)	....	2 ea.	....	¼	11 ft.	10 ft.
Rear (3 in. eye one end)	....	2 ea.	....	¼	36 ft.	35 ft.
Grounding assembly, fair-lead	....	1 ea.	....	....	....	....
Cable, grounding, static, tin-copper braid	5 ft.	5 ft.	....	....	....	....
Mat, grounding, 6 by 6 ft.	1 ea.	1 ea.	....	....	....	....
Rod, grounding, static, 8 ft. black pipe, ½ in.	1 ea.	1 ea.	....	....	....	....
Grounding assembly, winch	....	1 ea.	....	....	....	....
Cable, grounding, static, tin-copper braid	5 ft.	5 ft.	....	....	....	....
Mat, grounding, 6 by 6 ft.	1 ea.	1 ea.	....	....	....	....
Rod, grounding, static, 8 ft. black pipe, ½ in.	1 ea.	1 ea.	....	....	....	....
Leg, winch (3 in. eye one end)	....	1 ea.	⅛	....	Finished length plus 14½ in.	25 to 100 ft.
Line, handling, Mk. VI balloon (replacement)	....	....	....	....	....	....
Front (3 in. eye upper end, 6 in. eye lower end)	....	....	....	¼	41 ft. 7 in.	39 ft. 6 in.
Rear (3 in. eye upper end, 6 in. eye lower end)	....	....	....	¼	17 ft. 1 in.	15 ft.
Line, heaving (for mooring net)	....	2 ea.	....	¼	30 ft.	....
Pole, outrigging (for lower tandem-flown balloon) (bamboo pole 7 ft. long, 1 in. diam., metal sleeve fitting on one end)	....	2 ea.	....	....	....	....

Rope, foot, Mk. VI balloon (replacement)	....	....	....	....	....	....
Front (2 in. eye each end)	....	....	.067 diam., 500 lb. breaking strength	....	15 ft. 8⅝ in.	11 ft. 9¾ in.
Rear (2 in. eye each end)	....	....	.067 diam., 500 lb. breaking strength	....	17 ft. 5¾ in.	15 ft. 6¾ in.
Rope, side-hook, assembly (hook spliced in one end, 35 other hooks reeved on)	....	2 ea.	....	....	....	....
Hook, ground rigging, small, single loop	36 ea.	72 ea.	....	....	....	....
Rope	....	....	....	⅛	75 ft. 10⅛ in.	75 ft.
Strop, front foot-rope extension, assembly (for lower tandem-flown balloon) (1¼ in. thimbled eye each end)	....	1 ea.	....	....	....	....
Cable	....	....	⅛	....	24 ft. 10 in.	25 ft. 8 in.
Shackle, ⅜ in. screwed pin, ⅝ in. jaw	1 ea.	1 ea.	....	....	....	....
Thimble, cable, 1¼ in., for ⅛ in. cable	2 ea.	2 ea.	....	....	....	....
Strop, rear foot-rope extension, assembly (for lower tandem-flown balloon) (1¼ in. thimbled eye each end)	....	1 ea.	....	....	....	....
Cable	....	....	⅛	....	27 ft. 8 in.	25 ft. 8 in
Shackle, ⅜ in. screwed pin, ⅝ in. jaw	1 ea.	1 ea.	....	....	....	....
Thimble, cable, 1¼ in., for ⅛ in. cable	2 ea.	2 ea.	....	....	....	....
Strop, transfer, assembly (safety hook spliced in one end)	....	1 ea.	....	....	....	....
Hook, safety, snap	1 ea.	1 ea.	....	....	....	....
Rope	....	....	....	⅛	15 ft. 8 in.	15 ft.
Wire, flying, assembly (for singly flown balloon)	....	1 ea.	....	....	....	....
Eye, socket and wedge	2 ea.	2 ea.	....	....	....	....
Link, inertia, Mk. II, No. 3	2 ea.	2 ea.	....	....	....	....
Link, quick connecting	1 ea.	1 ea.	....	....	....	....
Shackle, ⅜ in. screwed pin, ⅝ in. jaw	1 ea.	1 ea.	....	....	....	....
Strop, anchorage, assembly	....	1 ea.	....	....	....	....
Cable (3 in. eye one end)	....	....	⅛	....	7 ft.	5 ft.
Clamp, cable, for ⅛ in. cable	3 ea.	3 ea.	....	....	....	....
Strop, grommet (6 in. long, ⅝ in. thimbled eye one end)	2 ea.	2 ea.	....	....	....	....
Cable, single strand of ⅛ in. cable	87 in.	9 ft. 6 in.	....	....	....	....
Thimble, cable, ¾ in., for ⅛ in. cable	1 ea.	2 ea.	....	....	....	....
Strop 100-foot (3 in. eye both ends)	....	1 ea.	⅛	....	102 ft. 4 in.	100 ft.
Strop, 25-foot, assembly (1¼ in. thimbled eye one end, 2¼ in. eye other end)	1 ea.	1 ea.	....	....	....	....
Cable	....	....	⅛	....	26 ft. 11 in.	25 ft.
Thimble, cable, 1¼ in., for ⅛ in. cable	1 ea.	1 ea.	....	....	....	....

TABLE IV—RIGGING AND BED INSTALLATIONS (VLA BALLOONS)—Continued

Item	Quantity per unit or assembly	Quantity per site	Cable size (inches)	Rope size (inches)	Cutting length	Finished length
Wire, flying, assembly (for singly flown balloon)—*Continued*						
Swivel	1 ea.	1 ea.	....	....	....	....
Wire, flying	2,000 ft.	2,000 ft.	....	....	....	....
Wire, flying assembly (for tandem-flown balloons)	....	1 ea.	....	....	....	....
Eye, socket and wedge	4 ea.	4 ea.	....	....	....	....
Hook, safety	1 ea.	1 ea.	....	....	....	....
Link, Mertia, Mk. II, No. 3	4 ea.	4 ea.	....	....	....	....
Link, quick-connecting	3 ea.	3 ea.	....	....	....	....
Shackle, 3/8 in. screwed pin, 3/4 in. jaw	1 ea.	1 ea.	....	....	....	....
Strop, anchorage, assembly	....	1 ea.	....	....	....	....
Cable (3 in. eye one end)	....	....	1/8	....	7 ft.	5 ft.
Clamp, cable, for 1/8 in. cable	3 ea.	3 ea.	....	....	....	....
Strop, grommet, assembly (6 in. long, 3/4 in. thimbled eye one end)	5 ea.	5 ea.	....	....	....	....
Cable, single strand of 1/8 in. cable	57 in.	23 ft. 9 in.	....	....	....	....
Thimble, cable, 3/4 in., for 1/8 in. cable	1 ea.	5 ea.	....	....	....	....
Strop, 100-foot (3 in. eye both ends)	2 ea.	2 ea.	1/8	....	102 ft. 4 in.	100 ft.
Strop, 25-foot, assembly (1 1/4 in. thimbled eye one end 2 1/4 in. eye other end)	2 ea.	2 ea.	....	....	....	....
Cable	1 ea.	2 ea.	1/8	....	26 ft. 11 in.	25 ft.
Thimble, cable, 1 1/4 in., for 1/8 in. cable	1 ea.	2 ea.	....	....	....	....
Strop, 39-foot (3 in. eye both ends)	1 ea.	1 ea.	1/8	..	41 ft. 4 in.	39 ft.
Swivel	2 ea.	2 ea.	....	....	....	....
Wire, flying	4,000 ft.	4,000 ft.	....	....	....	....
Wire, stabilizer bracing, Mk. VI balloon (replacement)	....	....	....	....	....	....
Front (1 in. eye each end)	....	....	.055 diam., 300 lb. breaking strength	....	7 ft. 4 5/8 in.	6 ft. 10 5/8 in.
Rear (1 in. eye each end)	....	....	.055 diam., 300 lb. breaking strength	....	7 ft. 8 in.	6 ft. 2 in.

13. RIGGING ATTACHMENTS *a. LA balloons* The attachments of various items of balloon and ground rigging for LA balloons are listed below.

Item	Attachment
Bridle, ballast-block	See figure 21.
Bridle, midship	See figure 20.
Bridle, tail-line	See figure 22.
Bungee assembly	See figure 17.
Cable, octagon	See figure 16.
Cable, tail-line mooring circle	See figure 5.
Cord, rudder air-scoop restraining	Attached at both ends around rudder air-scoop stiffener with clove hitch and half hitch, running end seized to standing part. Intermediate attachments to two circular patches on rudder and to center hole around air-scoop stiffener by clove hitches.
Cradle	See figure 11.
Extension, mooring-line	Reef-bent to lower eye of mooring line; also see figure 14.
Extension, tail-line	See figure 17.
Line, fin-furling	See figure 15.
Line, gas-valve operating	Tied to adjustable webbing strap at nose with double sheet-bend, running end seized to standing part. Attached to valve-line strop at tail by forming a 19 inch loop in end of line and reef-bending to valve-line strop. Loop made by tying

Item	Attachment
	bowline and sewing running end to loop.
Line, handling, lower part (replacement)	Reef-bent to lower eye of upper part of handling line.
Line, handling, upper part	Lark's-headed to loop on handling patch.
Line, lower cradle	For attachment of inner end, see figure 21; outer end tied to grommet on octagon with single bowknot.
Line, mooring	Lark's-headed to loop on handling patch.
Line, rigging	See figure 23. On balloons with delta-type rigging patches, ends are attached to front and rear loops by single sheet-bend and half hitch, running end seized to standing part. On balloons with finger-type rigging patches, ends are attached to front and rear suspension rings with clove hitch and half hitch, running end seized to standing part.
Line, rudder-protection sheet	Fastened to loop on circular patch on each end with clove hitch, running end seized to standing part; attached to intermediate circular patches by single sheet-bends.
Line, running, midship	See figure 20.
Line, running nose	For inflation only. Served end reeved through loop on nose

Item	Attachment
	patch, and tied to eye in other end with sheet bend. Mooring slip attached to mooring circle and fastened to running nose line.
Line, sandbag	See figure 24.
Line, tail	See figure 17.
Pyramid assembly	See figure 16.
Rope, foot (replacement)	See figure 25.
Sheet, rudder-protection	See figure 13. Eight-foot length of seine twine tied to eyelet in each front corner of sheet with square knot, and tied to patches on balloon with single bowknot. Fifteen-foot length of twine laced through eyelets in rear end of sheet and tied to patches on balloon with single bowknot. Hooks, attached to eyelets along sides of sheet with seine twine tied with a square knot, are hooked to rudder-protection-sheet line on balloon.
Slip, lower cradle	For attachment of inner end, see figure 21. Outer end hooked to grommet on octagon.
Slip, mooring	See figure 13.
Slip, running tensioning	Hooked to straight cut-splices in transverse strop.
Slip, snubber	Fastened to looped cut-splice made 25 feet from lower end of handling line.

Item	Attachment
Slip, tensioning	See figure 24.
Slip, upper cradle	For attachment of lower end, see figure 21. Upper end hooked to lower eye in bedding strop.
Strop, bedding	See figure 23.
Strop, pyramid reinforcing	One end reeved through quick-release shackle, other end reeved through flop ring on main point. Two ends lashed together with 3 turns of ½-inch rope tied off with a square knot.
Strop, scubber	Fastened to looped cut-splice made 15 feet from lower end of handling line.
Strop, tail-line mooring-circle	See figure 5.
Strop, track, midship	See figure 20.
Strop, transverse	Rear handling lines tied to each end with swab hitch. Running tensioning slip hooked to straight cut-splices.
Track, cable, midship	See figure 20.
Trolley, midship, assembly	See figure 20.

b. VLA balloons The attachments of various items of rigging for VLA balloons are listed below.

Item	Attachment
Extension, handling-line (for lower tandem-flown balloon)	Reef-bent to lower eye in handling line.
Line, handling	Small eye lark's-headed to appropriate rigging patch.

Line, heaving	Tied to front corner of mooring net.
Pole, outrigging (for lower tandem-flown balloon)	See figure 26.
Rope, foot (replacement)	Attached to rigging patches at upper end by thimbled eye-splice. Attached to shackle at lower end by soft eye-splice.
Strops, front and rear foot-rope extensions (for lower tandem-flown balloon)	Upper ends attached to eyes in front and rear foot ropes with ¾-inch shackles.
Wire, flying, assembly (for singly-flown balloon)	See figure 27.
Wire, flying, assembly (for tandem-flown balloons)	See figure 28.
Wire, stabilizer bracing	Attached to stabilizer by soft eye-splice, clippe to metal links on envelope with spring hooks.

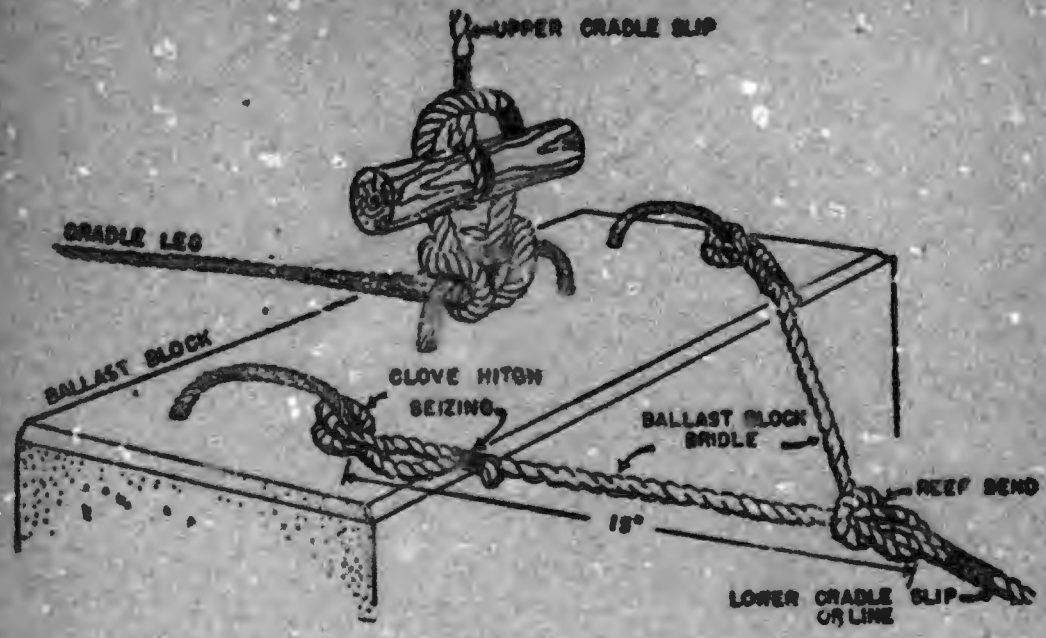


Figure 21. Attachments to ballast blocks

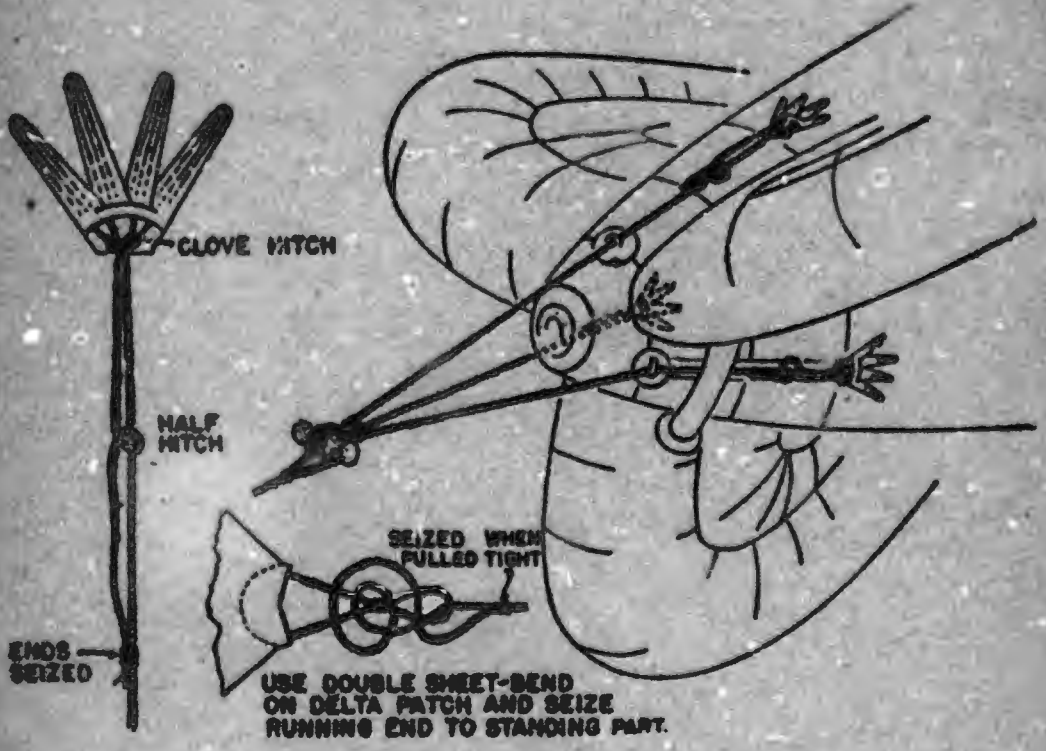


Figure 22. Tail-line bridle

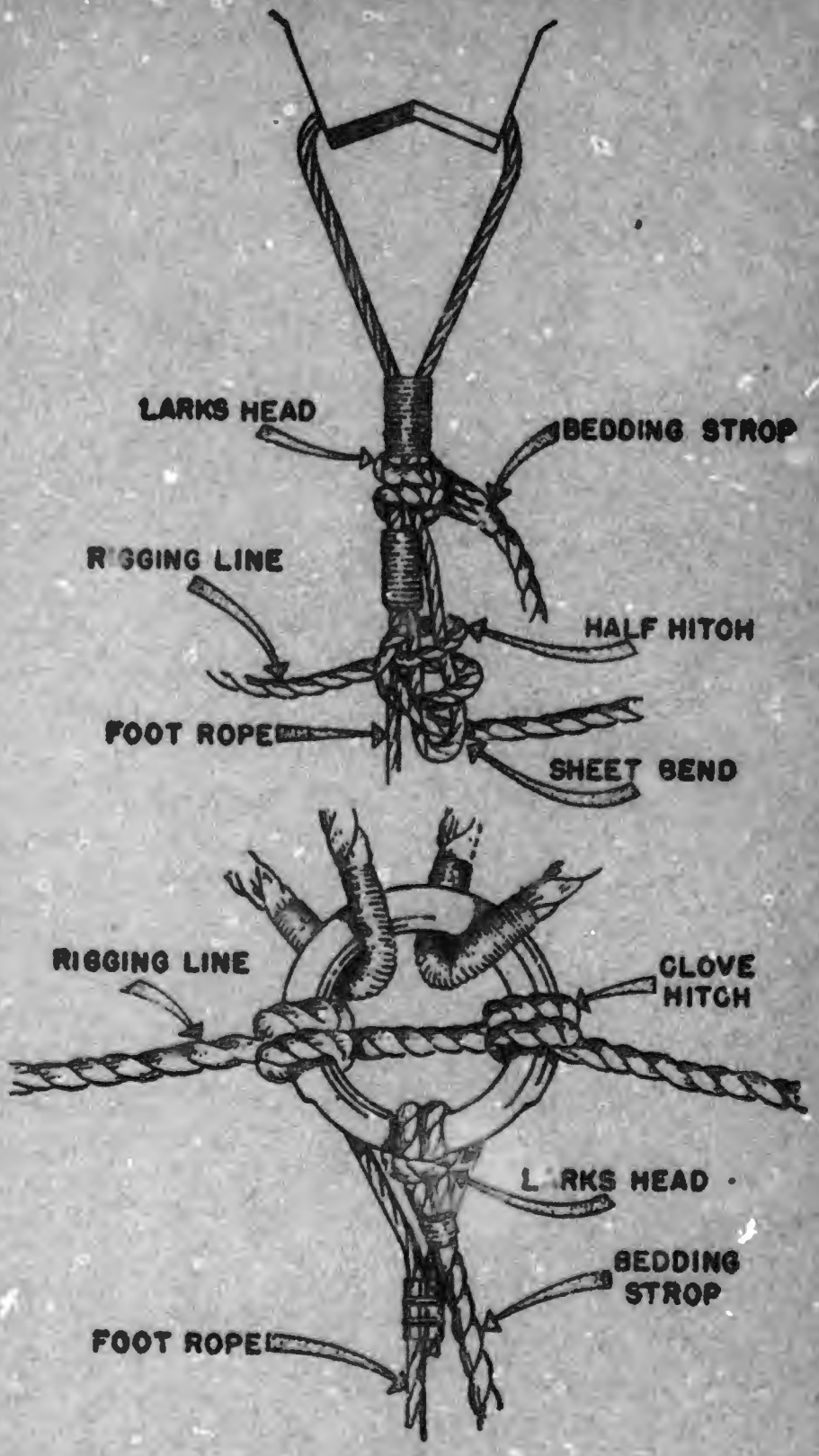


Figure 23. Attachment of rigging lines and bedding strops

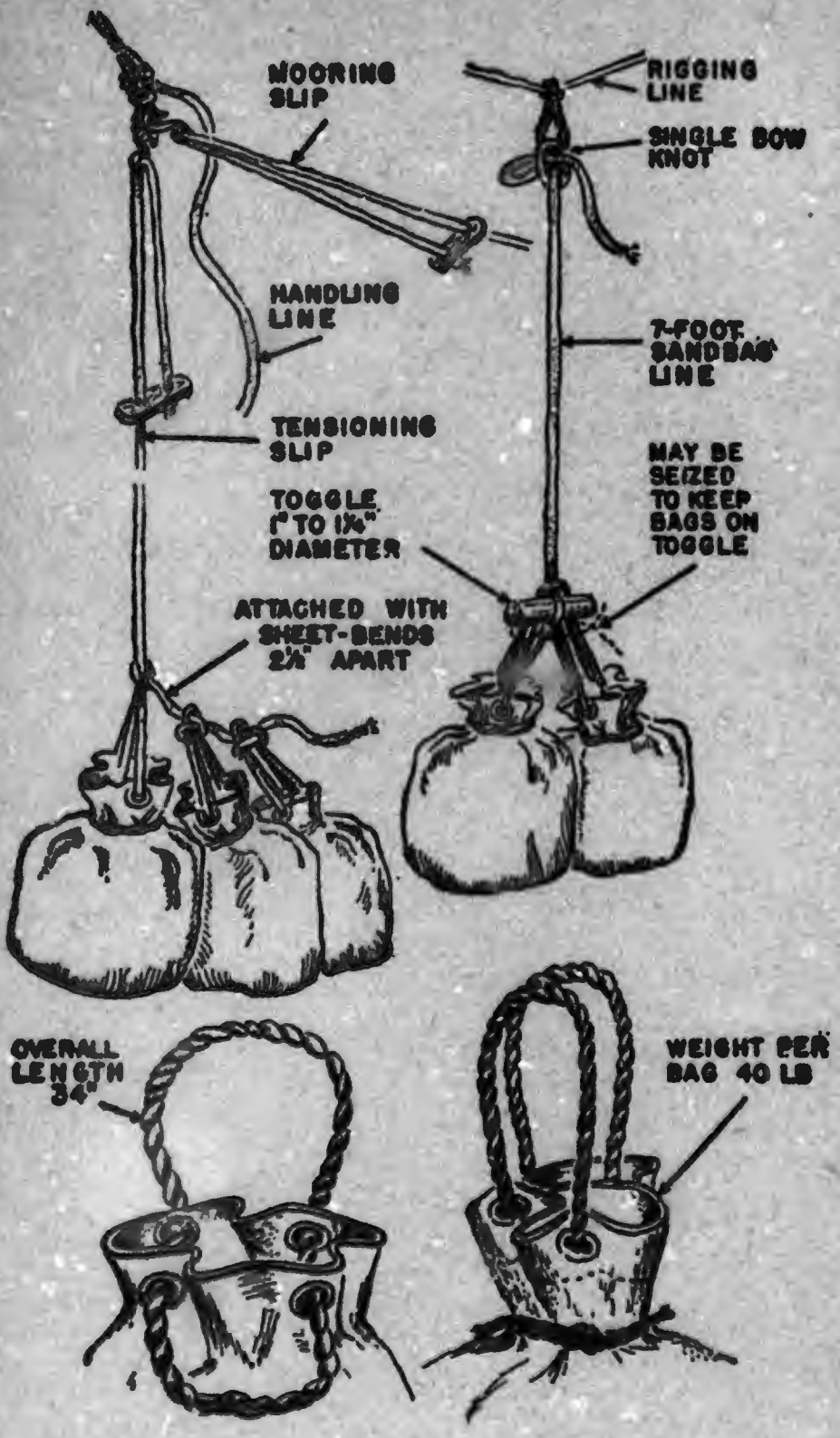


Figure 24. Rigging and use of sandbags

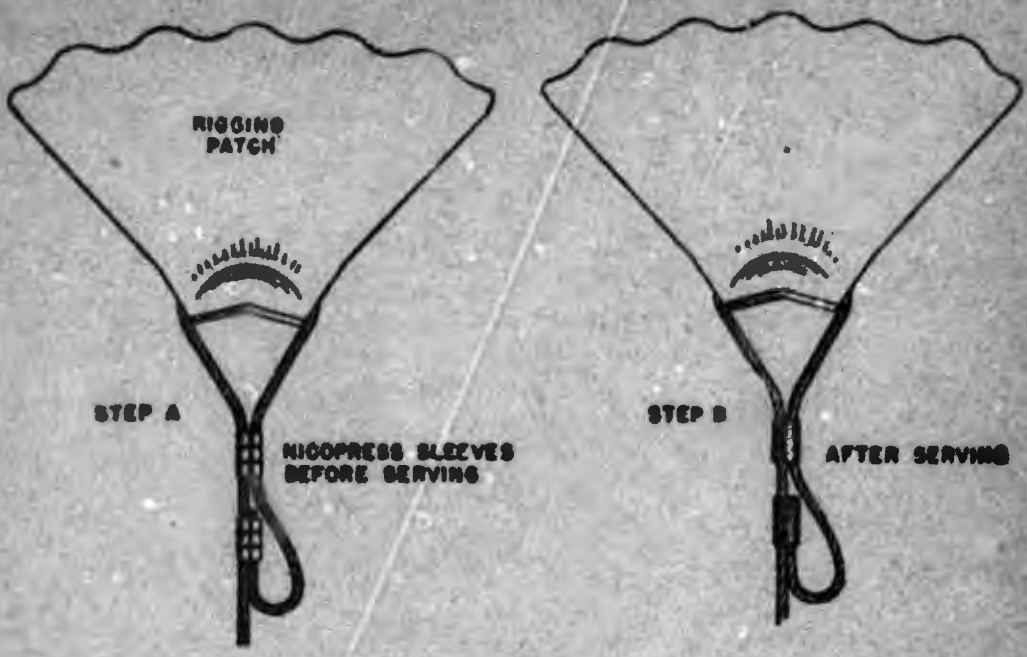


Figure 25. Attachment of foot ropes

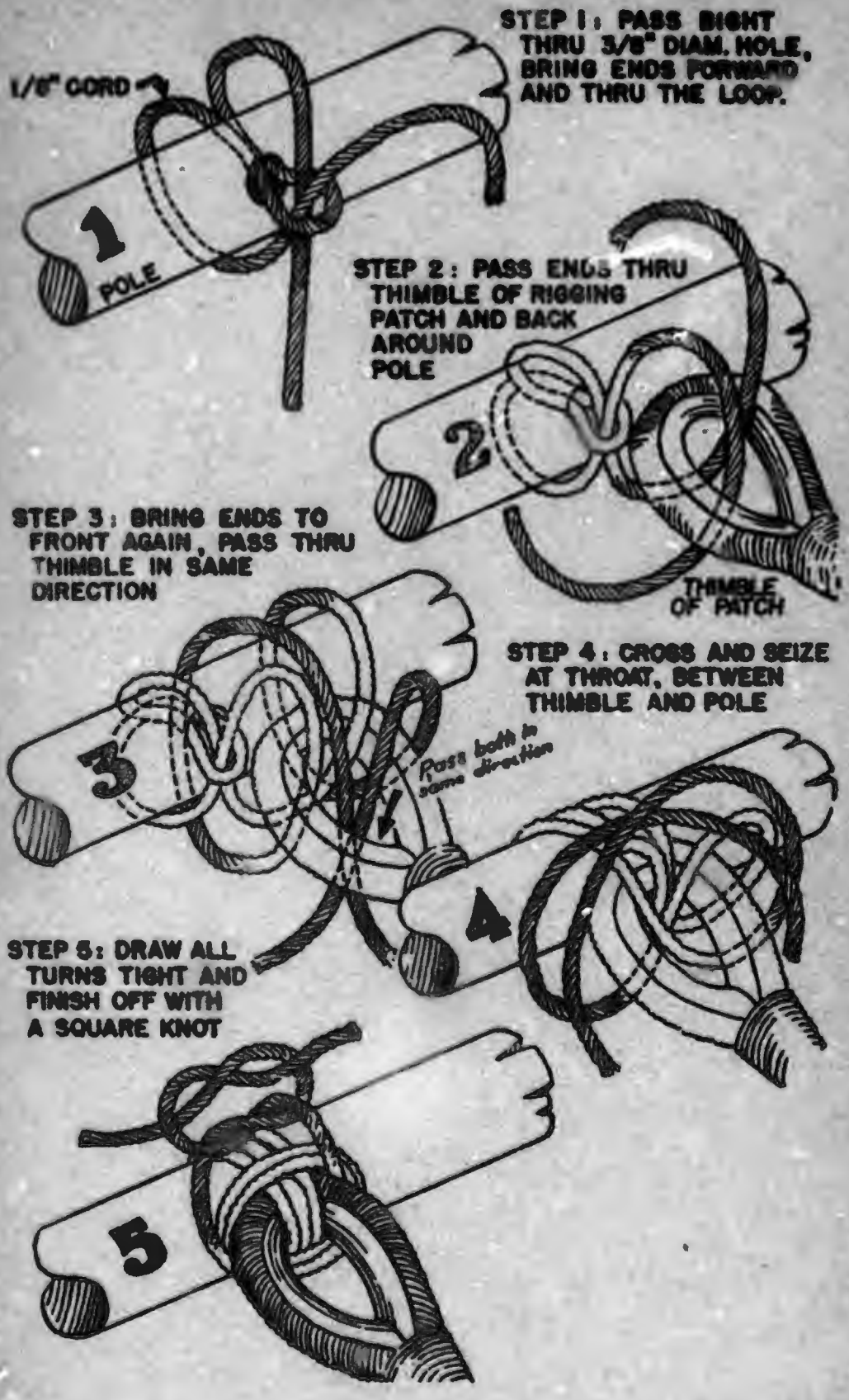


Figure 26. Attachment of outrigging poles to balloon, tandem flying

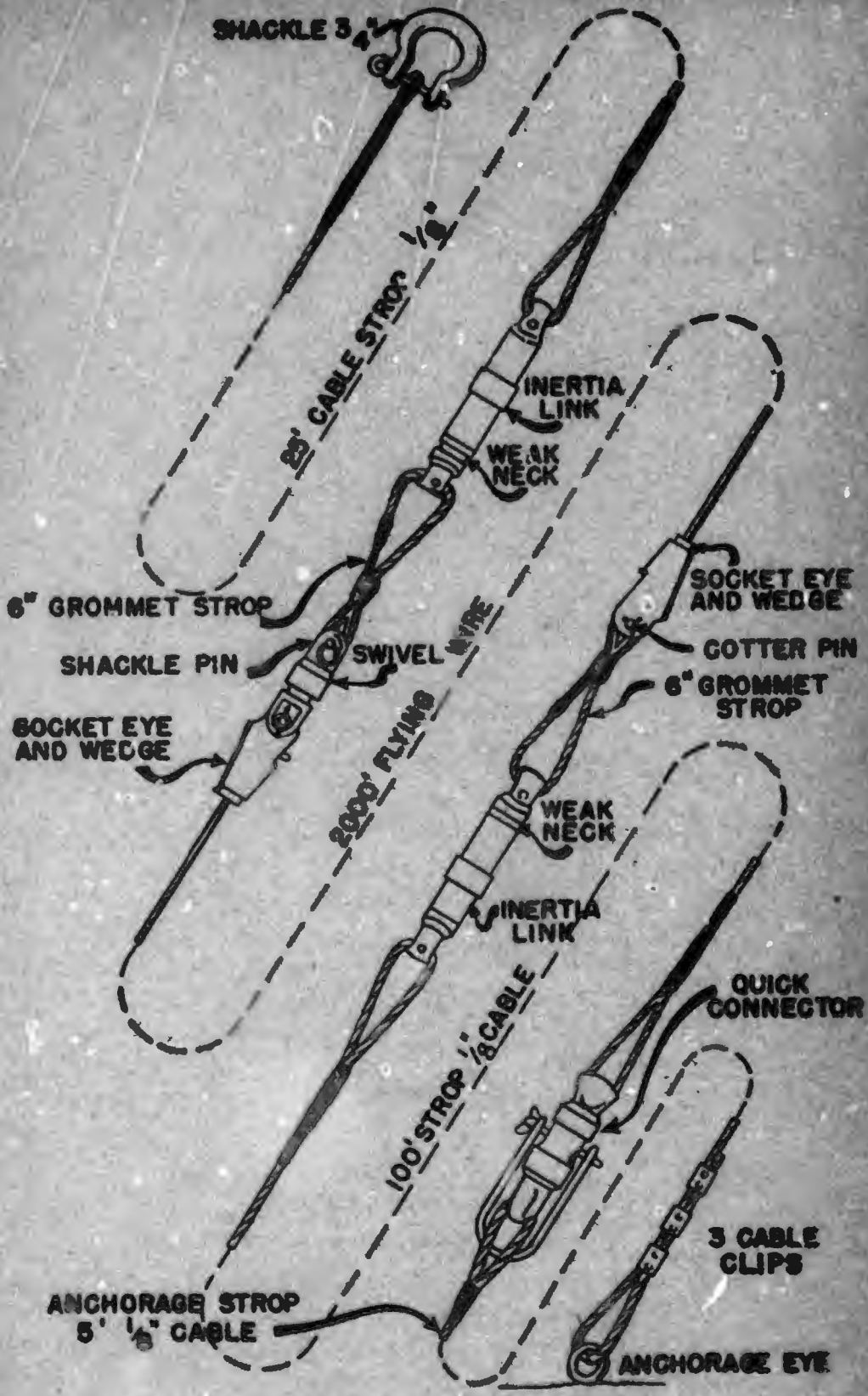


Figure 27. Flying-wire assembly VLA

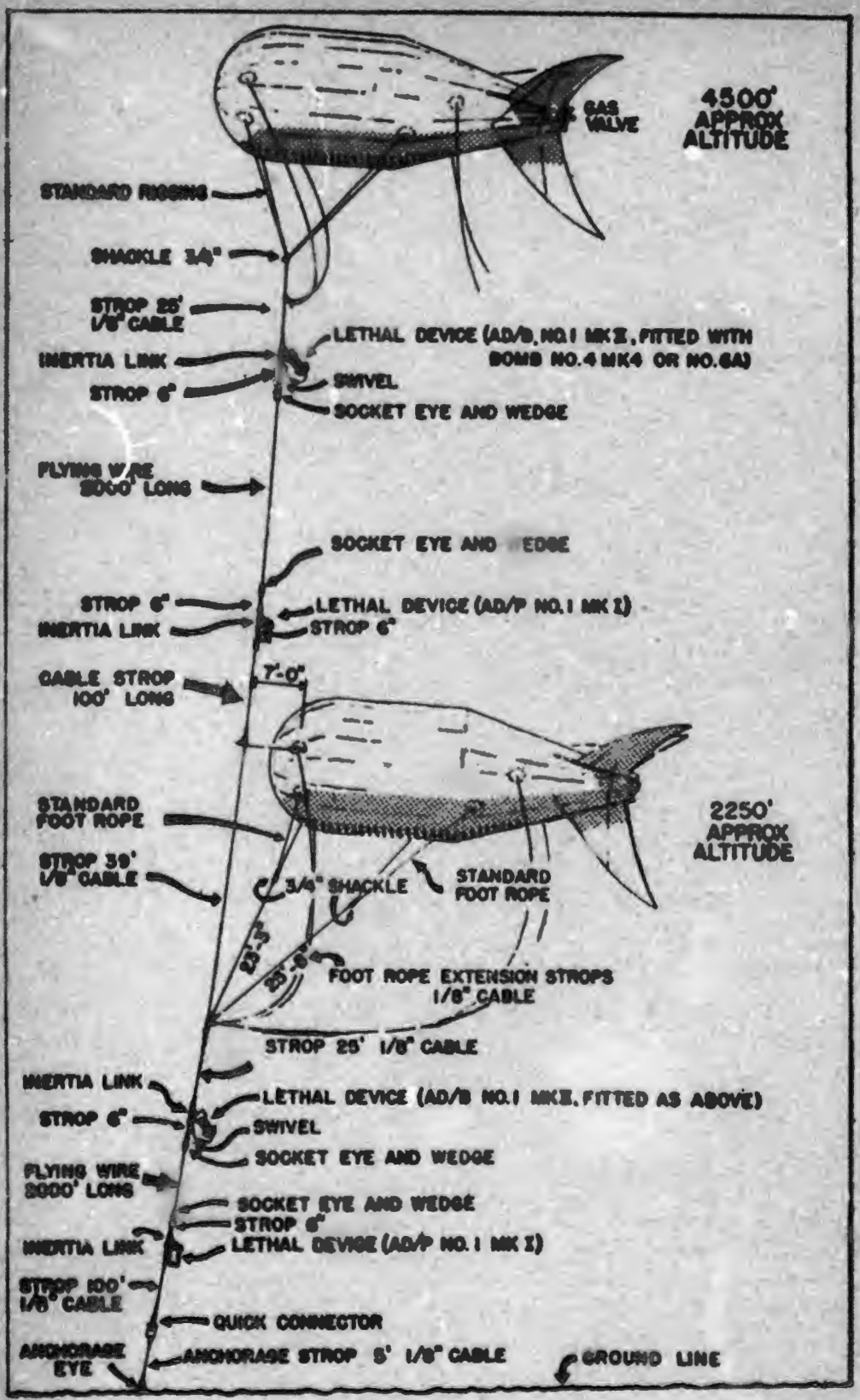


Figure 28. Arrangement of flying-wire assembly for tandem flying

14. MARKING HANDLING LINES The handling lines are marked at the point where they are to be tied onto the spider. The distances to the markings from the upper ends of the lines are shown below.

	Hauling from tail	Hauling from nose
Front handling lines Mk. VII, D–7	62 feet	51 feet
D–8	67 feet	54 feet
Center handling lines Mk. VII, D–7	61 feet	
D–8	64 feet	
Rear handling lines Mk. VII, D–7	51 feet	62 feet
D–8	54 feet	67 feet

15. ADJUSTING RIGGING LINES The rigging lines will have the following dimensions between patches:

Between patches	Mk. VII	
	D–7	D–8
1 and 2	6 feet	8 feet 6 inches
2 and 3	7 feet	9 feet 6 inches
3 and 4	8 feet	11 feet 6 inches
4 and 5	9 feet	12 feet 6 inches
5 and 6	11 feet	15 feet 6 inches

Chapter 5

ROPE

16. ROPE STRENGTHS *a. Tensile strengths* The tensile strengths of fiber ropes are shown in table V.

b. Working strength The working strength of a rope is one-third of its tensile strength.

TABLE V—MAXIMUM TENSILE STRENGTH OF ROPE (IN POUNDS)

Size (diameter in inches)	Manila yacht	Cotton	Commercial Manila	Sisal	Wartime*	Jute
1/8	....	120	....	....	....	....
3/16	570	250	450	273	336	300
1/4	770	450	600	358	440	400
5/16	1320	675	1000	608	760	700
3/8	1595	890	1350	829	1020	975
7/16	1925	..	1750	1138	1400	1300
1/2	2695	1450	2050	1722	2120	1680
9/16	3465	....	3450	2243	2760	....
5/8	....	2028	4400	2860	3520	2520
3/4	5390	3100	5400	3510	4320	3400
13/16	6490	....	6500	4225	5200	....
7/8	7700	3900	....	5005	6160	....
15/16	....	....	7700	5428	6660	....
1	9020	5100	9000	5850	7200	....

* A type of sisal rope.

Chapter 6

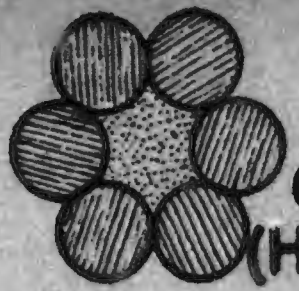
CABLE (WIRE ROPE)

17. CONSTRUCTION AND MEASUREMENT The construction of cable used in barrage balloon work and the method of measuring cable size are shown in figure 29.

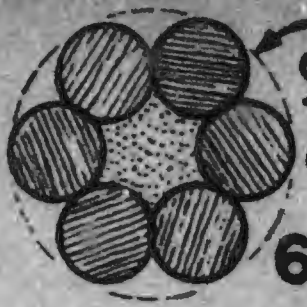
18. CHARACTERISTICS The characteristics of flying cable and wire used in barrage balloon work are shown in table VI.

TABLE VI—CHARACTERISTICS OF FLYING CABLE AND WIRE

Characteristic	Cable LA M2	Cable LA M1	Wire VLA M1	Cable VLA 1-in
Size (approximate)	0.24 in.	7/32 in.	0.072 in.	0.13 in.
Construction	6 x 1	7 x 7	Solid	6 x 1
Core	Hemp	Steel	None	Hemp
Tensile strength	7,600 lbs.	6,800 lbs.	1,300 lbs.	2,000 lbs.
Weight per 1,000 feet	90 lbs.	83 lbs.	14 lbs.	28 lbs.
Lay	2 in. right	1¾ in. right	None	1 3/16 in. right

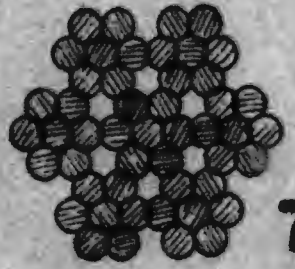


6 x 1
(HEMP CENTER)

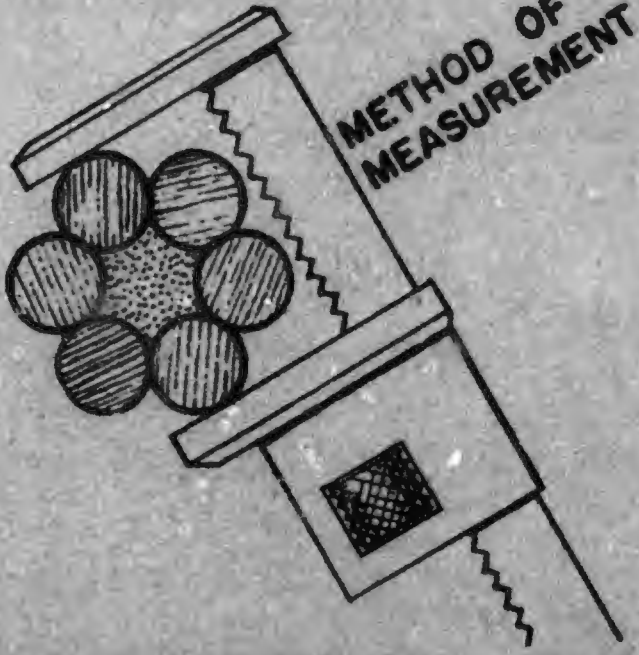


THE DIAMETER OF A CABLE IS THAT OF A TRUE CIRCLE.

6 x 1



7 x 7



METHOD OF MEASUREMENT

Figure 29. Cable construction and measurement

Chapter 7

GAS CYLINDERS

19. CHARACTERISTICS OF CYLINDERS The characteristics of gas cylinders are listed below.

Length (with cap)	4 ft. 9⅜ in.
Outside diameter (base)	9½ in.
Thickness of wall	⅜ in.
Weight	125–130 lbs.
Operating pressure (U. S. Army Specifications)	2,265 lbs. per sq. in.
Pressure to which normally filled (approximate)	2,000 lbs. per sq. in.
Volume of compressed gas	1.528 cu. ft.
Volume of free gas contained (approximate)	191 cu. ft.
Lift per cylinder of hydrogen (approximate)	12.5 lbs.
Lift per cylinder of helium (approximate)	11.5 lbs.
Threads	Left hand
Color of cap, Army hydrogen	Olive drab
Color of body, Army hydrogen	Olive drab or galvanized
Color of cap, Navy hydrogen	Black
Color of body, Navy hydrogen	Black, white band around middle

Color of cap, commercial hydrogen	Black
Color of body, commercial hydrogen	Black
Color of cap, Army helium	Yellow
Color of body, Army helium	Olive drab or galvanized
Marking, full cylinder	F, or no marking
Marking, empty cylinder	MT
Marking, defective cylinder	DEF

Chapter 8
WINCHES

28. WINCH CHARACTERISTICS *a. LA winches.*

Table VII gives the characteristics of LA winches.

TABLE VII—CHARACTERISTICS OF LA WINCHES

Characteristic	M-1	A-2	Mk. IV
Length	11 ft. 11 in.	11 ft.	15 ft. 6 in.
Width	4 ft.	4 ft.	5 ft. 9 in.
Height	5 ft. 2 in.	6 ft. 10 in.	7 ft.
Weight, less cable	4,575 lbs.	4,150 lbs.	5,100 lbs.
Mount	Skid	Skid	Skid
Size of cable used	¼ in.	7/32 in.	¼ in.
Storage drum capacity	9,200 ft.	8,500 ft.	13,000 ft.
Hauldown, maximum governed rate	900 ft. per min.	900 ft. per min.	900 ft. per min.
Payout, in gear, maximum governed rate	900 ft. per min.	900 ft. per min.	150 ft. per min.
Traction drums:			
Clutch	Positive, jaw	None	Positive, pin and plate
Material	Cast iron	Brass	Cast iron
Pitch diameter	12 in.	9⅛ in.	12 in. (approx.)
Upper drum grooves, number	5	3	5
Lower drum grooves, number	6	3	6
Storage drum friction clutch	Disc	Band	Disc
Storage drum brake	External contracting	Automatic band	Internal expanding
Service brake	External contracting	External contracting	Internal expanding
Snatch brake	External contracting on freewheeling unit	Automatic band	"Servo" cable unit
Gipsy head	Reversible	Nonreversible	Reversible
Engine:			
No. of cylinders	6	6	8
Brake horsepower	73	73	95
Ignition system	Magneto	Magneto	Battery
Starting system	Electric	Electric	Electric
Cooling system	Liquid	Liquid	Liquid
Clutch, type	Disk, dry plate	Disk, dry plate	Disk, dry plate
Transmission, type	Selective	Selective	Selective

b. VLA winches Table VIII gives the characteristics of VLA winches.

TABLE VIII—CHARACTERISTICS OF VLA WINCHES

Characteristic	Mk. VI	M1
Length	4 ft. 9 in.	5 ft. (approx.)
Width	4 ft. 5½ in.	3 ft. (approx.)
Height	3 ft. 1½ in.	3 ft. (approx.)
Weight, less cable	700 lbs.	1,000 lbs. (approx.)
Mount	Angular construction	Skid
Storage drum capacity, .072 in. wire	8,000 ft.	7,000 ft.
Hauldown rate, light load	450 ft. per min.	700 ft. per min.
Hauldown rate, heavy load	200 ft. per min.	150 ft. per min.
Payout rate	689 ft. per min.	1,000 ft. per min.*
Storage drum drive	Variable ratio friction	Direct
Storage drum brake	Internal expanding	External contracting
Service brake	Internal expanding	External contracting
Holding mechanism	Ratchet and pawl	Ratchet and pawl
Engine:		
No. of cylinders	1	2
Brake horsepower	5.25	10 (approx.)
Ignition system	Magneto	Magneto
Starting system	Manual	Manual
Cooling system	Air	Air
Transmission, type	Friction disc and pinion	Selective

* Or as fast as balloon will rise.

Chapter 9

WEATHER

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21. WEATHER MESSAGE *a. Time of issue* The weather message is issued four times daily (at 0400, 1,000, 1,600, and 2,200). Special weather messages are issued when a change of weather class occurs, when a special pibal is made, or when a special forecast is made.

b. Typical weather message:

WEATHER STATION
333 ANTIAIRCRAFT BALLOON BATTALION

Pilot balloon

H*	D*	V*
01	22	40
02	24	45
03	24	60
04	Balloon	
05	entered	
06	clouds	
07		
08		
09		
10		

CALCULATED WIND

02		

WEATHER MESSAGE

Date *2 August 1943*

Period *1,000 to 1,800*

Present weather class and remarks:

Class III above 2,000 feet due to winds; Class II at surface due to winds.

FORECAST

Clouds and weather: *Overcast at 3,000 ft., lowering to 1,000 ft. during frontal passage about 1800. Rain beginning about 1600.*

Surface winds: *SW 20 mph, increasing to 25 mph and shifting to NW during frontal passage. Very gusty as front passes.*

Icing level (if below 5,000 ft.): *3,000 ft.*

Changes in weather class: *Class III at surface by 1700 due to winds.*

Forecaster *J. D.*

* H = height (in thousands of feet).
D = direction from which wind is blowing (in tens of degrees).
V = wind velocity (in mph).

22. HOURLY REPORTS *a. Time of issue* The hourly report is normally issued 30 minutes past every hour. Special reports are added to report sudden weather changes.

b. Contents An hourly report contains the following information in the order listed:

(1) Time observation was made.
(2) Ceiling, in hundreds of feet.
(3) Sky coverage, indicated by sky symbols.
(4) Visibility, in miles.
(5) State of weather, indicated by letter symbol.
(6) Temperature, in degrees Fahrenheit.
(7) Dew point, in degrees Fahrenheit.
(8) Surface wind direction and speed.
(9) Station pressure, in inches of mercury.
(10) Wind direction and speed at some designated upper level.

c. Typical hourly report The following is an example of an hourly report together with its decoded meaning:

(1) *Example*: 1,830 30 ⊙ / ⊕ 4R–K– 70/66—15/010 023225

(2) *Meaning:* 1,830 local time; ceiling 3,000 feet; high scattered, lower broken clouds; visibility 4 miles due to light rain and light smoke; temperature 70° F, dew point 66° F; surface wind from the west, wind velocity 15 miles per hour; station pressure 30.10 inches; wind observation at 2,000 feet, direction 320°, velocity 25 miles per hour.

23. TONIGHT AND TOMORROW FORECAST A typical tonight and tomorrow forecast is shown below:

WEATHER STATION
ANTIAIRCRAFT BALLOON BATTALION
TONIGHT AND TOMORROW FORECAST

2 June 1943.

Thursday night:

Clear *Wind East* *5 to 10 mph*

Friday:

Cumulus clouds forming by noon with possible thunderstorms in late afternoon. Wind South 10 to 15 mph. Maximum temperature 98°.

Chapter 10

AEROSTATICS

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24. LIFT *a. Static forces* Figure 30 shows the static forces affecting a balloon.

b. Static lift The static lift of a balloon is determined by the following formula:

$$L = \frac{K\ V\ Y\ P}{T}$$

where L = Static lift of the balloon.
K = Constant (use 1.23 for hydrogen, and 1.14 for helium).
V = Volume of gas in the balloon.
Y = Gas purity (percent).
P = Barometric pressure (inches of mercury)
T = Air temperature (F° absolute).

c. Weigh-off Figure 31 shows a method for measuring the weigh-off (net lift) of a balloon. Point B (in figure 31) is the center of the central anchorage snatch-block.

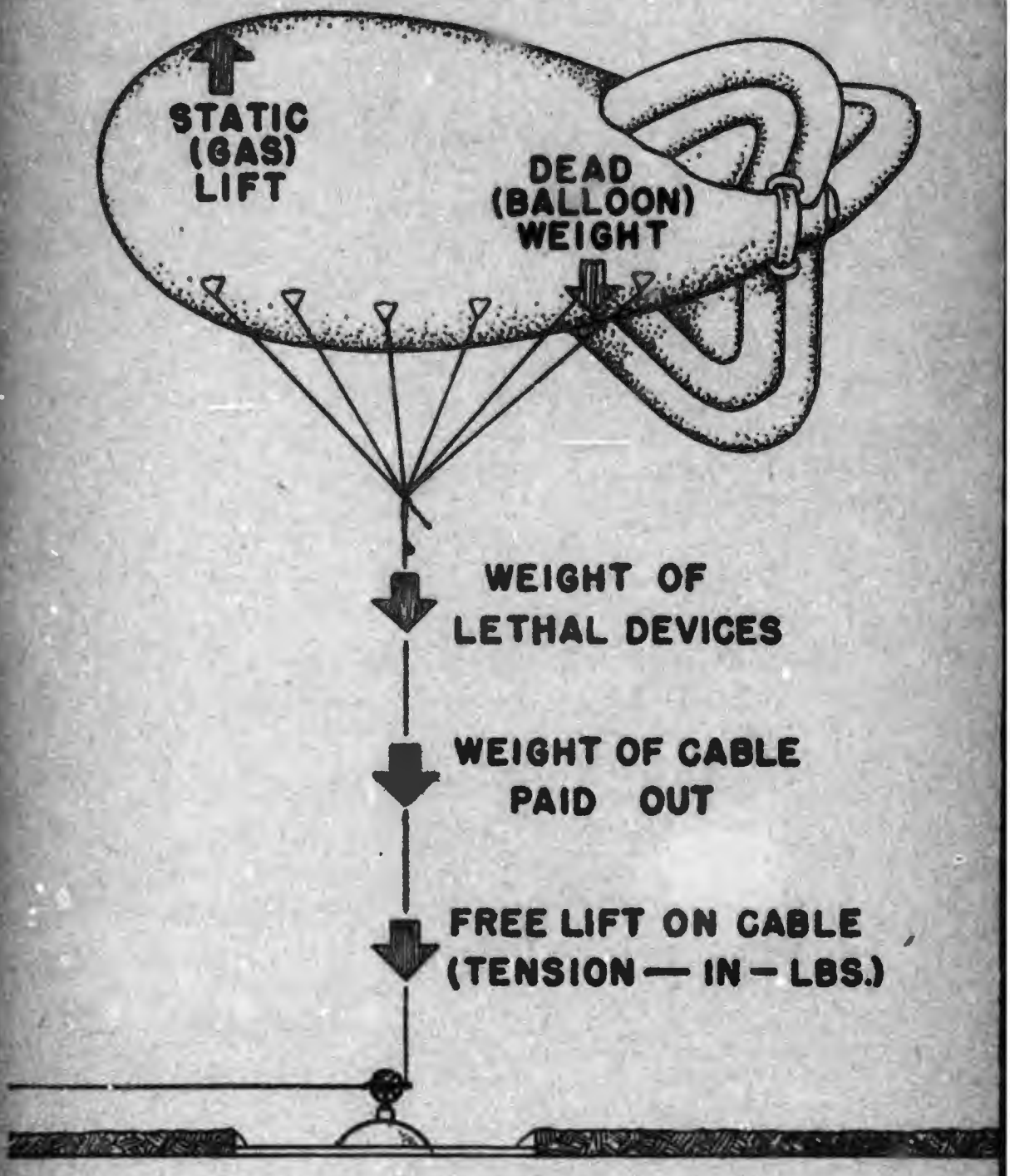

Figure 30. Static forces affecting a balloon

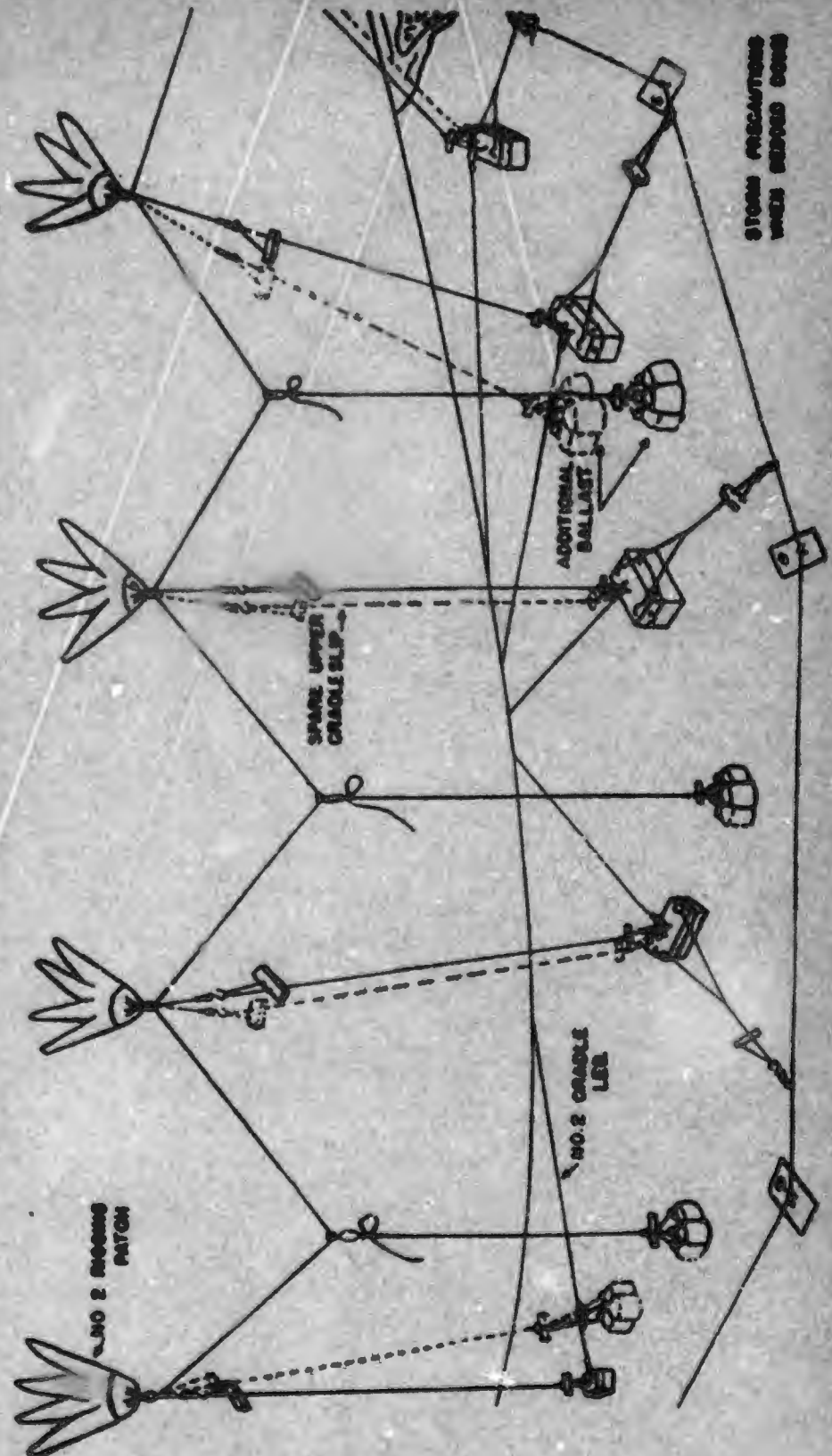

Figure 31. Method of measuring weigh-off

25. OPERATING CEILING *a. Formula* The operating ceiling of a balloon is determined by the following formula:

$$H = \frac{L'}{w \cdot \quad L'}$$

where H = Operating ceiling
L' = Maximum lift of balloon, calculated using temperature at sundown.
L_o = Fixed load.
w = Weight of cable per 1,000 feet.

b. Rules of thumb The operating ceilings of balloons inflated with 95 percent pure hydrogen when the atmospheric pressure is 30 inches of mercury and the characteristic atmospheric temperature (average temperature at sundown) is 60° F. are given below:

	M2 cable	M1 cable
	(Feet)	(Feet)
Mk. VII	5,500	6,000
D–7	4,600	5,000
D–8	5,400	5,800

To find the operating ceiling under conditions of purity, pressure, and temperature different from those above, apply the following corrective factors to the operating ceilings given:

(1) *Purity* Substract 100 feet for each 1 percent decrease in purity. Add 100 feet for each 1 percent increase in purity.

(2) *Pressure* Substract 300 feet for each 1 inch decrease in atmospheric pressure.

(3) *Temperature* Subtract 150 feet for each 10° increase in characteristic temperature. Add 150 feet for each 10° decrease in characteristic temperature.

26. INFLATION *a. LA balloon* A rule of thumb for determining the approximate number of cylinders required to inflate an LA balloon is:

$$\text{No. of cyl. required} = \frac{\text{Lift required}}{\text{Lift per cylinder}}$$

The lift required is the sum of the balloon weight, cable weight, lethal device weight (35 pounds), and free lift (50 pounds). The lift per cylinder is approximately 12.5 pounds for hydrogen and 11.5 pounds for helium. After the balloon is inflated, it is checked for minimum volume, required lift, and pressure height. Additional cylinders of gas are added if needed to give required lift or minimum volume.

b. Mk. VI balloon Use approximately 13 cylinders of gas, test with the manometer for 1.6 inches of water pressure, and add additional cylinders if required.

c. Topping-up An LA balloon is checked daily for minimum volume, required lift, and pressure height, and additional cylinders of gas are added if required. A Mk. VI VLA balloon is checked daily for 1.6 inches of water pressure, and additional cylinders of gas are added if required.

27. VOLUME *a. Calculating volume* The volume of gas in a balloon is calculated by the following formula:

$$V = \frac{L\ T}{K\ Y\ P}$$

where V = Volume.
L = Static lift (weigh off plus dead weight).
T = Air temperature (F° absolute).
K = Constant (use 1.23 for hydrogen and 1.14 for helium).
Y = Gas purity (percent).
P = Barometric pressure (inches of mercury).

b. Approximate volume The volume of gas in a balloon may be determined approximately by the method shown in figure 32. This method may be used to check the calculated volume.

D-7 BALLOON	
DIAPHRAGM HT.	GAS VOLUME IN CU. FT.
5 FT.	16,300
4 FT. 6 IN.	16,600
4 FT.	16,900
3 FT. 6 IN.	17,150
3 FT.	17,400
2 FT. 6 IN.	17,700
2 FT.	18,000
1 FT. 6 IN.	18,300
1 FT.	18,650
0 FT.	19,150

D-8 BALLOON	
DIAPHRAGM HT.	GAS VOLUME IN CU. FT.
5 FT. 3 IN.	20,000
4 FT. 9 IN	20,450
4 FT. 3 IN.	20,900
3 FT. 9 IN.	21,250
3 FT. 3 IN.	21,500
2 FT. 9 IN.	21,700
2 FT. 2 IN.	21,900
0 FT.	23,500

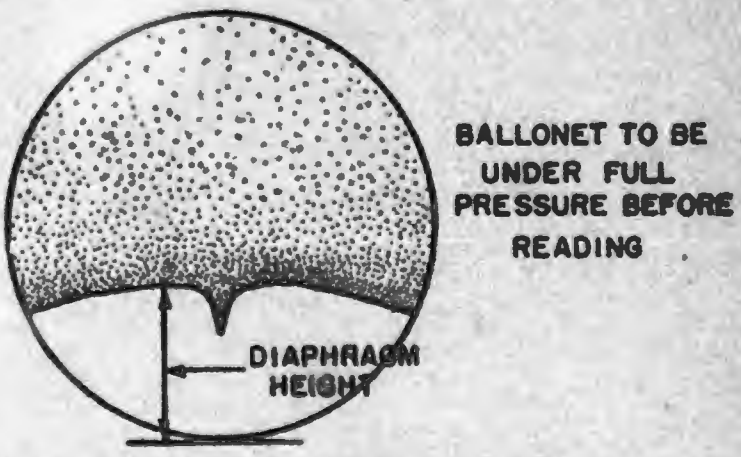

Figure 32. Gas volume by diaphragm height

c. Minimum volume The minimum volume of a balloon is checked by observing the position of the diaphragm. The correct and incorrect positions are shown in figure 33.

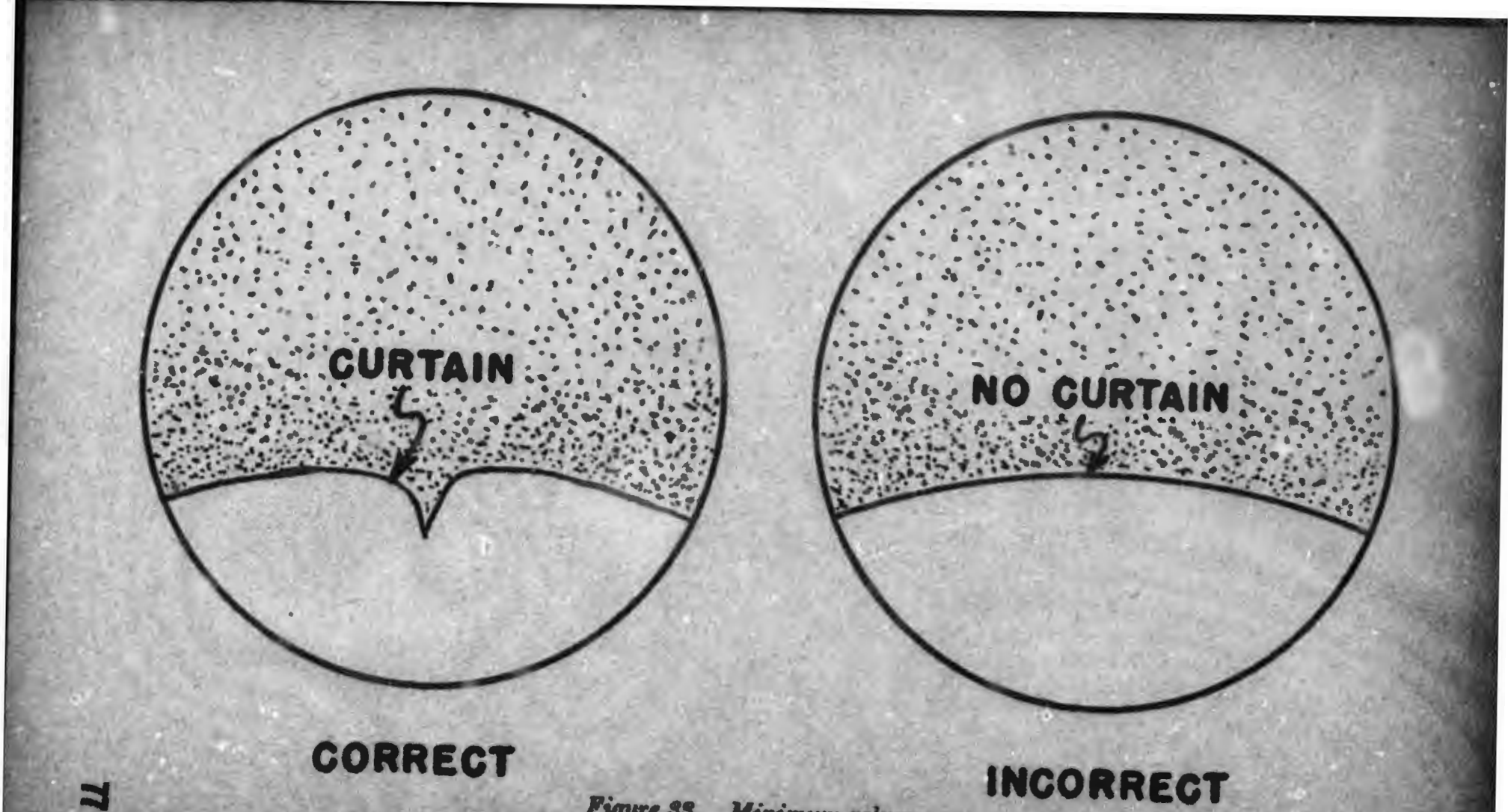

Figure 33. Minimum volume

d. Percentage of fullness The percentage of fullness of a balloon is obtained by dividing the actual volume of gas in the balloon by the designed volume of the envelope.

28. PRESSURE HEIGHT *a. Chart* Figure 34 is a chart for determining pressure height of a balloon. The

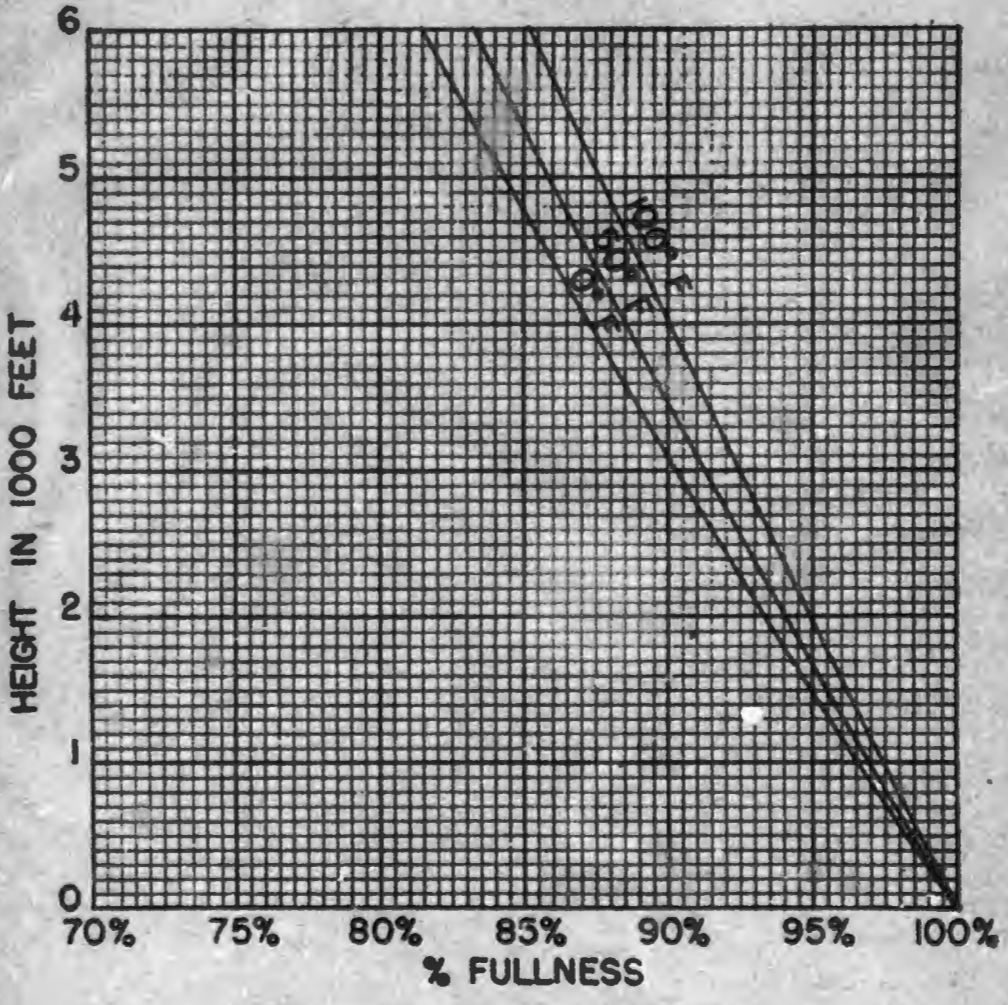

Figure 34. Pressure height chart

percentage of fullness and temperature at sundown will be used in determining the pressure height for the next 24-hour period.

b. Approximate pressure height Figure 35 shows a method of determining the approximate pressure height. The diaphragm height at sundown will be used in

determining the pressure height for the next 24-hour period. The approximate pressure heights shown in figure 35 are for an average sundown temperature of 50° F. Similar data can be compiled for other sundown temperatures by calculating the percentage of fullness for the various diaphragm heights and referring to the chart shown in figure 34.

D-7 BALLOON	
DIAPHRAGM HT.	PRESSURE HT. IN FT.
5 FT.	5,300
4 FT. 6 IN.	4,800
4 FT.	4,200
3 FT. 6 IN.	3,600
3 FT.	3,100
2 FT. 6 IN	2,500
2 FT.	2,000
1 FT. 6 IN.	1,500
1 FT.	1,000
0 FT.	0

D-8 BALLOON	
DIAPHRAGM HT.	PRESSURE HT. IN FT.
5 FT. 3 IN.	5,000
4 FT. 9 IN.	4,600
4 FT. 3 IN.	3,800
3 FT. 9 IN.	3,500
3 FT. 3 IN.	3,100
2 FT. 9 IN.	2,700
2 FT. 2 IN.	2,000
0 FT.	0

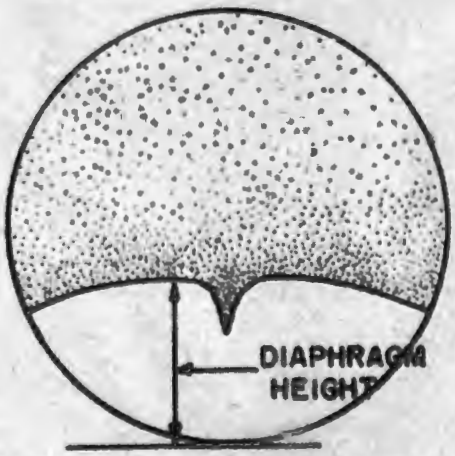

Figure 35. Method of determining approximate pressure height

29. SUPERHEAT The amount of superheat present in a balloon is determined by the following formula:

$$dT = \frac{dL\ Y\ T}{C\ L}$$

where dT = Amount of superheat (F°)
dL = Increase in lift due to superheat (difference in weight off with and without superheat).
Y = Gas purity (percent).
T = Air temperature when superheat is present (F° absolute).
C = Constant (use 1.08 for hydrogen and 1.16 for helium).
L = Static lift without superheat (pounds).

30. RULES OF THUMB *a. Effects of superheat* The approximate effects per 5° of superheat are listed below:

Increase in lift	15 lbs.
Increase in volume	200 cu. ft.
Reduction in pressure height	300 ft.
Increase in pressure (Mk. VI balloon)	.1 in.

b. Effects of flying above pressure height The approximate effects per 1,000 feet flown above pressure height are listed below:

Loss of gas	3 percent
Loss of lift	3 percent

31. HYDROGEN GENERATION *a. Materials* The amounts of gas generating materials used per charge in the M1 hydrogen generator and the average amounts of materials consumed per 1,000 cubic feet of gas generated are shown in table IX.

TABLE IX—MATERIALS FOR M1 HYDROGEN GENERATOR

Material	Amount needed per charge	Amount per 1,000 cu. ft. of gas (approximate)
Ferrosilicon	500–700 pounds	50 pounds
Caustic soda	200 pounds	95 pounds
Water	88 gallons	42 gallons
Caustic potash (for drying cylinder).	150 pounds	Refill every 85 hours

b. Reaction The reaction in the M1 hydrogen generator is:

$$2NaOH + Si + H_2O = Na_2SiO_3 + 2H_2$$

The iron (ferro) in the ferrosilicon is passed out of the generator as a waste product and does not enter into the reaction.

Chapter 11

ABBREVIATIONS

32. ABBREVIATIONS Abbreviations for terms dealing specifically with barrage balloons are listed below.

*Apparatus, aircraft defense	AAD
*Aircraft defense bomb	AD/B
*Aircraft defense parachute	AD/P
*Aircraft defense parachute, Navy	ADP/N
Balloon	Bln
Barrage	Bar
Cylinder	Cyl
Double parachute and ripping link	DP/R
Double parachute link	DPL
Effective balloon line	EBL
Inflation gas officer	Infl Gas O
*Kite balloon	KB
Low altitude	LA
*Low zone	Lz
*Mark	Mk.
Ruling operating height	ROH
Very low altitude	VLA
Weather officer	Wea O
Winch	Wn

* British term.

Chapter 12

GLOSSARY OF TERMS

33. GENERAL Following is a glossary of terms frequently used in barrage balloon work. Some terms are defined according to their limited meaning in barrage balloon work, even though they may have a different meaning in general use.

Absolute pressure. The pressure read on an ordinary pressure gage, plus atmospheric pressure; or the atmospheric pressure alone if gage pressure is not involved.

Absolute temperature. The temperature read on an ordinary thermometer, plus 460 on the Fahrenheit scale or 273 on the centigrade scale.

Aerostatics. The theory of the static forces affecting the equilibrium of a barrage balloon in flight.

Air speed. Speed of the air relative to the balloon.

Angle of dive. The angle between the course of an attacking aircraft and the horizontal, measured in the vertical plane containing the course of the aircraft.

Angle of trim. Acute angle between the longitudinal axis of the balloon and the horizontal when the balloon is flying.

Area of effectiveness. The area around a defended

objective in which barrage balloons may be placed in order to be effective against attacking aircraft.

Army effusion apparatus. An apparatus used to determine the purity of inflation gas.

Ascension point. The point from which a balloon cable extends upward to the balloon.

Ballonet balloon. A balloon designed so that the envelope shape will remain substantially constant as the gas volume changes. It contains a gas chamber and an air chamber (ballonet), separated by a fabric diaphragm.

Balloon barrage. The barrier presented to hostile aircraft by a number of barrage balloons sited according to a plan and operating to defend a given point or area.

Balloon bed. An area which is equipped for mooring and flying a barrage balloon.

Balloon class. A group of specified balloons in a barrage that are to fly under a certain weather class.

Balloon crew. The men necessary to perform a particular balloon-handling operation.

Balloon fabric. Cotton cloth which has been proofed with rubber or neoprene to make it airtight or gastight.

Airtight fabric. Double-ply fabric which does not have a gas film vulcanized between the plies.

Double-ply bias fabric. Fabric constructed by placing two plies together so that one ply is secured to the other at an angle of 45°.

Double-ply parallel fabric. Fabric constructed by placing two plies together so that the warp of one is parallel to the warp of the other.

Gastight fabric. Double-ply fabric which has a gas film vulcanized between the two plies.

Single-ply fabric. Fabric made from only one thickness of cloth.

Single-ply bias fabric. Single-ply fabric cut at an angle of 45° to the warp.

Balloon rigging. Mooring and handling equipment which flies with the balloon.

Balloon site. An area which contains all installations necessary to the operation of a barrage balloon.

Balloon squad. The total number of men assigned to a balloon site.

Block. A sheave, or set of sheaves, in a frame or shell.

Buoyancy. Upward static force exerted on a balloon equal to the weight of air displaced by the balloon.

Ceiling, cloud. Distance from the ground to the base of the clouds when the sky is more than half covered with clouds below 10,000 feet. If one half or less of the sky is covered with clouds, or clouds are above 10,000 feet, the ceiling is unlimited.

Ceiling, operating. The maximum altitude to which a balloon will lift the cable and attached lethal devices statically, and still maintain the desired cable tension at the winch.

Close-haul. Status of a balloon which is moored at point of attachment on a land site, or flying as near the point of attachment as practicable on a water-borne site.

Cumulonimbus cloud. A cloud formation (thunderhead) associated with thunderstorms. Prominent features are heavy masses, great vertical development, turbulence, summits resembling mountains or towers, and cauliflower appearance, often with an anvil-shaped top.

Deadman. Log, rail, or similar object buried in the

ground horizontally, with cables attached around the log or rail, used for mooring purposes.

Dead weight. The combined weight of the balloon and balloon rigging.

Dilatable balloon. A balloon designed to expand or contract, by means of rubber cords, in accordance with internal pressure changes.

Effective balloon line (EBL). A line around an objective formed by projecting to the ground points where a diving plane would enter the barrage.

Fixed load. Weight of balloon and lethal devices, plus the free lift.

Free lift. Static lift of a balloon remaining after the balloon has attained the desired altitude.

Gas film. A layer of rubber or neoprene vulcanized between the plies of a double-ply fabric to render the fabric impermeable.

Gas purity. The proportion of pure gas in a total volume, expressed in percent.

Grommet. A ring of rope or cable; also a metallic eyelet secured to fabric for reinforcing an opening.

Ground rigging. That rigging which is necessary for mooring or bedding down a balloon, but which does not go aloft with the balloon.

Lethal device. A device attached to a balloon flying cable or wire to enhance its ability to destroy aircraft.

Lift, dynamic. Lift produced by the wind due to kiting effect on the balloon.

Lift, free. Static lift desired after the balloon has reached the required altitude.

Lift, gross. Buoyancy less the weight of the buoyant gas.

Lift, maximum. Gross lift of a balloon inflated to its maximum volume.

Lift, net. The difference between the gross lift and the dead weight.

Lift, required. Sum of the dead [illegible], lethal device weight, and free lift.

Lift, static. Lift of the balloon produced by the buoyant gas.

Manometer. An instrument for determining the gas pressure in a balloon graduated in inches of water and indicating gage pressure.

Metro purity meter. An instrument which measures the percent of oxygen in a volume of hydrogen gas.

Minimum spacing. Minimum interval between adjacent balloons to prevent entanglement of their flying cables.

Minimum volume. The least volume to which a balloon may be inflated for safe operation.

Nurse bag. A fabric bag used as a gas reservoir, or to transport gas over short distances.

Percent of fullness. The ratio between the actual volume and the gross volume of a balloon, expressed in percent.

Point of attachment. Position of a balloon which is flying with the junction assembly approximately 6 feet above the central anchorage snatch-block.

Pressure height. The altitude at which a balloon becomes 100 percent full of gas.

Ruling operating height (*ROH*). Height at which barrage balloons are ordered flown.

Slip. Rope rigged with an adjusting block and a hook in the bight. Another hook or toggle may be attached to the free end.

Snatch-block. A single block having an opening in one cheek to receive a rope or cable.

Strop. A connecting rope or cable constructed with an eye at one or both ends.

Superheat. The difference between the temperature of the gas in a balloon and the outside air.

Top-up. To add gas to a balloon to increase lift, purity, or pressure.

Valve. Apparatus installed in the envelope of a gas or air chamber of a balloon for the purpose of automatically releasing air or gas from the envelope whenever the interior pressure exceeds the valve setting.

Weather class. A designation indicating the weather risk to balloons.

Weigh off. To determine the net lift of a balloon.

Appendix I

BARRAGE BALLOON CASUALTY REPORT (BBB FORM NO. 7)

Instructions:

1. The battalion (or separate battery) commander concerned will take appropriate action to insure that each casualty involving the replacement of a balloon on a site is investigated by a qualified officer within 24 hours of its occurrence.

2. The investigating officer will complete this form for each casualty and transmit it to the battalion (or separate battery) commander who will forward the form to the Commanding General, Antiaircraft Command, Richmond, Va.

3. The form may be filled out in pencil. It is intended to disclose defects and deficiencies in matériel, and errors in operation. Pertinent data not otherwise covered by the form will be entered under "Remarks."

SECTION A.—(To be completed in every case.)

Station *Camp Tyson, Tennessee* Battalion *299*

Btry *A* Site *17*

Date of casualty *14 Feb 1943* Time *1400*

Balloon No. *17468* Type *Mk. VII* Manufacturer *Dunlop*

Date of manufacture *Unknown*

Date of first inflation *10 Dec 1942*.

Date of last inflation *10 Dec 1942*.

Total number of days inflated *66*

If porosity proofed, give date *Not proofed*. Average daily gas consumption for last 4 weeks or since last inflation *0.80* cyls.

Remarks:

SECTION B.—(To be completed in every case.)

Classify the casualty by putting a check mark through one or, where applicable, more than one of the parentheses in statements 1 to 14, inclusive. Then complete all the other sections appropriate to the classifications marked by putting a check mark through every statement which applies.

Section O to be completed in every case (with special reference to starred items).

Other sections to be completed

Flying

1. Break-away ( ) Cable broke (not cut)..... C, D, E, G, H, J, N
2. Break-away ( ) Cable cut by firing of lower link.. C, D, E, G, J, N
3. Break-away (*x*) Upper link parted..... C, D, E, G, J, N
4. Break-away ( ) Cable cut deliberately..... C, D, E, G, J, N

5. Balloon damaged ( ) but not lost while flying.... C, D, E

Not flying

6. Balloon lost or damaged while bedded or moored or during handling ( ).....C, D, F

General

7. Balloon (x) damaged, ( ) lost, ( ) not recovered, (x) recovered, ( ) considered beyond repair.
8. Balloon ripped, ( ) not known, ( ) deliberately, ( ) accidentally, (x) automatically, ( ) rip cord broke.....C, D, F
9. Burned by lightning or otherwise ( ).....C, L, N
10. Casualty contributed to by failure of winch ( ).K
11. Balloon deflated because of porous fabric ( )...M
12. Balloon deflated because of low purity, or undue loss of gas ( ) cause ascertained ( ) cause not ascertained.....M
13. Balloon damaged ( ) by AA gunfire, ( ) enemy action.....
14. Other causes.....
15. Remarks:

SECTION C.—Weather and Site.

16. Estimated ground windspeed 10 Estimated wind at balloon altitude 43.
17. (x) Daylight, ( ) moonlight, ( ) dark.
18. ( ) Rain, ( ) snow, ( ) fog, ( ) clear.
19. ( ) Gusty, (x) sudden squall, ( ) wind veered suddenly, ( ) calm.
20. Marine site: Flying from ( ) buoy, ( ) moored vessel, ( ) mobile vessel.
21. Land site: Flying from ( ) winch, (x) concrete C.A., ( ) other C.A.
22. Remarks:

Front arrived sooner than forecasted.

SECTION D.—Details Affecting Balloon Behavior.

23. Days since balloon was last topped up 2.
24. Estimate gas purity or oxygen content 9
25. Gas used ( ) commercial, (x) field generated.
*26. Undue loss of gas, ( ) suspected, ( ) certain, ( ) seam opened, ( ) balloon burst.
27. Failure seen of ( ) patches, ( ) flying rigging, ( ) handling and mooring lines, slips or cradle, ( ) ground cable, pickets or anchorage points, ( ) rudder fabric, ( ) rudder diaphragms or internal lacings, ( ) fin fabric, ( ) fin spacer curtains.
28. Remarks:

SECTION E—Balloon Flying.

*29. Balloon misbehaved before it was damaged or lost (e.g., dive, spin, yaw off-wind); ( ) definitely not, ( ) suspected, (x) definitely did.
*30. At time of misbehavior winch was (x) stationary, ( ) being hauled in, ( ) being paid out, ( ) being brought to rest, ( ) clutch being let in.
31. Paid cable at time of misbehavior: ft. 4,500.
32. Paid cable at time of damage or of loss: ft. 4,500.
33. Just before damage, or loss, fins were (x) well filled, ( ) partly filled, ( ) flapping, ( ) nearly empty.
34. Just before damage, or loss, nose was ( ) definitely not cupping in, (x) cupping in slightly, ( ) cupping in badly.
35. Highest recorded tension in half hour before breakaway 1,600 pounds.
36. Tension increased ( ) gradually and progressively, (x) suddenly.
*37. Initial damage to balloon (x) in air clear of obstacles, ( ) fouled ground or obstacle, ( ) fouled another balloon or cable.

*38. If another balloon was fouled give distance between sites _____ yards.

39. Subsequent damage: ( ) in air clear of obstacles, ( ) fouled ground or obstacle, ( ) fouled another balloon or cable.

40. Was high building contributory cause? If so, building height _____ feet; distance to building _____ feet.

Remarks:

SECTION F —Balloon Grounded.

*41. Balloon damaged or lost at ( ) point of attachment, ( ) mooring-circle close-haul, ( ) tail-line mooring, ( ) on cradle bed.

*42. Balloon damaged or lost while ( ) changing between positions listed in question No. 41, ( ) turning, ( ) inflating, ( ) deflating, ( ) after ripping, ( ) transferring to or from ship or other floating site.

43. Remarks:

SECTION G —Particulars of Break-away.

44. Balloon damaged before break-away, (*x*) definitely not, ( ) suspected, ( ) definitely yes.

45. Cable ( ) fouled obstacle, ( ) parted where fouled, ( ) fouled electric line.

*46. (*x*) Sudden drop in cable angle just before break-away, ( ) large loop formed in cable.

47. Central anchorage or lead-off gear failed ( ).

48. Aircraft struck cable ( ) suspected, ( ) seem to have struck, ( ) aircraft brought down.

49. At time of break-away balloon was ( ) being paid out, (*x*) stationary, ( ) being brought to rest, ( ) clutch being let in, ( ) being hauled in.

50. Gear being used for hauling in ( ) 1st, ( ) 2nd, ( ) 3rd, ( ) 4th.

51. Gear being used for paying out ( ) reverse, ( ) freewheel.

52. At time of break-away, ( ) no appreciable jerk, ( ) slight jerk, (x) severe jerk, ( ) very severe jerk.

53. Obstacle (e.g., clamp, armament, cable terminal) hauled into lead-off gear_____ ( ).

54. Cable type ( ) 7x7 ( ) 7x19, (x) 1x6, ( ) VLA, M1, ( ) other.

55. Remarks:

SECTION H.—Further Particulars of Break-away.

56. Paid cable at moment of break: ft. 4,500.

57. Lowest point of breakage, ( ) in winch, ( ) at winch lead-off gear, ( ) between winch and central anchorage, ( ) at central anchorage, ( ) at gipsy head.

*58. Feet of paid cable from winch to break 4,500.

59. Broken end of cable had (x) no sign of kink, ( ) slight signs of kink, ( ) pronounced kink.

60. Number of weeks since swivel was last used *Not used*.

61. Number of cable reversals 612.

62. Remarks:

SECTION J.—Armament.

Lower lethal device.

63. ( ) Attached, (x) not attached, ( ) not recovered, ( ) recovered on cable, ( ) recovered detached from cable.

64. Loaded with safety clip removed, ( ) Yes, ( ) No, ( ) action not known, ( ) did not fire, ( ) fired and cut cable, ( ) fired but failed to cut cable.

65. If recovered and did not fire, was cartridge dented? ( ) Yes, ( ) No.
66. State color of spring (if painted) _____.
67. Days since last serviced _____.
68. Make of cartridge _____.
69. Flying time of cartridge, weeks _____.
70. Parachute ( ) not recovered, ( ) opened, ( ) did not open, ( ) strands twisted, ( ) other defect.
71. Distance of lower unit above ground _____ feet.

Remarks:

Upper letha' device.

72. ( ) Not fitted, (x) fitted.
73. ( ) Not recovered, (x) recovered on cable, ( ) recovered, detached from cable.
74. ( ) Switch on, ( ) action not known, ( ) did not fire, (x) fired and severed weak neck.
75. If recovered and did not fire, was cartridge dented? ( ) Yes, ( ) No.
76. State color of spring (if painted) _____.
77. Number of days since last serviced 7.
78. Make of cartridge FA 1942.
79. Flying time of cartridge 1 month.
80. Parachute ( ) not recovered, (x) opened, ( ) did not open, ( ) strands twisted, ( ) other defect.
81. Ripcord tied on ( ) above link, (x) below link, ( ) not attached.
82. Ripcord attached to concentration fitting by ( ) clip, (x) break-away cord; was run through shackle of concentration fitting, ( ) Yes, (x) No; was run through cable terminal ( ) Yes, (x) No.
*83. Any alternative or additional arming device attached. ( ) Yes, (x) No.

84. Remarks:

The DP/R link functioned normally when the balloon recovered from a dive and jerked the cable.

SECTION K.—Failure of Winch in any Way Contributed to Casualty.

85. Winch model ( ) A–9, ( ) Modified A–9, ( ) A–11, ( ) M–1, ( ) VLA, M–1, ( ) others.

*86. ( ) Winch dragged, ( ) dragged so that correct operation was difficult or impossible.

*87. ( ) Part of winch mechanism failed, ( ) engine failed to start, ( ) some other fault prevented normal operation of winch.

88. Serious over-run of storage drum ( ).

89. Winch brakes failed ( ).

90. Number of days since brakes were last adjusted ___.

91. ( ) Cable clamp failed, ( ) cable clip failed.

*92. Cable ran off traction drum, ( ) Yes, ( ) No.

93. When control was lost, ( ) was paying out, ( ) had been stopped for _____ minutes.

94. Speed of pay-out _____ ft./min.

95. Snatch brake was on when control was lost ( ).

96. Paid cable when control was lost, ft _____.

97. Remarks:

SECTION L.—Burned by Lightning or Otherwise.

*98. ( ) Balloon slightly burned while flying, ( ) completely burned while flying, ( ) balloon burned on ground, ( ) during inflation, ( ) during deflation.

99. ( ) Lightning seen or thunder heard, ( ) thunderstorm with several strokes.

100. Lightning predictor installed ( ) on site, ( ) within 3 miles, ( ) 3–6 miles, ( ) over 6 miles.

101. Warning received ( ) none, ( ) under 5 minutes, ( ) 5–10, ( ) over 10.

102. Remarks:

SECTION M.—Balloon Deflated for Porous Fabric.

103. If porosity proofed, balloon total flying days since proofing _____.

104. If proofed, balloon total flying days before proofing _____.

105. Leak Detector Readings ( ) positiv , ( ) negative, ( ) not made.

NOTE:—Append diagram or table giving panels, gores, or seams and where possible identify markings of fabric found porous.

106. Purity of H _____ %, or oxygen content _____ %, on date of last inflation; date _____.

107. Purity of H _____ %, or oxygen content _____ %, on date of last deflation; date _____.

108. Remarks:

SECTION N.—Wind Factors (to be Obtained from Barrage Control Room)

109. Wind at height balloon was flying at time of casualty was *48* mph.

110. Wind had been greater than 45 mph. ( ) under 1 hour, ( ) 1–3 hours, ( ) 3–6 hours, ( ) over 6 hours.

111. Direction of wind at balloon height was *WNW*.

112. Battalion weather forecast, Class (*x*) I, ( ) II, ( ) III.

113. Remarks:

Class III forecast for 1430.

SECTION O.—Short account of casualty with special reference to starred items and remarks.

It is believed that the sudden appearance of the front caused a shrinkage of gas volume and loss of lift. The turbulent wind seemed to push the nose down, causing the balloon to go into a dive. When the balloon recovered it jerked the cable, causing the DP/R link to function. No matériel deficiencies noted.

Investigating officer's signature *Oliver Smith*.

Rank *1st Lt., CAC* Date *15 Feb 1943*.

Organization *Btry A, 299th AA Bln. Bn.*

Distribution:

Commanding General, Antiaircraft Command, Main & Laurel Streets, Richmond, Virginia.
(One copy).

Appendix II

BALLOON SERVICE RECORD (BBB FORM NO. 8)

TYPE *D–8* MANUFACTURER *B. F. Goodrich Co.,*
SERIES _____ NO. *43–3001*.

SECTION 1.—Inspection certificate

I certify that Balloon No. *43–3001* has been air inspected and is accepted for service.

Contract No. *W–978 — Eng.*
Purchase Order No. *6741*
Inspection Report No. *101*

The gas valve cord has been set in accordance with Section *3* of constructional specification for *D–8* balloons. The outboard end of the gas valve webbing strop is *1* ft. *6* in. from the outboard end of the gas valve bu kle; this setting is for gas.

Date *1 Feb 1943.* Signed *John Jones, C. E. 1078*
(Signature and number of inspector)

At *Akron, Ohio.*

For Chief of Engineers.

Remarks (if any) *Cotton-rayon fabric.*

SECTION 2.—Alterations to valve cord

Date (1)	Unit (2)	Authority (3)	Details of alterations (4)
1 June	*300th Bn.*	*Eng. O. 300th Bn.*	*Shortened cord 6 inches.*

SECTION 3.—Modification log, manufacturer's or contractor's portion

SECTION 4.—Modification log, service portion

The following modifications have been completed.		Serial numbers of modifications (3)	Authority (4)	Date of completion (5)
Serial Nos. of modifications (1)	Signature of battery commander or responsible officer (2)			
		(Relocated handling patches)		
		None	*C. E. Memo 1*	*5 Mar 1943.*

SECTION 5.—Assignment log

Date of receipt (1)	Unit (2)	Date of transfer (3)	Unit to which transferred (4)	Signature of responsible officer (5)
20 Aug 1943.	*300th Bn.*	*15 Aug 1943.*	*Col. Depot*	*J. Jenkins, 2nd. Lt.*
30 Aug 1943.	*Col. Depot*	*25 Aug 1943.*	*340th Bn.*	*S. Smith, 1st. Lt.*

SECTION 6.—Particulars of final disposal

This log card has been closed because the balloon to which it relates has been:

a. ____ Lost.

b. X Damaged beyond repair but parts salvaged.

c. Other disposition _____.

d. Authority *C. E. Memo., 6 Jan 1943.*

Signed *S. Smith*
(Battery commander or responsible officer)

Rank *1st. Lt.,* Date *2 Oct 1943*.

Organization *340th AA Bln. Bn.*

Appendix III

BALLOON RECORD AND MAINTENANCE FORM (BBB FORM NO. 9)

Sheet No. 1 Bn. 300th Btry A Site No. 4.
Month June Year 1943 .
Balloon No. 43-3001 Type D-8 .
Total number of days inflated at beginning of this month 42 .

	Balloon Chief	Period	
		From	To
	Sgt. Oakes	20 May 43	

SECTION 1.—Daily log

Date (1)	Accumulated number of days inflated (2)	Gas consumption (cylinders) Initiation (3)	Gas consumption (cylinders) Topping-up (4)	Purity (5)	Maximum altitude flown (6)	Inspection Bln. Chief Daily (7)	Inspection Plm. Comdr. Weekly (8)	Hours flown today (9)	Total hours flown this month (10)	Remarks (11)
1										*Valve cord shortened 6 in.*
2	43	212	43	99.4	0	G.O.*	S. S.*	0	0	*Air inst., gas inflated.*
3	44				4000	G.O.		14	14	
4	45		2	99.0	5000	G.O.		20	34	
5	46				5000	G.O.		20	54	
6	47		3	99.0	5000	G.O.		20	74	*Repaired rudder air scoop.*
7	48				1000	G.O.		10	84	*High winds aloft.*
8	49		2	99.0	5000	G.O.	S. S.	21	95	
9	50			98.7	150	G.O.		10	105	*Training new crew members.*
10	51		3			G.O.			105	*Bln. grounded—winch repairs.*
11	52					G.O.	S. S.		105	*Bln. deflated—torn by high ground wind.—To be repaired and stored.*
12										
13										
14										
29										
30										
31										
Total	52	212	52							
	(a)		(b)							

Average daily consumption of gas for topping-up $\left\{ \frac{b}{a} = 1 \text{ Cyls} \right.$

*Initials.

This form is to be retained at the site. At the end of the month it is to be sent to Battery Headquarters.

SECTION 2.—Defects, damage, repairs, replacements and modifications

Date (1)	Organization (2)	Brief description of damage or defect (3)	Repairs and replacements (4)	Modifications (serial number) (5)	Performed by (6)	Inspected by (7)	Date of completion (8)
12 Jun 43	*300th Bn.*	*Torn by ground wind*	*Patched ballonet—replaced one air relief valve.*		*Btry. A. Riggers*	*G.O.**	*20 Jun 43*

It is certified that all entries are correct. Sgd. *J. Jenkins* Rank and Org. *1st. Lt., C. A. C., 340th AA Bln. Bn.* Date *30 Jun 1943.* When completed, this form is to be placed in the Balloon Service Record (BBB Form No. 8) Envelope, with all previous BBB Forms No. 9.

* Initials.

Appendix IV

BARRAGE BALLOON WINCH SERVICE RECORD (BBB FORM NO. 10)

Type *L. A.* Model *A-9* Serial No. *142* Manufacturer *Mar - Herrington*
Contract No. *A. C. 16432* Purchase Order No. *W-1423*

SECTION 1.—Inspection and test certificate

The above winch has been inspected and accepted for service.

Date *20 Jun 1941.* *B. Jones, 142.*
(Signature and number of Inspector For Chief of Engineers)

REMARKS (if any) *Experimental shock absorber added.*

SECTION 2.—Record of assignment

Date of receipt	Organization and Station	Authority for transfer	Signature of responsible officer	Date of transfer
2 Aug 1942.	300th AA Bln Bn	C.E.	I certify that all entries are correct. W. Smith, 1st. Lt.	2 Aug 1942.
	Camp Tyson, Tenn.			
29 Aug 1942.	A. A T.C.Camp Davis	C.E.	B. Banks, Capt.	15 Aug 1942.

SECTION 3.—Record of repairs, replacements, and modifications

Date completed	Brief Description	Classification (Code if any)	Cost, if accomplished by contractor	Authority
3 Sept 1942	Repaired friction drive			C.O. 300th Bn.
20 Dec 1942	Ground valves			C.O. 300th Bn.
1 Jan 1943	Cyl. block cracked		$25.00	C.O. 300th Bn.

(Paste on extra sheets when needed)

SECTION 4.—Cable reversals and renewals

Date (1)	Cable turned end for end (2)	Reversal of operation (3)	Renewal due to normal wear (4)	Feet of cable cut off (5)	Renewal due to other cause (describe briefly) (6)
20 Aug 42.				*150*	
2 Jan 43.	*W. M.**	*347*			
16 May 43.		*650*	*W. M.**		

* Initials.

SECTION 5.—Final disposition

This Winch Service Record is closed because the winch to which it relates has been—

a. _____ Destroyed.
b. __x__ Condemned.

Brief description of disposition *Hit by AA shell fragment during target practice. Damage too extensive to repair. Salvaged.*

Authority *C. G., A. A. T. C.*

Station *Camp Davis, N. C.*

B. Bond
Responsible Officer

Date *3 Dec 1942.*

Capt. CAC
Rank and Organization

Appendix V

BARRAGE BALLOON WINCH AND CABLE RECORD AND MAINTENANCE FORM (BBB FORM NO. 21)

Winch type *LA, A-9* No. *142*

Manufacturer *Mar-Herrington*

Aug. 1942 (1)	[illegible] (2)	[illegible] (3)	[illegible] (4)	[illegible] (5)	[illegible] (6)	[illegible] (7)	[illegible] (8)	[illegible] (9)	[illegible] (10)	[illegible] (11)
[1]										
1										
2	*10*	*10*	*6*	*A.O.*[a]	*6*		*2*	*2*	*S.O.*	
3		*10*			*6*		*4*	*6*	*S.O.*	*x*
4		*10*			*6*		*2*	*8*	*S.O.*	
5	*2*	*12*	*1*		*7*	*2*	*4*	*12*	*S.O.*	*x*
6										
7										
8										
9										
10										
11										
12										
13										
29										
30										
31										

[a] Initials.

[1] Accumulated totals carried forward from previous month.

[2] A reversal of operation is a complete ascent and descent except short operations due to bedding balloon.

[3] Check this column and enter remarks on back of sheet.

Gasoline consumed this month *16* gals. Oil consumed this month *3* qts.

Sgd. *Sgt. A. Oakes*
(Balloon Chief)

I certify that monthly entries as necessary have been made in Winch Service Record, BBB Form No. 10.

W. Wilson (Ditty commander or responsible officer) | *1st Lt.,* (Rank) | *300th Bn.* (Organization)

21 Aug 1942. (Date)

Date	REMARKS (Enter date. Describe briefly all repairs, inspections, adjustments, cleaning spark plugs, modifications, etc.)
3 Aug	*The spark plugs were fouled. Carbureter out of adjustment*
5 Aug	*Adjusted friction drive.*

Appendix VI

CONCRETE

1. QUANTITIES OF MATERIALS Table I shows the quantities of materials required to produce one cubic yard of concrete.

TABLE I—QUANTITIES OF MATERIALS REQUIRED TO PRODUCE ONE CUBIC YARD OF CONCRETE

Mix	Sand (cu. yd.)	Gravel (40 percent voids) (cu. yd.)	Sand (cu. yd.)	Stone (45 percent voids) (cu. yd.)	Bags of cement	
					Gravel	Stone
[1]1–1.42–2.9	0.41	0.83	....	....	7.7	....
1–2–3	0.50	0.74	0.52	0.77	6.7	7.0
1–2–3½	0.46	0.80	0.48	0.83	6.2	6.4
1–2–4	0.43	0.85	0.45	0.89	5.8	6.0
1–2½–4	0.49	0.79	0.51	0.81	5.3	5.6
[2]1–3–5	0.49	0.82	0.52	0.86	4.4	4.6

[1]Mix to be used to secure about 14-day strength of a 1–2–4 mix in 48 hours. Mix concrete two minutes or more and reduce water to an absolute minimum.

[2]Used in building anchorages for barrage balloons.

2. WATER-CEMENT RATIO Figure 36 shows the 28-day strength of concrete with various mixtures of water and cement.

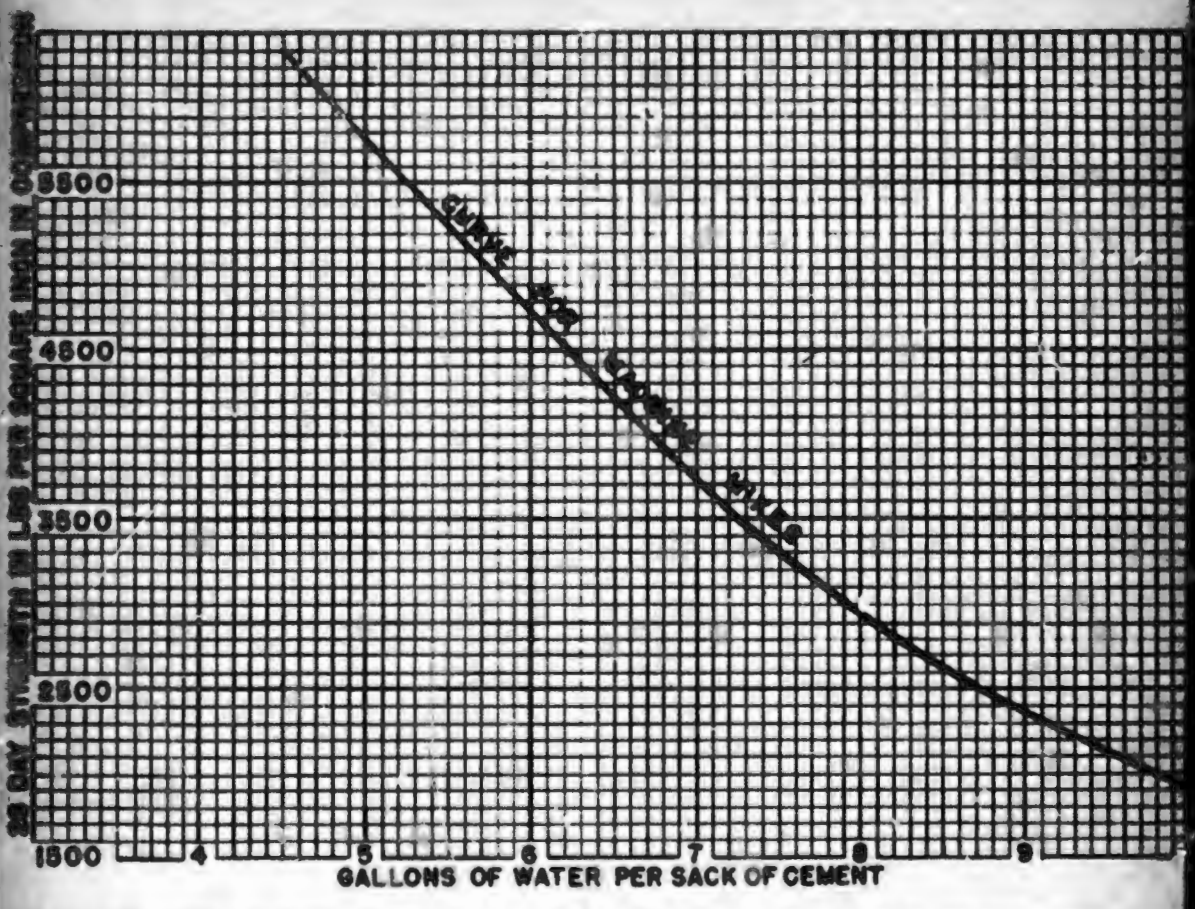

Figure 36. Water-cement ratio

3. AMOUNT OF WATER IN SAND AND GRAVEL

The amount of water that may be expected in one cubic foot of sand and gravel is listed below:

Very wet sand	¾ to 1 gal.
Moderately wet sand	½ gallon
Moist sand	¼ gallon
Moist gravel or stone	¼ gallon

4. RULES FOR MIXING, PLACING, AND CURING CONCRETE *a. Cement* Use a standard brand of portland cement; net weight 94 pounds per sack (1 cubic foot). Store in a dry, tight building.

b. Sand Use sand which is clean, sharp, and free of clay, salts, or foreign substances; and which is graded between No. 4 and No. 100 sieves, maximum passing No. 100 sieve, 8 percent.

c. Gravel Use gravel which is clean, sharp, and free of clay balls, salts, or foreign substances, and which is graded between No. 4 and 1½-inch sieves. Common fault is excess of fines or pea gravel (¼-inch gravel).

d. Stone Use stone which is free of an excess of stone dust, sticks, or foreign material, and which is graded between No. 4 and 1½-inch sieves.

e. Bulking of sand and gravel Damp, loose sand and gravel will occupy a greater volume than when dry and compact. If sand and gravel are damp and loose, increase sand proportion up to 20 percent, and gravel proportion up to 6 percent.

f. Water Use water which is clean and free of salts and vegetable matter. See figure 36 for amount to be used; an excess of water in the mix washes out the cement, makes large voids in the concrete, brings weakening fines to the top which will cause scaling, and weakens the concrete. An extra gallon of water per sack of cement will reduce the strength of the concrete as much as leaving out one sack of cement per cubic yard of concrete.

g. Mixing Machine mixing is preferable; machine mix for one minute. If mixing is done by hand, mix the materials dry, add water slowly, and continue to mix until aggregates are thoroughly coated with cement. Do not hand mix batches greater than 1 cubic yard.

h. Temperature If temperature is 35° F. or below, heat the aggregates and water to not more than 90° F. before mixing, and protect the concrete by heat or suitable covering after placing.

i. Placing Place continuously. Discard excess concrete; do not attempt to retemper it. Do not use concrete after initial set has taken place. Discard all frozen or foreign materials in the concrete. Be sure subgrade is damp, free of mud and not frozen.

j. Finishing Remove all rough edges. Do not trowel excessively. Do not use cement as a dryer. "Final finish" after water leaves surface.

k. Curing After set has taken place, cover with wet burlap, or a protective covering of sand, earth, paper, straw, or equivalent. Protect for curing period of at least 5 days and preferably 14 days.

Appendix VII

EXAMINATION FOR BALLOON OPERATORS

Section 1

GENERAL

1. PURPOSES OF EXAMINATIONS Examinations for balloon operators have the following purposes:

a. To serve as a basis for the instruction of antiaircraft balloon personnel in the operation and maintenance of barrage balloon matériel.

b. To determine the knowledge of antiaircraft balloon personnel concerning the operation and maintenance of barrage balloon matériel, and to furnish a basis for their classification as balloon operators.

c. To provide an incentive for barrage balloon troops to become proficient in barrage balloon work.

2. CLASSIFICATION OF BALLOON OPERATORS

a. Definition A *balloon operator* is any individual who has

passed one or more of the examinations set forth in this manual. The classification of *balloon operator* in antiaircraft balloon units will be comparable to the classification of *gunner* in other antiaircraft units.

b. Classes Balloon operators will be divided into three classes—second-class, first-class, and expert. The examinations for second-class and first-class balloon operator cover general phases of barrage balloon operations. Examinations for expert balloon operator cover specialized phases of barrage balloon operations.

c. Qualifying marks Qualifying marks will be not less than the following averages:

(1) Second-class balloon operator—75 percent.
(2) First-class balloon operator—85 percent.
(3) Expert balloon operator—90 percent.

3. ELIGIBILITY OF CANDIDATES Any individual of an antiaircraft balloon unit whose battery or detachment commander certifies that his character is at least "very good" is eligible to take the examination for second-class balloon operator, provided he has been properly instructed. A candidate for first-class balloon operator must have qualified previously as a second-class balloon operator, and a candidate for expert balloon operator must have qualified previously as first-class balloon operator. The lapse of time between qualifications is immaterial.

4. REQUALIFICATION *a.* An individual having qualified as expert or first-class balloon operator may elect to retain classification as such during the current enlistment without requalification, with the understanding that he may not draw nor be on the eligible list for additional compensation for more than 18 months from date of qualifying. In order to carry the

retained rating to a new enlistment, a qualified enlisted man must reenlist within 20 days from date of discharge in the unit from which discharged, such reenlistment being within 18 months of date of qualification.

b. An individual holding a rating as expert or first-class balloon operator is not required to requalify in a lower rating.

5. ADDITIONAL COMPENSATION Additional compensation will be paid only as set forth in Army Regulations.

6. BADGES Badges will be issued in accordance with Army Regulations.

7. INSTRUCTION OF CANDIDATES Training schedules will allot time for instruction of candidates, if practicable.

8. REFERENCES References will include pertinent Field and Technical Manuals, Training Films, and Film Strips.

Section 2

BOARDS OF EXAMINATION

9. RESPONSIBILITY FOR CONVENING BOARDS Boards of examination will be convened by commanders of separate antiaircraft balloon units or higher units. Individuals of antiaircraft balloon units who are not members of the command of the convening authority, and for whom provision for examination has not otherwise been made, will be examined upon application to the examining board. If found qualified, they will be designated balloon operators by the authority convening the board.

10. COMPOSITION OF BOARDS The examining board will consist, when practicable, of not less than three coast artillery (barrage balloon) officers. No officer will examine candidates from his own battery except in the case of boards convened by commanders of separate batteries.

11. LOCATION OF EXAMINATION As far as practicable, examinations will be held where the matériel pertaining to the subject is located.

12. CONDUCT OF EXAMINATIONS Credit will be given for practical knowledge of the subject rather than for memorized textbook answers. The examination must be sufficiently searching to eliminate the candidate who is not thoroughly prepared. The examination of a candidate will be discontinued when it is evident that

he cannot qualify even if he obtains a perfect score on all remaining questions.

13. RECORDS AND REPORTS Records will be kept and reports will be made in accordance with Army Regulations.

Section 3

SCOPE AND SCORING OF EXAMINATIONS

14. GENERAL The scope and scoring of the examinations for balloon operators are prescribed below.

15. SECOND-CLASS BALLOON OPERATOR The candidate will be examined on all of the following subjects:

	WEIGHT	
	LA balloon	VLA balloon
a. The balloon	85	85
(1) Nomenclature and functioning of parts.		
(2) Nomenclature and functioning of gas and air valves.		
b. The flying cable (or flying wire)	25	25
(1) Nomenclature and identification.		
(2) Maintenance.		
c. Inflation gas and equipment:	35	35
(1) Gas containers.		
(2) Inflation equipment.		
(3) Safety precautions in handling hydrogen on land and water.		
d. Site and site equipment	100	85
(1) Nomenclature and functioning of mooring and bedding-down equipment for land sites.		
(2) Nomenclature and functioning of equipment for emergency haul-down.		
e. Maneuvering and operating (duties of each crewman)	350	325
(1) Drills in maneuvering the balloon.		
(*a*) Inflating.		

	WEIGHT	
	LA balloons	VLA balloons
(b) Bedding-down.		
(c) Flying.		
(d) Turning.		
(e) Mooring.		
(f) Deflating.		
(2) Operations.		
(a) Prior to flying.		
(1) Unpacking.		
(2) Preparing for inflation.		
(3) Inflating.		
(4) Topping-up.		
(5) Preparing for adverse weather.		
(b) After flying.		
(1) Preparing for deflation.		
(2) Deflating.		
(3) Packing.		
f. Winch	85	75
(1) Nomenclature and functioning of main parts.		
(2) Practical operation under normal conditions.		
(a) Starting.		
(b) Paying out cable.		
(c) Flying the balloon.		
(d) Hauling in the balloon.		
(e) Operating during ground maneuvers. (Applicable only to LA balloons).		
g. Fabric, cordage, and mechanical maneuvering equipment	100	100
(1) Nomenclature of fabrics and simple repair of fabrics.		
(2) Cordage.		
(3) Elementary mechanical maneuvering equipment for land sites.		
h. Cable armament	70	100
(1) Nomenclature and functioning of parts.		
(2) Attaching and detaching.		
i. Communication	50	70
(1) Laying wire and making connections.		

	WEIGHT	
	LA balloon	VLA balloon
(2) Sending, receiving, and recording telephone messages.		
(3) Flags or panels (applicable primarily to VLA balloons).		
j. Motor transportation	40	40
(1) Nomenclature of major parts of motor vehicles.		
(2) Practical operation of motor vehicles, including driving and fueling.		
k. Small arms with which the balloon squad is equipped	60	60
(1) Nomenclature.		
(2) Action.		
(3) Maintenance.		
(4) Ammunition.		
(5) Targets.		
(6) Drill.		
Total	1000	1000

16. FIRST-CLASS BALLOON OPERATOR The candidate will be examined on all of the following subjects:

	WEIGHT	
	LA balloon	VLA balloon
a. The balloon	130	130
(1) Structural features.		
(2) Dimensions and capacities.		
(3) Inspecting, adjusting, and maintaining.		
(4) Servicing gas and air valves.		
b. The flying cable (or flying wire)	20	20
(1) Inspecting.		
(2) Attaching to winch and balloon.		
(3) Reversing the flying cable. (Applicable only to LA balloons.)		
c. Inflation gas and equipment	60	60
(1) Gas for inflation.		
(2) Rules of thumb for inflating and flying.		

	WEIGHT	
	LA balloon	VLA balloon
d. Site and site equipment	120	120
(1) Site layout.		
(2) Nomenclature and functioning of equipment for water-borne sites.		
(3) Inspecting, adjusting, and maintaining.		
(4) Demolition of material in event capture appears imminent.		
e. Maneuvering and operating (duties of the balloon chief)	180	180
(1) Organization of balloon squad.		
(2) Forming and telling off crew.		
(3) Individual duties of squad personnel.		
(4) Safety precautions in handling the balloon on land and water.		
f. Winch	50	50
(1) Emplacement.		
(2) Site maintenance.		
g. Cordage and mechanical maneuvering equipment	80	80
(1) Characteristics of wire rope.		
(2) Mechanical maneuvering equipment for water-borne sites.		
(3) Gaging, handling, maintaining, and storing fiber and metal rope.		
h. Cable armament	90	90
(1) Inspection and maintenance.		
(2) The parachute.		
(*a*) Nomenclature, construction, and functioning.		
(*b*) Repairing and packing (applicable only to LA balloons).		
(*c*) Inspecting and maintaining.		
i. Elementary definitions for barrage balloons	40	40
j. Map and photograph reading	40	40
(1) Elementary map reading.		
(2) Elementary photograph reading.		
k. Communication	80	80
(1) Field telephone and switchboard apparatus.		
(2) Testing for and remedying trouble in a field telephone system.		

	WEIGHT	
	LA balloon	VLA balloon
(3) Switchboard operation.		
(4) Installation and operation of battalion or higher unit telephone net.		
l. Motor transportation	80	80
(1) Duties of driver in the care, service, repair, and maintenance of motor vehicles (first-echelon maintenance).		
(2) Trouble-shooting and making minor repairs.		
(3) Operting vehicles *not* in convoy.		
(4) Operating vehicles in convoy.		
(5) Handling trucks under adverse conditions.		
m. Records and reports	30	30
(1) Types.		
(2) Where kept.		
(3) Procedure in keeping.		
(4) Responsibility for keeping.		
(5) Disposition of final forms.		
Total	1000	1000

17. EXPERT BALLOON OPERATOR The candidate will be given one of the examinations listed below. He will be examined on all subjects marked "Required." For any *one* of the nonrequired subjects in his examination he may substitute *one* of the alternate subjects listed in paragraph *f*. The candidate must indicate in advance of the examination the substitution he desires to make.

	WEIGHT	
	LA balloon	VLA balloon
a. AA—Bln. Gas Chief.		
(1) Elementary chemistry and physics of lighter-than-air gases, includir g sources. (Required)	100	100
(2) Generation of hydrogen in the field. (Required)	400	400
(*a*) Nomenclature of equipment and functioning of parts.		
(*b*) Maintenance of equipment.		
(*c*) Repair of equipment.		

	WEIGHT	
	LA balloon	VLA balloon
(*d*) Safety precautions.		
(3) Testing gas for purity. (Required).....	200	200
(4) Preparation of gas records and reports. (Required).....	200	200
(5) Ability to instruct concerning inflation gas....	100	100
Total.....	1000	1000
b. AA—Bln. Rigger.		
(1) Fabrics. (Required).....	150	150
(*a*) Principles of manufacture.		
(*b*) Cutting and using patterns.		
(*c*) Inspecting and storing.		
(2) Auxiliary materials used with barrage balloon fabrics. (Required).....	100	100
(*a*) Cements.		
(*b*) Cleaners.		
(*c*) Patches.		
(*d*) Miscellaneous.		
(3) Reading blue prints.....	100	100
(4) Use of hand tools (practical). (Required)....	100	100
(*a*) Fabric worker's tools.		
(*b*) Cordage worker's tools.		
(5) Constructing ground rigging. (Required)....	200	200
(6) Installing and adjusting internal and external balloon rigging.....	100	100
(7) Advanced cordage and mechanical maneuvering equipment. (Required).....	150	150
(*a*) Splicing wire rope.		
(*b*) Ability to construct and use mechanical maneuvering equipment.		
(8) Ability to instruct in rigging and fabric repair.	100	100
Total.....	1000	1000
c. AA—Bln. Weather.		
(1) Effects of weather on barrage balloons. (Required).....	150	
(2) Laws governing atmospheric phenomena.....	100	

	WEIGHT	
	LA balloon	VLA balloon
(3) Methods and instruments used in investigating atmospheric conditions. (Required).....	250	
(4) Weather station operation. (Required).....	400	
(5) Ability to instruct in meteorological subjects..	100	
Total.....	1000	

d. AA—Bln. Chief (low altitude).

(1) The balloon and the winch. (Required).....	150	
(*a*) Adjusting gas and air valves.		
(*b*) Installing and adjusting internal and external balloon rigging.		
(*c*) Detailed functioning and operation of winch.		
(2) Constructing ground rigging. (Required).....	200	
(3) Maneuvering and operating, including drill of a squad in all operations. (Required).....	400	
(*a*) Duties of platoon personnel.		
(*b*) Maneuvering in emergencies.		
(*c*) Transferring balloons over water.		
(4) Ability to instruct on all cable armament equipment. (Required).....	150	
(5) Ability to instruct concerning other balloon matériel.....	100	
Total.....	1000	

e. AA—Bln. Chief (very low altitude).

(1) The balloon and winch. (Required).....		100
(*a*) Major repairs.		
(*b*) Constructing and attaching special equipment for tandem flying.		
(2) Maneuvering and operating. (Required).....		200
(*a*) Siting of balloons.		
(*b*) Duties of platoon personnel.		
(*c*) Transferring balloons over water.		
(*d*) Packing equipment for transferring the barrage.		
(3) Flying wire or cable assembly. (Required)...		200
(*a*) Construction for singly flown balloon.		
(*b*) Construction for tandem-flying.		
(*c*) Construction for flying from moving objects.		

	WEIGHT	
	LA balloon	VLA balloon
(4) Armament. (Required).....		300
(a) Repair.		
(b) Explosives.		
(1) Characteristics:		
(2) Uses.		
(3) Storage.		
(4) Safety precautions:		
(5) Ability to instruct in all balloon matériel.....		100
(6) Practical weather.....		100
Total.....		1000
f. Alternate subject matter.		
(1) Winches.....	100	100
(a) Detailed nomenclature and functioning of parts.		
(b) Inspecting and making second-echelon repairs.		
(c) Ability to instruct concerning the winch.		
(2) Radio: the ability to install, operate, maintain, inspect, and repair the radio equipment used by the candidate's unit.....	100	100
(3) Teletype: the ability to operate, service, and make minor repairs.....	100	100
(4) Visual signaling: practical und rstanding of and ability to use lights, flags, or panels....	100	100
(5) Cable armament: practical knowledge of and ability to inspect, maintain, repair, and pack all cable armament equipment.....	100	100
(6) Wire rope: (practical) demonstrate ability to make various kinds of wire splices.....	100	100

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