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FM 4-108

WAR DEPARTMENT

COAST ARTILLERY
FIELD MANUAL

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BARRAGE BALLOON
SERVICE OF THE BALLOON
AND
BALLOON EQUIPMENT

March 18, 1942

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FIELD MANUAL



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SERVICE OF THE BALLOON
AND
BALLOON EQUIPMENT

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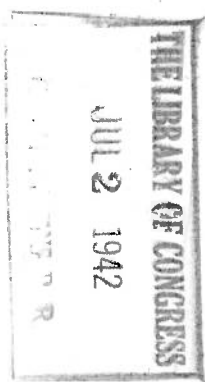


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CHAPTER 1

GENERAL

■ 1. SCOPE.—a. This manual prescribes the procedure to be employed by low-altitude balloon crews in the performance of their duties with the balloons and balloon equipment. This text has particular reference to the type A-9 winch and to balloons of the following types: D-5 (dilat-able), D-4 (ballonet), and D-6 (dilatable).

b. The matter contained in this manual is intended only as a guide in the assignment of individuals and duties. Changes may be made to meet variations in the matériel manned and the mechanical handling gear employed.

c. No other Field or Technical Manual dealing with barrage balloons has been previously published. This manual, therefore, contains more matter than is ordinarily included in a service of the piece Field Manual.

CHAPTER 2 BALLOON EQUIPMENT AND SITE

SECTION I. Nomenclature	Paragraphs 2
II. Balloon site	3-6

SECTION I NOMENCLATURE

■ 2. GENERAL.—The illustrations in this section are given to familiarize the user with the nomenclature of balloons and balloon equipment.

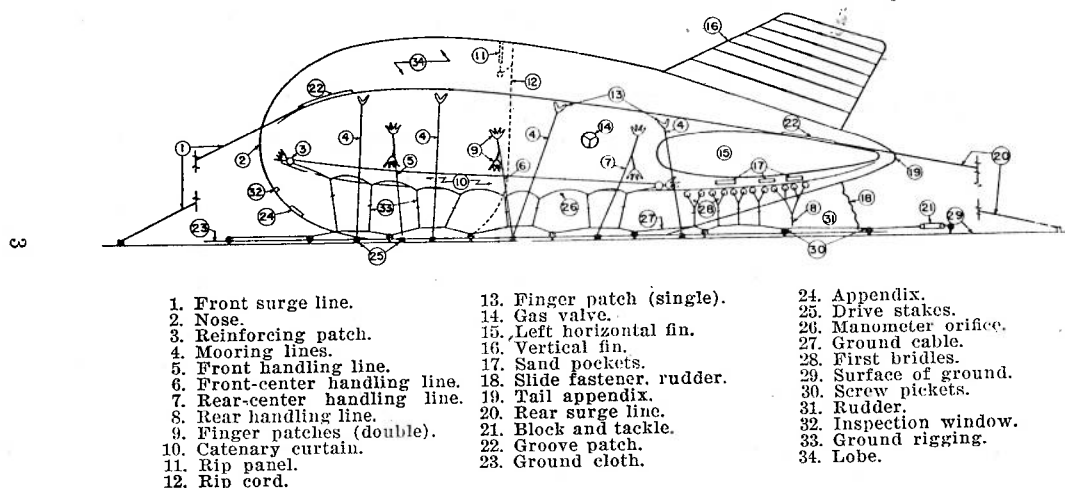
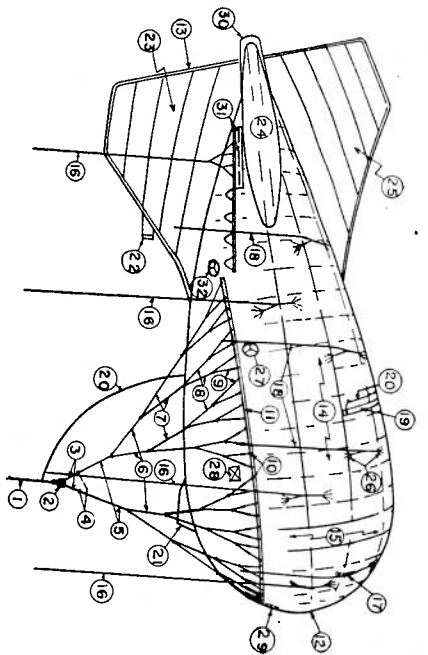
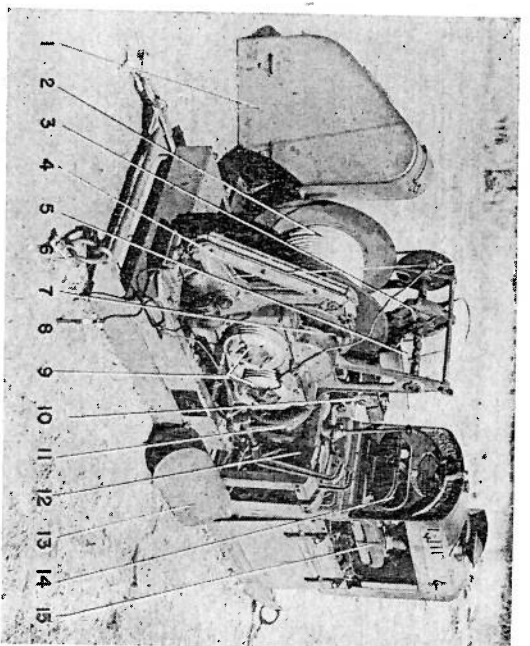


Figure 1.—Dilatable balloon, type D-5, bedded down.



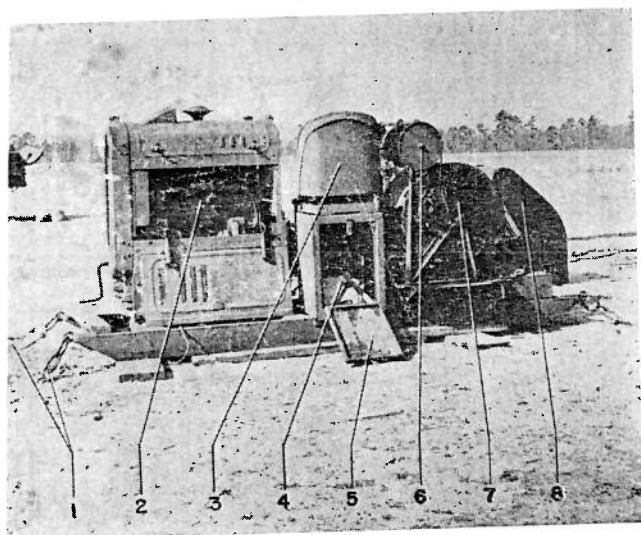
1. Balloon cable.
2. Junction assembly.
3. Strops.
4. Toggles.
5. Foot ropes.
6. Fourth bridles.
7. Third bridles.
8. Second bridles.
9. First bridles.
10. Batonette.
11. Rieging band.
12. Nose.
13. Slide fastener, rudder.
14. Gore (fabric).
15. Ring (fabric).
16. Handling lines.
17. Surge line.
18. Mooring lines.
19. Rip panel.
20. Rip cord.
21. Air scoop.
22. Rudder.
23. Right horizontal fin.
24. Vertical fin.
25. Finger patches.
26. Gas valve.
27. Air appendix.
28. Air appendix.
29. Tail appendix.
30. Sand pockets.
31. Air valve.
32. Air valve.

Figure 2.—Balloonet balloon, type D-4, in flight.



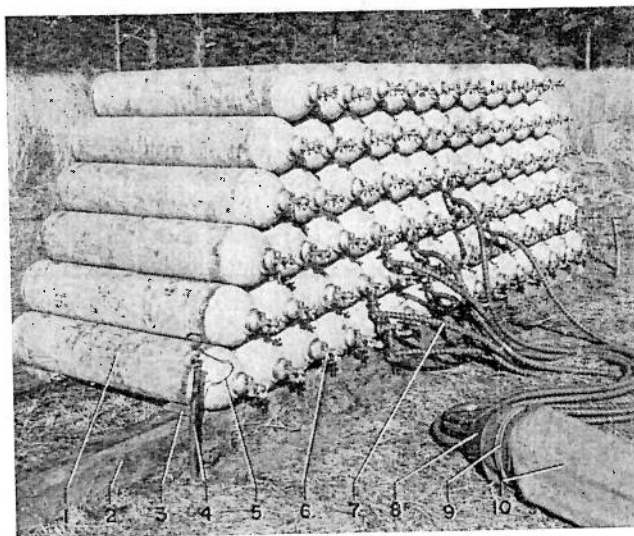
1. Winch assembly cover.
2. Storage drum.
3. Spooling device.
4. Lead-off gear.
5. Operator's seat.
6. Cables of deadman.
7. Friction drive.
8. Grounding wire and post.
9. Surge drums.
10. Snatch brake.
11. Foot brake.
12. Clutch and transmission assembly.
13. Surge drum cover.
14. Engine control.
15. Engine assembly.

Figure 3.—Winch, type A-9, right side.



1. Cables to deadman.
2. Engine assembly.
3. Operator's seat.
4. Tool compartment.
5. Tool compartment cover.
6. Spooling device.
7. Storage drum.
8. Winch assembly cover.

Figure 4.—Winch, type A-9, left side.



1. Cylinders.
2. Dunnage.
3. Chock.
4. Grounding rod.
5. Grounding wire.
6. Cylinder valve.
7. Manifold hose.
8. Manifold bell.
9. Tie-off cord.
10. Inflation tube or sleeve.

Figure 5.—Gas equipment.

SECTION II

BALLOON SITE

■ 3. LAY-OUT OF SITE.—*a.* A balloon site is the area that contains the ascension point, the balloon bed, the winch position, and maneuvering area. The general location of a site is designated by the battery commander or the barrage commander. The exact location of the site will be determined by the platoon commander, but the location selected should be close to the general area prescribed by higher authority.

b. It is desirable that a balloon site have an area at least 100 yards in diameter, and clear of all obstructions above the ground level which might damage the balloon. Within this larger area there is constructed a balloon bed, the dimensions of which will be determined by the type of bed to be constructed. The remaining area will be the maneuvering area. The ascension point will be located at the center of the cleared site. The bed may be located at any point on the site, but should be constructed so that the balloon may be maneuvered readily to the ascension point. For an outline of the lay-out of a site, see figure 7.

■ 4. BALLOON BED CONSTRUCTION.—*a. Direction of bed.*—If possible, all beds should be constructed so that the nose of the balloon will face into the prevailing winds, or will face not more than 45° from the prevailing wind direction.

b. Steps in construction.—The first step in balloon bed construction is to stake off an area of the size required, as determined by the type of bed to be built. An area 100 feet in radius around the center of the bed must be thoroughly cleared of all vegetation and trash, and all obstructions such as stumps, etc., must be removed if possible or cut to a depth of 6 inches below the ground surface. All types of beds must have a high center and must slope toward the outside for proper drainage. A 12- by 12-inch ditch must be dug around the bed, and the dirt removed from

1. Gas cylinders.
2. Inflation manifold.
3. Inflation tube.
4. Thimble.
5. Balloon.
6. Winch.
7. Blower.
8. Pickets.
9. Mooring lines.
10. Sandbags.
11. Valve.
12. Ground cloths.
13. Fins.
14. Tail appendix.
15. Fin appendixes.
16. Packing box and cover.
17. Ground cables.
18. Drainage ditch.

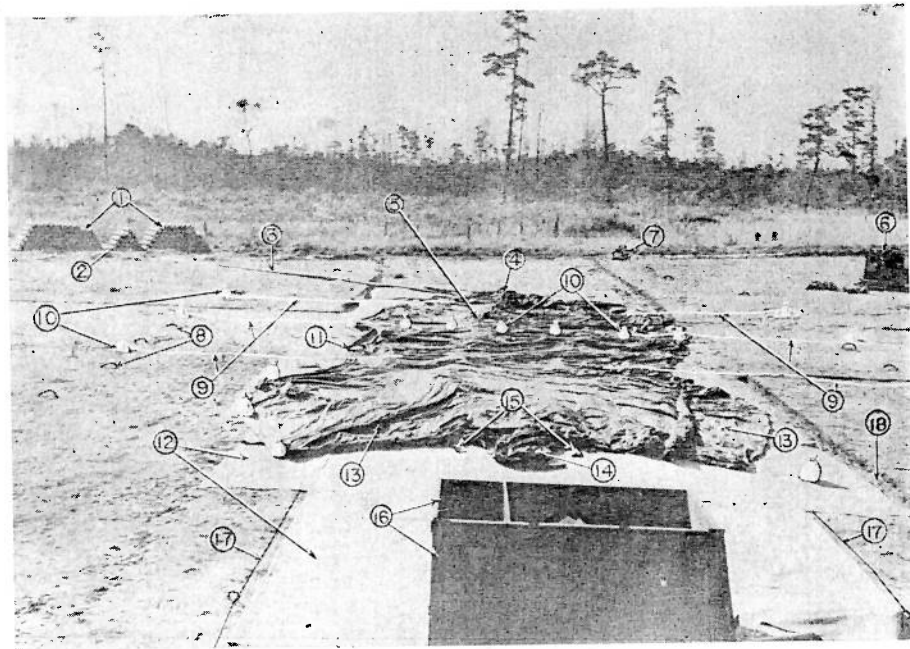


Figure 6.—Dilatable balloon ready for inflation.

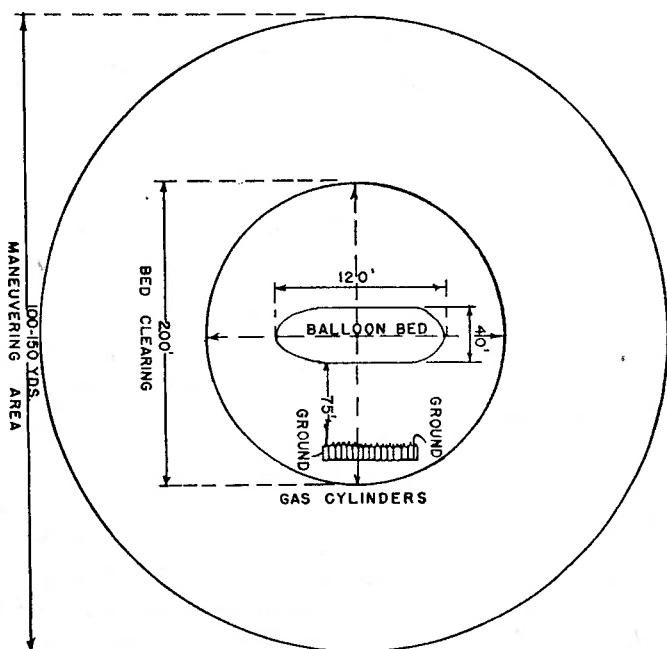


Figure 7.—Lay-out of balloon site.

this ditch may be used to build up the center of the bed. The center of the bed should be raked to a smooth surface free of foreign matter dangerous to the balloon fabric. The next step should be to place the screw pickets in the ground flush with the ground level in their proper locations. Then the ground cable should be run through the screw picket eyes, pulled taut, and fastened. The ground cloths should then be spread on the bed and swept clean of all dirt or abrasive materials, and the bed will be ready for use.

c. *Equipment required for construction.*—To prepare a balloon bed, sufficient quantities of all or part of the following equipment will be needed:

100-foot tape.	Matlocks.
Axes.	Picks.
Clamp, buffalo grip.	Rakes.
Crosscut saws.	Screw pickets.
Ground cable and cable clamps.	Scythes or machetes.
Ground cloths.	Shovels.
Ground rigging.	Stakes.
Grubbing hoes.	Tool kit.

If a number of beds are to be built in a short time, some power equipment may be needed, such as tractors, power graders, bulldozers, blasting equipment, power drag saws, etc.

■ 5. *Types of Beds.*—a. *One-way bed.*—This type of bed will allow the balloon to be bedded down in one direction. The lay-out of this bed is shown in figure 8.

b. *Two-way bed.*—The two-way bed is an extension of the one-way bed, and will allow the balloon to be bedded down in two directions, 180° apart. A two-way bed may meet the minimum requirements of wind direction with a minimum of material and labor. It has the disadvantage of not providing adequately for shifting wind directions. The lay-out of the two-way bed is shown in figure 8.

c. *Four-way bed.*—A bed of this type will allow the balloon to be bedded down in four different directions, and therefore will keep the balloon nose within at least 45° of the wind direction. For a lay-out of this type bed, see figure 8. The four-way bed also affords a convenient location for a central anchorage. (See par. e.)

d. *L-shaped bed.*—This type bed is simple to construct, and allows the balloon to be bedded down in four directions. With this type bed, the balloon can be bedded down so its nose is always within at least 45° of the wind direction. For the lay-out of this type bed see figure 9.

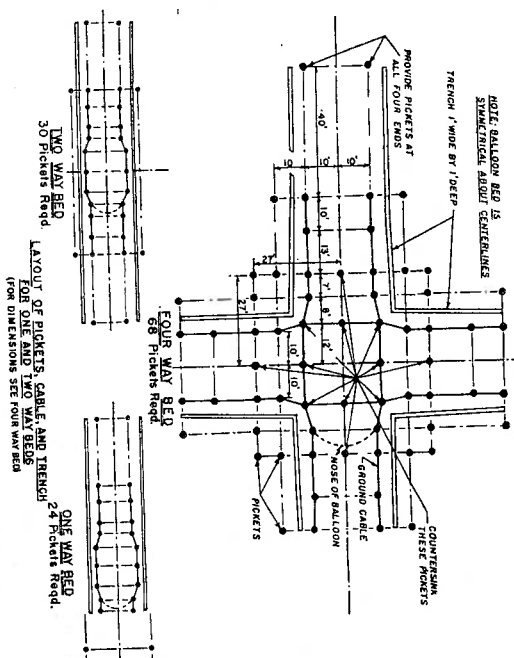


Figure 8.—Lay-out of one-way, two-way, and four-way beds.

e. Six-way bed.—This type of bed will allow the balloon to be bedded down in six different directions. It is especially suited for flying the balloon from the center of the bed by means of a snatch block arrangement, with the winch located some distance from the ascension point. The arrangement at the center of the bed which permits flying the balloon with the winch offset is referred to as a central anchorage. Lay-out of a six-way bed is shown in figure 10.

f. Precaution.—No one balloon bed picket arrangement will be satisfactory for all types of balloons. Therefore, when a balloon is initially inflated an examination of all handling and mooring lines should be made by the balloon chief to determine whether any of the lines are in contact with the balloon fabric when they are secured through the pickets. Such contact causes excessive chafing and dangerous fabric wear and should be remedied by moving the pickets, through which the lines contacting the balloon are secured, out from the center of the bed.

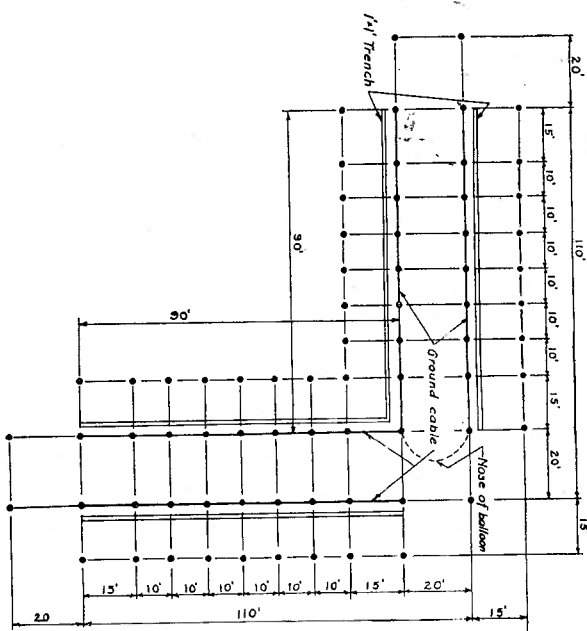


Figure 9.—Lay-out of L-shaped bed.

■ 6. *MOORING AND BEDDING DOWN EQUIPMENT.*—This equipment consists of ground cable, ground rigging, ground cloths, and sandbags as follows:

a. The ground cable is the cable that is run through the screw picket eyes, and to which the ground rigging is attached.

b. The ground rigging is composed of a number of short ropes fitted with snap hooks, adjusting blocks, and open end hooks, which are attached to the ground cable at intervals and are used to connect the balloon rigging band or catenary curtain to the ground cable in bedding down the balloon.

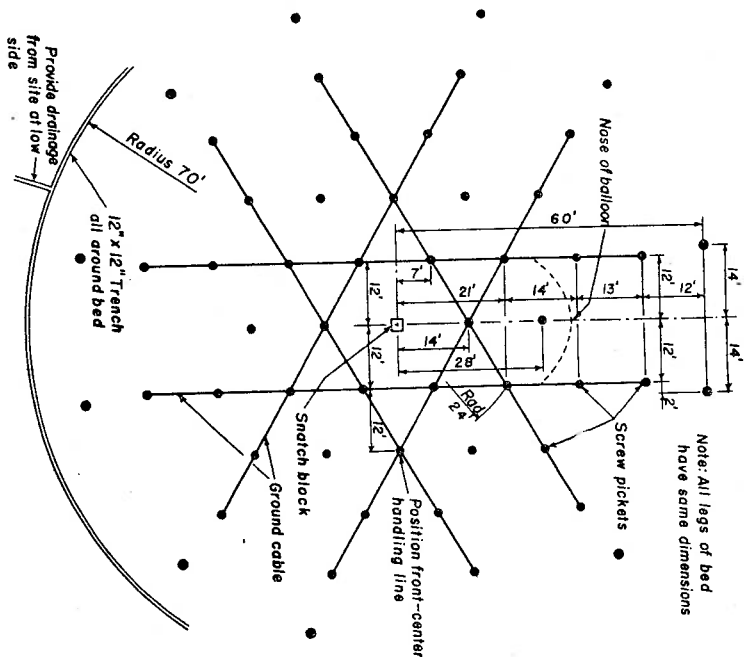


Figure 10.—Lay-out of six-way bed.

c. A ground cloth is a heavy canvas that is placed on the bed to protect the balloon fabric from damage through contact with the ground.

d. Sandbags are canvas bags for holding sand. They are filled with a known weight of sand, usually 33-1/3 pounds when dry, and are used as weights in bedding down or mooring balloons. They are also used to determine the weigh-off. All sandbags at a site should have the same weight.

CHAPTER 3

ORGANIZATION AND COMMAND DUTIES OF PERSONNEL

SECTION I.	Organization	Paragraphs
II.	Command duties of personnel	7-9 10-14

SECTION I

ORGANIZATION

■ 7. PLATOON.—The barrage balloon platoon is composed of a platoon headquarters and nine balloon squads for operating nine balloons. The platoon headquarters is organized for tactical functions and not for administration. The total personnel of the platoon is 118 men (plus 11 basic), which includes one first lieutenant and one second lieutenant.

■ 8. BALLOON SQUAD.—The balloon squad is composed of 12 men (plus 1 basic): a sergeant, who is the balloon chief; a gas worker; a winch operator; and 9 crewmen, including a corporal (assistant balloon chief) and a telephone operator.

■ 9. BALLOON CREW.—a. A balloon crew contains the men necessary to handle a balloon at the balloon site. It is the operating unit for inflating a balloon, placing and maintaining it in flight, bedding down, and deflating. When mechanical equipment for handling a balloon is provided, the balloon squad will constitute a balloon crew. No such mechanical handling equipment has as yet been adopted as standard.

b. Whenever balloons must be handled by manpower, it will be necessary for two balloon squads to combine to form a balloon crew to handle their balloons successively.

c. Under adverse weather conditions, such as strong winds, it may be necessary to add more crewmen to the

crew for handling the balloon. When unfavorable weather forecasts have been received, the platoon commander will decide in advance on the disposition of personnel to be made.

SECTION II

COMMAND DUTIES OF PERSONNEL

- 10. PLATOON COMMANDER.—*d.* The platoon commander, a first lieutenant, is responsible for the technical training and efficiency of the personnel assigned to the platoon.
- b.* He is responsible for the condition and technical handling of matériel assigned to the platoon.
- c.* He is responsible for the siting of the balloons in his platoon in compliance with the tactical plan prescribed by higher authority, and supervises the organization of the balloon sites.
- d.* He is responsible for the local defense of the balloon sites.
- e.* He is responsible for insuring that all safety precautions pertaining to the service of the balloon and balloon equipment are observed by the platoon.
- f.* He is responsible for the tactical handling of the platoon. Normally, the decision as to the times that balloons will be flown, and the number of balloons and altitude to be flown will be prescribed by higher authority. However, such decisions may sometimes become the responsibility of the platoon commander.
- g.* He specifies the platoon communication net that will be laid.
- h.* He is responsible for the adequate supply of inflation gas to the balloons in his platoon.
- i.* In the event that a balloon is lost or damaged, he will investigate the circumstances and forward a report to the battery commander.
- j.* He will report all hits, indicating whether they are disabling or nondisabling hits, and whether the hit involved a hostile or friendly aircraft. When a friendly aircraft is hit, he will further investigate the circumstances and make a report thereof to the battery commander.

- 11. PLATOON EXECUTIVE.—*a.* The platoon executive, a second lieutenant, is second in command to the platoon commander, and aids the platoon commander in carrying out his duties.
- b.* In the absence of the platoon commander, he takes command and performs such duties of the platoon commander as may be required.
- c.* He aids at all times in the planning and training of the platoon.
- 12. PLATOON CHIEF.—*a.* The platoon chief, a technical sergeant, assists the platoon commander and platoon executive in the execution of their duties. He, or a commissioned officer, is on duty at all times that the command is in ground readiness or any balloon is inflated or in flight.
- b.* He is particularly charged with supervising the preparation of flight and maintenance inspection records, barrage balloon logs, balloon and winch service records, and all other reports and records required to be made by the platoon headquarters or by subordinate units of the platoon.
- c.* He prepares the balloon manning table under the direction of the platoon commander, and insures that sufficient personnel is available at all times to man the balloons assigned to the platoon.
- d.* He insures that an adequate supply of inflation gas is delivered to the several balloon sites, and that the empty gas cylinders are returned promptly for refilling.
- e.* He keeps accurate records of the supply of gas on hand at the various balloon sites, and prepares reports of gas expenditures and of gas requirements.
- 13. PLATOON RIGGER.—*a.* The platoon rigger, a sergeant, is charged with the technical training and instruction of the personnel of the balloon squads in rigging and fabric maintenance and repair.
- b.* He is charged with technical inspection of fabric and rigging of all balloons operated by the platoon.

c. He makes minor repairs to rigging and fabric.

d. He makes frequent visits to balloon sites and makes technical inspections of the rigging. He is present during as many maneuvering operations as practical and renders technical assistance.

■ 14. BALLOON CHIEF.—a. The balloon chief, a sergeant, is in charge of one balloon site and the balloon squad assigned to him.

b. He supervises the preparation of the balloon site for occupancy.

c. He is responsible for the condition of the balloon, winch, and other equipment assigned to him, and for the operation of this equipment. He makes frequent inspections of the balloon, rigging, balloon bed, winch, ground rigging, sandbags, gas cylinders, air blower, inflation equipment, and all other property at his balloon site, and maintains all equipment in proper condition at all times.

d. He is responsible for the efficiency of the personnel of his squad.

e. He organizes the members of his squad into reliefs so that necessary personnel will be on duty at all times. He insures that a person qualified to operate the winch is on the alert at all times when the balloon is in flight or close-hauled, and that an armed guard is on duty at the balloon site at all times.

f. Whenever action is ordered, he causes its execution and reports to platoon headquarters.

g. He is responsible for the observance of all safety regulations.

h. He is responsible for the policing of the balloon site and for sanitary conditions at the site.

i. He commands the balloon squad in action against ground forces.

j. He commands, the balloon crew working at his site, whether the balloon crew consists of his balloon squad, or of his squad augmented by other personnel for handling the balloon by manpower.

CHAPTER 4

OPERATING AND MANEUVERING

SECTION	Paragraphs
I. Formation and duties of balloon crew	15-17
II. Preparing balloon for use	18-25
III. Maneuvering the balloon	26-36
IV. Winch operation	37-40
V. Deflation and packing	41-42

SECTION I

FORMATION AND DUTIES OF BALLOON CREW

■ 15. GENERAL.—Until mechanical equipment is provided which will enable one squad to handle a balloon, it will be necessary for two squads to combine to form a crew for handling their balloons successively. When two squads are thus combined, the balloon chief and winch operator of one squad will remain on duty at their site, while the other 10 men in the squad will go to the other site and combine with the balloon squad there to form a crew. A crew for handling the balloon by manpower will therefore be composed of 22 men: a balloon chief; 2 assistant balloon chiefs (corporals), who are called side chiefs when performing duties in a manhandling crew; a winch operator; and 18 crewmen.

■ 16. FORMATION FOR MANHANDLING.—The balloon crew is formed as shown in figure 11. To form the crew, the balloon chief takes his post 3 paces in front of where the crew is to form and commands: FALL IN. The crew forms in two ranks 15 paces from the nose of the balloon facing to the left of the balloon. The front rank is composed of the members of the squad at the site, and the rear rank is composed of the members of the squad from another site. Ranks are 40 inches apart, with 4 inches between files. No. 1 in each rank is the side chief, and the numbered men in the crew run through No. 9 in each rank. If additional men are to be added to the crew, they fall in to the left of

Nos. 9 and are also numbered. The winch operator, gas worker, and assistant gas worker form in two ranks 3 paces to the left of the numbered men. At the command COUNT OFF, the numbered men in both ranks count off simultaneously and consecutively from right to left, and the winch operator, gas worker, and assistant gas worker call off their titles.

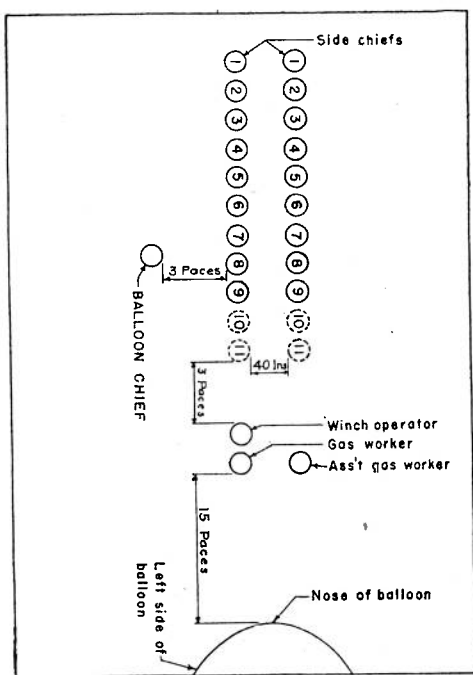


Figure 11.—Formation of balloon crew.

17. DUTIES OF INDIVIDUAL CREW MEMBERS.—*a. Balloon chief.*—The balloon chief is in command of the crew. For his duties, see paragraph 14.

b. Assistant balloon chiefs.—The assistant balloon chiefs fall in as Nos. 1 and during maneuvering are side chiefs. They are responsible for the execution of commands on their respective sides of the balloon and report to the balloon chief when commands have been executed. Whenever necessary, they may move men from their normal positions to wherever they are needed. During ground maneuvering the side chief nearest the rip cord carries the free end. The

side chief nearest the electric bonding is responsible for fastening and unfastening the electric bonding from a grounding post.

c. Nos. 2 and 4 operate the front handling lines.

d. Nos. 6 operate the front-center handling lines.

e. Nos. 8 operate the rear-center handling lines.

f. Nos. 9 operate the rear handling lines.

g. Nos. 3 and 5 operate front and center mooring lines. They remove or attach ground rigging and remove or attach sandbags to the bridges. They also assist in handling the balloon, especially at the nose.

h. Nos. 7 operate the rear mooring lines, remove or attach ground rigging, and add or remove sandbags from the junction assembly. They assist in attaching and detaching the cable from the junction assembly.

i. Winch operator.—The winch operator is responsible for the operation and care of the winch and cable. During maneuvering of the balloon, the site telephone is located at the winch and the winch operator answers telephone calls. The winch operator operates the blower during inflation of the balloon with air.

j. Gas workers.—The gas worker at a site is the gas worker for the manhandling crew operating at his site. The gas worker from another site will operate as the assistant gas worker. The gas worker reads the manometer and is responsible for keeping the proper pressure within the balloon. He attaches and detaches the cable from the junction assembly and attaches and detaches the rip cord, electric bonding, and lethal devices from the cable. Together with the assistant gas worker, he installs the gas and air valves and air scoops, and attaches and detaches the inflation manifold and inflation tube. The gas workers operate the gas cylinders during inflation. They are responsible for the proper furling and unfurling of the rudder, and for keeping the rudder off the ground during ground maneuvering.

SECTION II

PREPARING BALLOON FOR USE

■ 18. UNPACKING.—*a.* After the bed is prepared and the ground cloth laid out, swept clean, and dampened, the balloon box is brought to the site and unloaded on the downwind side of the bed at the edge of the ground cloth. The top of the box is removed, and the box is turned over on its side so that the open top of the box faces the bed. The balloon crew is formed, and the balloon chief commands: **RE-MOVE THE BALLOON FROM THE BOX.** At this command, members of the crew from opposite sides carefully grasp the fabric and lift the balloon out of the box. At intervals of a few feet, the remaining members of the crew grasp the fabric and the balloon is carried onto the bed. Care must be exercised in handling the balloon fabric during unpacking. It should not be pulled or jerked out of the box. Crew members should remove the balloon by lifting, and not by pulling.

b. At the command **LAY THE BALLOON ON THE BED**, the crew places the balloon on the bed.

c. At the command **SPREAD THE BALLOON**, the crew spreads the lobes, fins, and folded fabric, so that the balloon lies flat upon the bed.

d. At the command **UNWRAP RIGGING**, the crew removes all parceling from ropes and lines, and saves parceling for rewiring.

■ 19. AIR INFLATION.—*a.* Under normal conditions, balloons are air-inflated, inspected, and repaired by the service platoon of the barrage balloon command or separate battalion, and are delivered to the site ready for gas inflation. However unusual conditions may require that the balloon be air-inflated and inspected at the site.

b. After the balloon is unfolded on the bed and the parceling removed, the balloon chief commands: **PREPARE FOR AIR INFLATION.** At this command, Nos. 2, 4, 6, 8, and 9 extend the mooring and handling lines to the sides and attach sandbags to them. Nos. 3, 5, and 7, with shoes

removed, place sandbags or a rolled-up ground cloth across the balloon one-third of the balloon length back from the nose. The winch operator procures the air blower, inspects it, and gives it a test run. Gas workers procure and install gas and air valves, and attach the inflation tube to the appendix at the nose of the balloon and to the blower, using thimble and elastic tie-off cords. Side chiefs inspect the external rigging. (See par. 20.)

c. After preparations for air inflation are completed, the balloon chief commands: **REPORT.** Gas workers, winch operator, and side chiefs then report for their respective details as follows: "Valves and inflation tube in order," "Air blower in order," and "Envelope and rigging in order."

d. The balloon chief then commands: **INFLATE WITH AIR.** Nos. 3, 5, and 7 take positions on the envelope astern of the row of sandbags and the winch operator starts the blower engine, taking care that fumes from the engine exhaust are not sucked into the fan and blown into the balloon. Gas workers take posts at the appendix and insure the adjustment of the tubing and the security of the connection. The winch operator remains at the air blower. As the inflation proceeds, Nos. 3, 5, and 7 move the sandbags toward the rear as air fills the forward part of the envelope. Nos. 2, 4, 6, 8, and 9 under the direction of the side chiefs, adjust the handling and mooring lines on their respective sides of the balloon. Nos. 3, 5, and 7 attach sandbags to the catenary curtain grommets when directed by the balloon chief. When inflation has proceeded to a point where sandbags attached to lines are being dragged along the ground, the balloon chief directs Nos. 2, 4, 6, 8, and 9 to detach sandbags and tie the handling lines through the screw picket eyes.

e. Inflation will proceed until the entire balloon and fins are well filled. When the balloon has been filled with air, the balloon chief commands: **CEASE INFLATION.** The winch operator stops the air blower and disconnects the inflation tube. The gas workers disconnect the inflation tube from the appendix and close appendix unless otherwise instructed.

f. In the case of a ballonet balloon the gas chamber is inflated as described above, and after internal inspection, the gas workers attach the inflation tube to the ballonet appendix. The ballonet is then inflated with sufficient air to allow an inspector to enter and have ample room to maneuver under the diaphragm.

■ 20. *INSPECTION.—a. Initial external inspection.*—While the balloon is being air-inflated, the side chiefs will inspect all seams and finger patches on the outside of the balloon for signs of defective cementing. All of the rigging is also inspected to see that the balloon is properly rigged according to the manufacturer's specifications, or according to marks locating the positions of the knots on the rigging. All splices and servings are inspected for imperfections. Fabric will be inspected for signs of chafing by the rope rigging which may have occurred while packed.

b. *Initial internal inspection.*—This inspection is for the purpose of locating any holes or tears in the balloon envelope and fins, and is conducted by the platoon rigger if available, or by the side chiefs under the direction of the balloon chief. One or more inspectors will enter the balloon through the appendix with an inspection light. When the light is turned off, the inspector will be able to locate all holes in the fabric upon a thorough inspection of the interior. He will mark each hole by circling it with a red pencil or chalk. The entire envelope is inspected in this manner. The balloon may be turned over on its side for inspection of the bottom. The fins are inspected from the inside through an opening between the envelope and fins. Care must be exercised by the men in the balloon, so that the fabric will not be damaged. They must enter the balloon with their shoes removed, or wear shoes with soft rubber soles. All of the patches made as a result of the original inspection are made on the inside of the envelope.

c. *Inspection of ballonet diaphragm.*—One inspector will enter the gas chamber with an inspection light and another inspector will enter the air chamber. By prearranged plan, the inspectors will progress from one end of the diaphragm to the other. When a hole or tear is found, the inspector

under the diaphragm will hold his finger against the diaphragm at that point, while the other inspector will circle the spot with red pencil or chalk.

■ 21. *Air Deflation.*—After the inspection is completed and all necessary repairs made, the balloon chief commands: **DEFLATE THE BALLOON.**

a. If the balloon is to be deflated by manpower, the gas workers hold the appendix open while the crew members roll up the entire envelope tightly toward the nose, and release the lines from pickets as deflation proceeds.

b. If an exhaustor is used, the gas workers attach a metal tube between the appendix and the exhaustor. The winch operator controls the exhaustor. The balloon is deflated and lies spread upon the bed.

c. After complete deflation by either method, the gas workers tie the appendix off tightly to prevent air from seeping back into the balloon.

■ 22. *GAS INFLATION.—a.* After the balloon has been spread on the bed and the parceling removed, the balloon chief commands: **PREPARE FOR GAS INFLATION.** At this command Nos. 2, 4, 6, 8, and 9 extend the handling and mooring lines to the sides and attach sandbags to them. Nos. 3, 5, and 7, with shoes removed, place sandbags or a rolled-up ground cloth across the balloon one-third of the balloon length back from the nose. The gas workers procure and install the gas and the air valves. They then procure the inflation manifold and attach the manifold hose to gas cylinders. The rolled-up inflation tube is procured and attached to the inflation manifold. After this connection is made, the winch operator unrolls the inflation tube toward the balloon appendix. The gas workers attach the inflation tube to the appendix by means of a rubber-covered thimble and elastic tie-off cord. The assistant gas worker fastens the electric bonding to a grounding post. During these preparations, the side chiefs inspect all external rigging on their respective sides and make any necessary adjustments.

b. At the command INFLATE WITH GAS, the gas workers open the valves on the cylinders attached to the inflation manifold. As cylinders empty, the gas workers close the valves, mark the empty cylinders "MT" with chalk or crayon, and connect the inflation manifold hose successively to full cylinders until the computed number of cylinders of gas has been injected. As inflation progresses, Nos. 3, 5, and 7 take positions on the envelope astern of the row of sandbags and move the sandbags gradually toward the tail. Nos. 2, 4, 6, 8, and 9 adjust the handling and mooring lines on their respective sides of the balloon under the direction of the side chiefs. When inflation has proceeded to the point that sandbags attached to the lines are being dragged along the ground, the balloon chief directs Nos. 2, 4, 6, 8, and 9 to detach sandbags and tie the handling lines through pickets. At the direction of the balloon chief, Nos. 3, 5, and 7 attach sandbags to the catenary curtain grommets. When the computed number of cylinders has been injected, the balloon chief commands: CEASE INFLATION. At this command the gas workers close the valves on the cylinders attached to the inflation manifold, attach the manometer, and read the pressure. If the computed number of cylinders of gas is insufficient to give a minimum pressure, enough gas will be added to give a minimum reading of 1 inch of water pressure. The dilatible balloon will not be flown with less than 1 inch of water pressure.

c. All manometer readings will be taken with the bottom of the balloon free from the bed, since pressure against the bottom of the balloon when it is bedded down may cause an erroneous pressure reading. For accurate readings, the manometer must be held vertically and at the same height above the ground as the manometer orifice of the balloon. If it becomes necessary to read the manometer at a level below the level of the orifice, a correction equal to $\frac{1}{8}$ inch of water pressure for each 9 feet of difference in level must be added to the reading.

d. With a ballonet balloon, after the computed number of cylinders of gas has been injected, the gas workers at-

tach the inflation tube to the blower and to the ballonet appendix and the winch operator starts the blower. Air is added until the air valve allows air to escape. Gas workers attach and read the manometer on the gas chamber, which at this point should read the desired pressure of 1½ inches of water. Gas workers then remove the inflation tube from the air chamber and the gas worker inspects the diaphragm by inserting his head into the air appendix. Using a light, he determines whether the diaphragm is partially or completely extended. For proper operation, the diaphragm should be only partially extended. If fully extended, gas workers add gas to the gas chamber, thus expelling air from the ballonet compartment and releasing the fullness of the diaphragm. The manometer reading is checked for the desired minimum pressure of 1½ inches of water.

e. When the computed number of cylinders of gas has been injected, or enough additional cylinders have been injected to give minimum pressure, inflation ceases. With help of Nos. 7, the winch operator disconnects the inflation tube and securely ties off the appendix. The appendix is forced into the envelope and the slide fasteners closed and secured.

f. When the balloon is gas-inflated, the balloon chief commands: ATTACH AIR SCOOP. At this command the gas workers procure the air scoop and attach it to the rubber, and report: "Air scoop in order." For a ballonet balloon, the gas workers also install the rubber stiffener around the air scoop of the air ballonet.

■ 23. TRIM.—After the balloon has been gas-inflated, and the air scoop has been attached, the balloon chief commands: EASE OFF SLOWLY. At this command tension is removed from mooring and handling lines but the men hold fast to them. The balloon chief observes the action of the balloon, making sure that there are enough sandbags on the junction assembly to balance the lift of the balloon. The gas workers, assisted by Nos. 7 and the winch operator, hold the junction assembly steady a few feet off the ground. The balloon chief determines the angle of trim by measuring the distance from the hole in the D-ring of the

junction assembly to the ground and the distance from the lowest point of the rudder to the ground. By subtraction, he obtains the difference between these two distances. Using this figure, he refers to the manufacturer's chart and determines the angle of trim. He then directs the side chiefs to add or take off ballast pouches from the sand pockets to bring about the angle of trim prescribed.

■ 24. **WEIGH-OFF.**—a. When the balloon has the proper trim, the crew chief commands: TAKE OFF (NUMBER) SANDBAGS, or ADD (NUMBER) SANDBAGS. At this command the winch operator and gas workers take off or add the designated number of sandbags to the junction assembly. This process is repeated until the balloon is in equilibrium without tension on the handling lines, which are still manned by crew members. The balloon chief then counts and records the number of sandbags on the junction assembly. The total weight of the sandbags used will be equal to the net weight the balloon will lift. Any change in weight of the sandbags due to rain or other causes should be taken into account. The minimum cable tension desired is deducted from the total weight of the sandbags, and the net result will be the weight of the cable that the balloon will lift. This weight of cable in part determines the maximum altitude or ceiling that the balloon will attain. Weigh-off is normally accomplished during the early morning or late evening, and when there is no wind.

b. In case the result of the weigh-off shows insufficient lift, the balloon is bedded down and topped-up. The weigh-off procedure is then repeated to determine if sufficient lift has been obtained.

■ 25. **TOPPING-UP.**—a. When the gas pressure within a balloon falls below the minimum pressure prescribed for the balloon, sufficient gas must be added to raise the pressure to the desired level. This addition of gas is called topping-up. Topping-up may also be used to increase the purity of gas within a balloon, and to increase the lift of a balloon.

b. A manometer reading is necessary to determine whether the balloon needs to be topped-up due to low pressure. The manometer reading should be taken at the

same time daily and before the balloon acquires additional pressure due to superheat. The method for taking a manometer reading is described in paragraph 22c.

c. Topping-up is accomplished by injecting the required amount of gas into the balloon.

SECTION III

MANEUVERING THE BALLOON

■ 26. **GENERAL.**—a. Maneuvering is any operation incidental to removing from bed, weighing-off, ground handling, ascension, descension, and bedding down of an inflated balloon. A balloon is maneuvered at the commands of the balloon chief.

b. During all maneuvering, for the protection of personnel and matériel, the following precautions will be observed:

(1) The nose of the balloon must be kept pointed into the wind at all times, irrespective of the direction in which the balloon is being moved, except possibly during the final stages of bedding down. This is accomplished by allowing the tail of the balloon to swing with the wind.

(2) Even tension must be maintained on the lines at all times unless otherwise prescribed by the balloon chief. All lines should be given even, steady pulls, and should never be jerked.

(3) In handling lines, they should always be payed out hand under hand and hauled in hand over hand.

c. Whenever several men are holding the same line, the man nearest the end should be the last to release it. No man should release any line until ordered, unless he is holding it at the end and is being lifted off the ground by the balloon. Should the balloon break away from the crew, the rip cord should be pulled.

d. Unless otherwise specified, all balloon chief commands apply to both sides of the balloon. If action is desired on one side of the balloon only, it must be so specified. For example, the following commands would indicate action on one side only: FOUR SANDBAGS OFF RIGHT (LEFT) SIDE, OR

THREE SANDBAGS OFF RIGHT (LEFT) TAIL. The following commands would indicate action on both sides: REMOVE THREE SANDBAGS, OR RELEASE MOORING LINES.

■ 27. POSTING CREW.—The crew is formed as described in paragraph 16, and the balloon chief commands: 1. DETAILS, 2. POSTS. At this command, the front rank walks rapidly to the left side of the balloon, the rear rank walks to the right side of the balloon, the winch operator goes to the winch, and the gas workers go to the manometer. The crew members take posts as shown in figure 12.

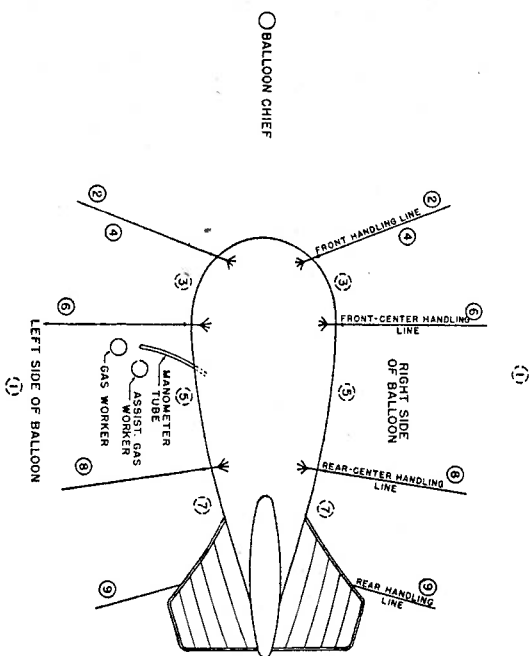


Figure 12.—Position of crew at details, posts.

■ 28. PREPARING FOR ASCENSION.—*d.* The balloon crew is formed and posted. The balloon chief then commands: PREPARE FOR ASCENSION. At this command, the side chiefs inspect the rigging of their respective sides. Before any lines are released, the side chief nearest the junction assembly insures that approximately 15 sandbags are at-

tached to the junction assembly grommets. If sufficient sandbags are not available, they should be transferred to the junction assembly as they are removed from the catenary curtain. The side chief nearest the electric bonding unfastens the electric bonding, and the side chief nearest the rip cord unfastens and carries the rip cord. The side chiefs report when their respective sides are in order. The winch operator starts the winch engine and reports when the winch is in order.

b. At the command RELEASE MOORING LINES, Nos. 3, 5, and 7 release the extensions from the mooring lines.

c. At the command RELEASE HANDLING LINES, Nos. 2, 4, 6, 8, and 9 remove the handling lines from the pickets and maintain tension on them. If necessary to hold the balloon, the balloon chief may command: MAN HANDLING LINES THROUGH PICKETS. At this command, the lines are reeved through the screw picket eyes.

d. At the command RELEASE GROUND RIGGING, Nos. 3, 5, and 7 release the ground rigging from the catenary curtain grommets.

e. At the command (NUMBER) SANDBAGS OFF, Nos. 3, 5, and 7 remove sandbags from the catenary curtain grommets as directed. Sandbags are ordinarily removed from tail to nose. If approximately 15 sandbags are not on the junction assembly grommets, the balloon chief will direct that sandbags be placed on the grommets as they are removed from the catenary curtain.

f. At the command EASE OFF, the men on the handling lines pay out the handling lines hand under hand.

g. When the belly of the balloon is just off the ground, the balloon chief commands: HOLD IT. At this command the men on the handling lines cease paying out and hold the balloon in place. The gas worker, assisted by the assistant gas worker, reads the manometer and reports the reading. After reporting the pressure reading, the gas worker and assistant gas worker go to the rudder.

h. After receiving the gas pressure reading from the gas worker, the balloon chief commands: EASE OFF. Men on

the handling lines pay out the lines hand under hand. Numbers 3, 5, and 7 work down the front bridges and down the foot ropes to the junction assembly. While the balloon is being eased off, the side chief nearest the junction assembly will insure that the sandbags on the junction assembly grommets remain in place.

i. When the junction assembly and attached sandbags are off the ground, the balloon chief commands: **HOLD IT.** At the command (NUMBER) **SANDBAGS ON (OFF) JUNCTION ASSEMBLY**, Nos. 7 will add or remove the specified number of sandbags from the junction assembly grommets. The balloon chief will direct the necessary number of sandbags placed on the junction assembly grommets to maintain the balloon in equilibrium above the ground. While the above is being accomplished, the gas worker and assistant gas worker unfurl the rudder, close the rudder slide fastener, and prepare the rudder for flight.

j. If the handling lines are reeved through the screw picket eyes, they are removed at the command **REMOVE HANDLING LINES FROM PICKETS**. The balloon is now ready to be trimmed and weighed off as described in paragraphs 23 and 24.

■ **29. GROUND MANEUVERING.**—To maneuver the balloon on the ground, the following commands are used:

a. **EASE OFF.**—The handling lines are paid out slowly, hand under hand.

b. **HOLD IT.**—The movement of the balloon is stopped.

c. **WALK THE BALLOON FORWARD (TO THE REAR) (RIGHT) (LEFT).**—The balloon is moved in the direction indicated.

d. **WALK THE NOSE (TAIL) TO THE RIGHT (LEFT).**—The indicated portion of the balloon is moved in the desired direction.

e. **NOSE RIGHT (LEFT), TAIL LEFT (RIGHT).**—The balloon is turned in a horizontal plane.

f. **CHECK IT, OR CHECK RIGHT (LEFT) (NOSE) (TAIL).**—The appropriate men hold their lines in place. This command is used when the balloon is drifting.

g. **TENSION ON THE LINES, OR TENSION ON THE RIGHT (LEFT).**—Slack in the lines is taken up steadily without jerking, as ordered.

h. **SLACK LINES, OR SLACK LINES ON THE RIGHT (LEFT).**—At this command the men walk toward the balloon allowing the lines to loosen.

i. **STEADY, OR STEADY ON THE RIGHT (LEFT).**—Men at all positions perform evenly.

j. **HAUL DOWN, OR HAUL DOWN ON THE RIGHT (LEFT) (NOSE) (TAIL).**—The handling lines are hauled in, hand over hand.

■ **30. ATTACHING CABLE TO JUNCTION ASSEMBLY.**—a. After the balloon has been maneuvered near the ascension point, the balloon chief commands: **EASE OFF.** At this command all men on handling lines ease off hand under hand to get the junction assembly in a convenient position to attach cable.

b. The balloon chief then commands: **HOLD IT, and ATTACH CABLE.** At the last command, the balloon chief and the gas worker, assisted by Nos. 7, attach cable to the junction assembly.

c. At the command **EASE OFF**, all men on handling lines ease off hand under hand until the balloon chief commands: **HOLD IT.**

d. When the cable becomes taut, the balloon chief commands: **HOLD IT, and SANDBAGS OFF.** At the last command the gas worker and Nos. 7 remove the sandbags from the junction assembly. At this time the balloon chief checks the foot ropes to insure that the lift of the balloon is evenly distributed. Without further command, the gas worker tapes the electric bonding to the cable below the junction assembly, fastens the rip cord to the cable below the electric bonding, and slides the metal safety disk in place on the cable. If a lethal device is attached to the cable near the junction assembly, this is put in place by the gas worker.

■ **31. FLYING THE BALLOON.**—When the balloon is ready to ascend and the winch is in order, the balloon chief com-

mands: **ONE MAN TO A HANDLING LINE**, and all men except the man nearest the end of each handling line release the lines and step back out of the way. The man nearest the end of each handling line moves to the end of the line. The balloon chief then commands: **FLY THE BALLOON AT (ALTITUDE)**. At this command, the winch operator simultaneously eases off the brake and engages the clutch, keeps the engine running at slow speed, and allows the balloon to ascend slowly. As the balloon rises, the men at the handling lines walk in toward the balloon until the ropes are pulled out of reach. If lethal devices are to be used, the ascent is stopped at appropriate altitudes and the gas worker attaches the devices at the appropriate locations on the cable. The gas worker also attaches and detaches a cloth cone, which is placed on the cable so that it will fly about 50 feet above the winch to assist in determining the location and angle of the cable. When the balloon is raised to the desired altitude, the winch is stopped and the gas worker attaches the grounding wire to the cable.

■ **32. Hauling Down.**—*a.* When the order to haul down the balloon is received, the balloon chief commands: **1. WINCH OPERATOR, 2. HAUL DOWN**. The gas worker unfastens the grounding wire from the cable. The engine on the winch is started, and the balloon is hauled down in first, second, or third gear, depending on the desired rate of descent. The gas worker detaches the lethal devices from the cable during descent. When the balloon comes within 200 feet of the ground, the descent is stopped to permit the motion of the balloon to become stabilized. After the motion becomes stabilized, the balloon is hauled down as rapidly as possible until the handling lines touch the ground.

b. When the balloon is within 200 feet of the ground, the balloon chief commands: **1. LANDING FORMATION, 2. FALL IN**. At this command, the men take their proper positions under the descending balloon so they will be ready to control it when the handling lines touch the ground.

c. When the handling lines touch the ground the crew members grasp the proper handling lines, and at the command **HAUL DOWN**, they haul down on the lines hand over hand. When the balloon is hauled down to where sandbags may be hung on the junction assembly, the balloon chief commands: **HOLD IT**, and then: **(NUMBER) SANDBAGS ON JUNCTION ASSEMBLY**. At this command, the gas worker and Nos. 7 place the designated number of sandbags on the junction assembly.

d. The balloon chief then commands: **DETACH CABLE**. At this command, the gas worker, assisted by Nos. 7, detaches the rip cord and hands the free end to the side chief on the rip cord side, unfastens the electric bonding, and detaches the cable.

■ **33. Bedding Down.**—*a.* After the cable is detached, the balloon is maneuvered with nose into wind to the edge of the ground cloth so that the sandbags on the junction assembly will come down on the side of the bed when the balloon is hauled down.

b. The necessary commands to haul the balloon down onto the bed are then given, such as **HAUL DOWN (SLOWLY)**, **HAUL DOWN ON THE RIGHT (LEFT) (NOSE) (TAIL)**. At these commands, the crew members haul down as directed. When the balloon is being hauled down, the nose should never be above the horizontal. As the rudder nears the ground, the gas workers hold it off the ground, deflate it, and furl it.

c. The next command given by the balloon chief is: **SANDBAGS ON THE NOSE (TAIL) (RIGHT) (LEFT) (ALL AROUND)**. At this command, the sandbags are placed as directed by Nos. 3, 5, and 7, starting at the nose. If necessary to hold the balloon, the balloon chief may command: **MAN HANDLING LINES THROUGH PICKETS**.

d. Before the bottom of the balloon is pulled down on the bed, the gas workers attach the manometer and tube and take the reading.

e. The balloon is then pulled down on the bed, and the ground rigging is fastened from nose to tail by Nos. 3, 5, and 7 at the command **FASTEN GROUND RIGGING**.

f. At the command **FASTEN MOORING AND HANDLING LINES**, Nos. 3, 5, and 7 connect the extensions to the mooring lines and securely fasten the lines through screw picket eyes, and Nos. 2, 4, 6, 8, and 9 fasten the handling lines through screw picket eyes. The side chiefs secure the rip cord to a picket and attach the electric bonding to a grounding post.

g. The side chiefs inspect all lines, knots, ground rigging, ground cable, pickets, the attached sandbags, rip cord, electric bonding ground, and fabric, and report, "Right (left) side in order." The winch operator covers the cable at the winch, covers the engine, and locks up the winch.

■ 34. **REMOVING BALLOON FROM BED DURING ADVERSE WIND CONDITIONS.**—To remove the balloon from the bed during adverse wind conditions, sandbags should be placed on the junction assembly as in the regular procedure. Sandbags are taken off the tail of the balloon, leaving sufficient sandbags on the balloon to equalize approximately three-fourths of the lift. Mooring and handling lines are then released, the ground rigging is unfastened, and the balloon is eased off until it is just clear of the bed. With all crewmen in their positions, the tail of the balloon is permitted to swing with the wind. The balloon is again hauled down with the nose into the wind and the remaining sandbags are removed and the rudder is unfurled. The balloon is then eased off in the regular manner.

■ 35. **BEDDING DOWN UNDER ADVERSE WIND CONDITIONS.**—When a cross wind is blowing, it is impossible to bed down the balloon with the nose into the wind. The following procedure should make the operation of bedding down less difficult:

a. The balloon is hauled down with the nose into the wind until the bottom of the balloon touches the ground cloth.

b. With the balloon in this position, sufficient sandbags are attached to the catenary curtain to equal approximately three-fourths of the lift of the balloon.

c. The balloon is then eased off the bed several feet and moved upwind until the tail has passed the center line of the bed.

d. While the tail is held in place, the nose is permitted to swing down wind until the balloon is parallel with, and several feet up wind from the center line of the bed. During this operation, it may be necessary to remove all sandbags from the junction assembly, or the drag of these sandbags might cause the balloon to be blown over on its side.

e. The balloon is then hauled down rapidly onto the bed. If the down-wind side of the balloon is hauled down slightly ahead of the up-wind side, a wedging effect may be secured which will prevent shifting of the balloon on the bed. When this difference is taken up on the up-wind side, a firm anchorage is provided.

f. The ground rigging should then be attached and sandbags added as rapidly as possible.

■ 36. **EMERGENCY HAULING DOWN.**—a. When the winch is out of order, a maneuvering spider (fig. 13) will be used to haul down the balloon. A maneuvering spider will also be used to haul down the balloon if the cable becomes entangled in surface obstructions.

b. The gas workers are responsible for obtaining the spider and snatch block and attaching it to the cable. Other members of the crew are detailed to obtain sandbags to attach to the grommets on the spider.

c. The crew is formed and at the command **MAN THE SPIDER**, posts, they will take positions at the arms of the spider, as shown in figure 13. Gas workers will hang a sufficient number of sandbags on the spider grommets to equalize the lift of the balloon.

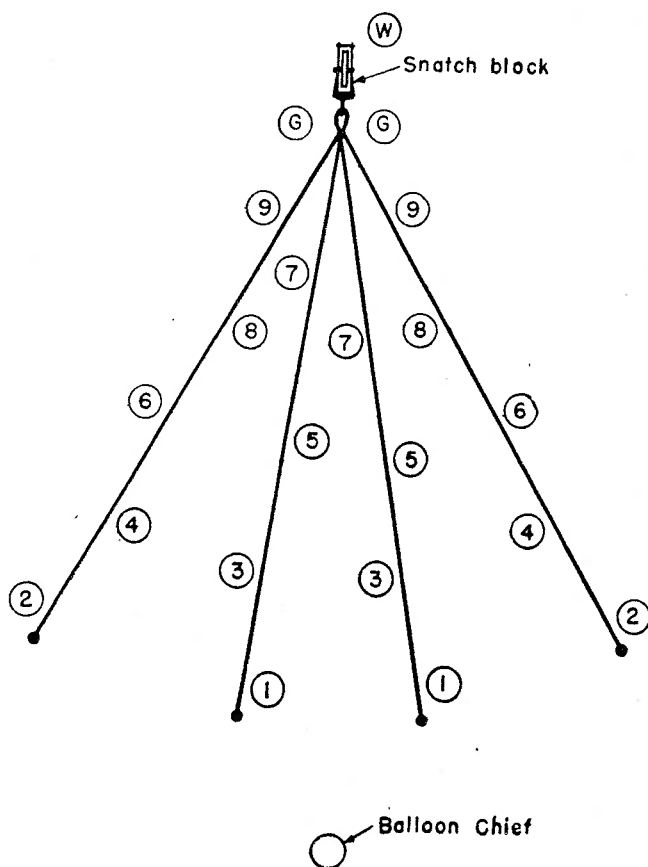


Figure 13.—Position of crew at MAN THE SPIDER, POSTS.

d. The commands for maneuvering the spider are WALK THE SPIDER FORWARD (TO THE REAR). At the command HOLD IT, the crew will hold the spider in its present position.

e. When the balloon has been lowered to a point where the handling lines are within reach, the crew members will

be transferred from the spider to the handling lines by the command: 1. BY THE NUMBERS, 2. MAN HANDLING LINES; 2, 4, 6, 8, 9, 3, 5, 1. At this command, the men designated will leave their posts at the spider and assume their posts at the handling lines as in DETAILS, POSTS.

f. At the command SANDBAGS ON JUNCTION ASSEMBLY, the gas workers and Nos. 7 will transfer the sandbags from the spider to the junction assembly of the balloon. The cable may then be detached from the junction assembly and the balloon may be walked to the bed.

SECTION IV

WINCH OPERATION

■ 37. PREPARATION AND INSPECTION.—a. The operator is responsible that the winch (and the snatch block, if a central anchorage is used) is properly anchored, and that steps are taken to ground the winch and snatch block. Inspection is made to see that all parts of the winch are properly lubricated and in good running order. The lead-off gear is inspected to make sure that the ignition system is not accidentally grounded.

b. The winch storage drum friction drive brake bands will be disassembled at least each third operating day. All grease, dirt, rust, or other foreign matter will be removed from the bands and the band grooves. Steel wool and dry cloths will be used for this purpose. Liquids will not be used on these parts, and they will not be lubricated.

c. Before putting a winch in operation, prior to each ascension, the following procedure will be followed:

(1) Start winch engine.

(2) Place transmission in reverse gear and release clutch, thus paying out cable. The free end of the cable will be walked away to a distance of about 30 feet so that constant tension is maintained on the cable from the lead-off gear outward.

(3) While the cable is being payed out, the winch operator will observe and determine whether the storage drum friction drive brake bands chatter and if there is slack in

the cable between the storage drum and the spooling device, indicating that the bands need tightening. If there is no slack between the storage drum and the spooling device, and a growling noise can be heard at the brake bands (due to excessive friction between the bands and the grooves), probably the bands need loosening. Another indication that the bands are too tight is a bending of the spooling device shaft during operation when the spooling idler arm is near its center position of travel.

(4) The winch operator will adjust the tension of the bands by turning the toggle (a spring-loaded turnbuckle). The brake bands are tightened by turning the toggle in a clockwise direction. Proper tension is indicated when the winch operator can just barely turn the storage drum with his hands. If the bands cannot be adjusted so the cable can be payed out and reeled in properly, the swivel connecting the free ends of the bands will be checked to determine if it is binding on its pivot.

(5) If at any time during ascent or descent the cable between the storage drum and the spooling device becomes slack, the balloon will be brought to a stop slowly by throttling down the engine in conjunction with gradual depression of the foot brake, and depression of the clutch. The winch operator will then adjust tension on the friction brake bands as indicated above.

■ 38. ASCENSION.—The winch operator raises the balloon on orders from the balloon chief. The engine is placed in reverse gear and the balloon is allowed to rise slowly. The operator watches the balloon and increases the speed of the engine until the desired rate of ascent is attained. The normal rate of ascent is about 600 feet per minute. The dilat-able balloon can be raised or lowered as rapidly as the winch will operate, but if the ballonet balloon is allowed to rise too rapidly it will valve gas. The winch operator watches the balloon at all times during ascent, and as the balloon approaches the desired altitude, he decreases the speed by throttling down the engine. When the desired altitude is reached, the balloon is stopped by disengaging the clutch and gradually applying the brake. After the ascent

is stopped, the snatch brake is set, the lock is applied on the foot brake pedal, and grounding clamp is attached to the cable.

■ 39. DURING FLIGHT.—The operator inspects the winch periodically to see that it is in operating condition. When the temperature is below freezing, the engine is operated at regular intervals so that it will be warm enough to start easily if needed for a quick haul-down. Tension on the cable is checked and recorded periodically. When the balloon cannot be seen, the cable angle is the only indication of the location of the balloon. The cable angle should be watched closely, and the balloon chief should be notified whenever it appears likely that the cable will become entangled in surface obstructions or adjacent balloon cables.

■ 40. HAULING DOWN.—The winch operator will not lower the balloon without orders, except in case of emergency. When orders to haul down the balloon are received, he starts the engine and lowers the balloon in first, second, or third gear depending upon the desired rate of descent. If the ballonet balloon is lowered too rapidly, the ballonet may not fill with air and the pressure may drop until the wind will cup in the nose of the balloon. If this happens, the balloon is likely to dive. If the balloon goes into a dive while being hauled down, the winch operator stops reeling in cable, puts the winch in reverse, and pays out cable as rapidly as it is possible to do so and still keep the cable taut. If the winch operator does not have time to shift into reverse gear before the balloon starts to regain altitude, he may depress the clutch pedal and allow the cable to pay out by free wheeling. When the balloon has righted itself and has taken all slack out of the cable, the ascent is stopped by gradually applying the foot brake. Experience has shown that when the balloon is within approximately 200 feet of the ground, the descent should be stopped to permit the motion of the balloon to become stabilized. The balloon should be hauled down the rest of the way as rapidly as possible in order to keep it from diving at low altitudes. When the handling lines touch the ground, the winch operator stops hauling down.

SECTION V

DEFLATION AND PACKING

■ 41. DEFLATION.—*a.* Whenever the purity of the hydrogen in the balloon falls below 85 percent, and it appears that the purity cannot be increased by topping-up, the balloon will be deflated. Other reasons for deflating include the necessity for making repairs to the balloon, and the necessity for moving the balloon to a new site. Helium-filled balloons are also deflated whenever the purity falls below such limit as may be prescribed.

b. To prepare for deflation, a balloon containing hydrogen will be bedded down. At the command of the balloon chief, the air scoop will be removed and packed. All usual safety precautions will be observed, and extra precautions taken against fire. Electric bonding will be grounded. All engines within 150 feet of the balloon will be stopped. In dry weather, the ground cloth and balloon fabric should be wet down.

c. At the command DEFLATE THE BALLOON, the gas worker pulls the rip cord and allows the gas to escape. The rip cord should be pulled steadily, without jerking, to prevent damage to fabric.

d. No other openings should be made in the balloon before or after the rip cord is pulled. More than one opening may result in air mixing with the hydrogen to form an explosive mixture.

e. After the gas has been permitted to escape, crew members start at the tail and roll up the balloon to the rip panel, and then start at the nose and roll back to the rip panel.

f. Helium-filled balloons are deflated by attaching the inflation tube to a nurse bag or to the compressor of the purification plant, and the crew members then force the gas out of the balloon, starting at the tail.

■ 42. PACKING.—After the balloon has been deflated and again unrolled upon the bed, the gas workers remove the valves and pack them, and the crew members wrap the rig-

ging in the parceling cloth. Under supervision of the balloon chief, the balloon is folded and placed in the packing case, beginning with the tail. When placing the balloon in the case, the balloon should be lifted and not dragged over the edge of the case, so the fabric will not be damaged. The metal parts are replaced in their original packings and securely fastened. The canvas and waterproof packings are folded over the balloon and the waterproof packing is cemented shut. The top of the case is screwed on tight.

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CHAPTER 5

ADDITIONAL INFORMATION ON SERVICE OF BALLOON

SECTION I. Rigging and fabric repairs II. Records and reports	Paragraphs 43-44 45-49
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SECTION I

RIGGING AND FABRIC REPAIRS

■ 43. **RIGGING REPAIRS.**—Repairs to rigging and fabric will be made under the supervision of the platoon rigger. Repairs to rigging by personnel at the site will be limited to the replacing of worn ropes, renewing of rope servings, and rope splicing.

■ 44. **FABRIC REPAIRS.**—Repairs to fabric by personnel at the site will be limited to the patching of small holes with repair fabric and cement. Large holes or tears may be patched with repair fabric and cement temporarily to prevent loss of gas until proper repairs can be made.

SECTION II

RECORDS AND REPORTS

■ 45. **OPERATION LOG.**—This log is a record of tactical operation at a balloon site for a 24-hour period. It includes messages received, the time each message was received, observations made at the site, actions taken, and the time each action was taken. This log is prepared in duplicate daily, and one copy is sent through the platoon to the battery for consolidation.

■ 46. **DAILY EQUIPMENT REPORT.**—This report is a technical report concerning the number and condition of winches, cables, balloons, and gas cylinders at each site. The report also lists repairs made to equipment and the number of

cylinders of gas used during a 24-hour period. It is prepared in duplicate daily, and the original is sent through the platoon to the battery for consolidation.

■ 47. **BALLOON FLIGHT AND MAINTENANCE CHART.**—This chart is 24 by 36 inches in size and is kept conveniently displayed at the site. It is a complete record of the technical details of repairs and maintenance of each balloon. The chart covers a 90-day period from the date the balloon is put into action.

■ 48. **BALLOON SERVICE RECORD.**—This is a book form of service record for each balloon, starting from the time the balloon leaves the factory, and embodying a complete record of the balloon wherever it may go.

■ 49. **WINCH SERVICE RECORD.**—This is a book form of service record for the winch, embodying the same features and used in the same way as the balloon service record.

CHAPTER 6

SAFETY PRECAUTIONS

	Paragraphs
SECTION I. Handling, transporting, and storing inflation gas	50-57
II. During inflation	58-60
III. During routine operation	61-69
IV. During deflation	70
V. Winch operation	71-75
VI. Break-away	76-77
VII. First aid	78

SECTION I

HANDLING, TRANSPORTING, AND STORING
INFLATION GAS

■ 50. GENERAL.—Due to the fact that the supply of helium is limited, hydrogen will normally be used for inflating barrage balloons. Hydrogen gas is colorless, odorless, and tasteless, and cannot be distinguished from air except when containing impurities which may give it a slight odor or color. Gas tests for impurities will ordinarily be made daily when hydrogen is used. Any volume of hydrogen containing more than 15 percent of air is dangerous, and when the purity of gas within a balloon falls below 85 percent, the balloon must be deflated. Safety rules and regulations prescribed for hydrogen will also be observed when helium is used in order that safety will become a matter of habit.

■ 51. FIRE.—*a. Prevention.*—A certain amount of impurities are present in the balloon at all times, and therefore the danger of fire or explosion may be present. The following fire preventive measures should be observed at the balloon bed, hydrogen gas generator, hydrogen cylinders, nurse bags, and storage tanks:

(1) No fire or other source of ignition must be permitted within a distance of 150 feet.

(2) A specific smoking area should be designated at a distance of at least 150 feet away.

(3) The sentry on duty will at all times enforce fire prevention regulations.

(4) Signs should be erected to denote the limits of the danger and smoking areas.

(5) All animals should be kept away from above listed installations as a precaution against static electricity.

b. Action in case of fire.—If a gas fire occurs and a balloon inflated with hydrogen explodes, burning particles of fabric will be spread over a large area. In case of fire at a balloon site or other installations listed above, the following action should be taken:

(1) The person who first observes the fire will call "Fire." Other persons in the vicinity will repeat the call until it is certain that all are aware of the fire.

(2) All gas cylinder valves will be closed immediately.

(3) If, in the judgment of the balloon chief, it is possible to extinguish the fire, he will order all available men to combat the blaze.

(4) If at any time, in the judgment of the balloon chief, personnel will be seriously endangered by remaining at the site, he will order all personnel out of the danger zone by the command ABANDON SITE. Other personnel will repeat the command until it is certain that all are aware of the order.

(5) When the site is ordered abandoned, everyone should place his hand over his nose and mouth if there is a possibility of breathing in flames, close or cover his eyes if this does not interfere with getting away, run at least 100 feet, fall forward, and crawl on his stomach until out of the danger zone.

■ 52. IDENTIFICATION OF CYLINDERS.—*a. Gas cylinders are identified as follows:*

(1) Army hydrogen cylinders are painted with a standard olive-drab paint, or are galvanized with the neckbands and caps painted olive drab. The word "hydrogen" is painted on the cylinder body.

(2) All Navy hydrogen cylinders are painted black with a white band around the middle.

(3) Commercial hydrogen cylinders are usually painted black.

(4) Oxygen cylinders are painted green.

(5) Compressed air cylinders are painted blue.

(6) Army helium cylinders are painted olive drab with a yellow neckband and cap, or are galvanized, with a yellow neckband and cap.

(7) Carbon dioxide cylinders are painted red.

b. In case the repainting of hydrogen, helium, or other gas cylinders is necessary in the field, the colors and markings listed above should be used.

c. All hydrogen and helium cylinders have left-hand threads.

■ 53. HANDLING OF CYLINDERS.—In the handling of gas cylinders the following rules should be observed:

a. Because of high pressure, cylinders must always be handled with care. They should never be dropped or subjected to heavy jars. This also applies to empty cylinders.

b. Cylinders must never be exposed to fire or heat. They should be protected from the direct rays of the sun by means of suitable covers. Otherwise, the increase in pressure due to heat may rupture the safety disk.

c. The valve protecting cap should be kept in place.

d. Two men should always handle gas cylinders. One man should handle each end of the cylinder, and they should avoid striking the cylinder caps and possibly causing a leakage of gas.

e. Cylinders should be stacked in groups of not more than 150 cylinders, and not more than 6 tiers high. Groups should not be less than 10 feet apart.

f. Wooden dunnage, upon which to stack cylinders, should be used. Each cylinder of the bottom row should be securely chocked.

g. Each stack of cylinders should be grounded at all times. This is done by grounding a copper wire which is

placed between the first and second tier of cylinders while the cylinders are being stacked.

h. As the cylinders are stacked, the valve outlets should be pointed downward with all the valves on the same side of the stack.

i. In order to properly connect the inflation manifold hose to the valves of the bottom tiers of cylinders, a trench 6 inches wide and 6 inches deep should be dug directly underneath the line of valves.

j. When preparing to discharge a cylinder, all connections and joints should be cleaned of dirt, grit, and foreign materials before making the connections. Care should be exercised to see that all joints are gastight.

k. When the gas is exhausted from a cylinder, it should be labeled at once by means of the letters "MT" marked with chalk or crayon.

l. The cylinder valve of an empty cylinder should be kept closed to prevent air from entering the cylinder.

m. The valve of a gas-filled cylinder will not be opened unless it is attached to a manifold hose or a pressure gage.

■ 54. DEFECTIVE VALVES.—Repairs to valves should not be made in the field. Tightening of the gland nut to prevent leakage is permissible. A valve which cannot be opened by hand or is suspected of being defective should be marked "defective" and the cylinder returned. A wrench should never be used to open a valve.

■ 55. DAMAGED CYLINDERS.—Any cylinders exposed to fire should be marked "defective" and returned. They must be retested before being used. Any cylinders dented by rough handling or suspected of being defective should be marked "defective" and returned, together with a full explanation. These cylinders must be retested before being used again. A damaged connection, valve outlet, or connection for the outlet should never be used. In testing for leaks, a mixture of soap and water should be used. An open flame should not be used to test for leaks.

■ 56. SHIPMENT OF CYLINDERS.—When cylinders are shipped by railway car, motor truck, or boat, they should be se-

curely chocked to prevent undue motion, and should be placed in well ventilated compartments. Hydrogen should not be shipped in closed boxcars.

■ 57. STORAGE OF CYLINDERS.—The cylinder and cap should be given a new coat of paint before being stored. The valve should be coated with cosmoline or slush, and the valve protecting cap threads should be well cleaned and oiled. Cylinders should be stored in a shed that has free ventilation. This prevents the accumulation of hydrogen in the event of a leaky valve. When an empty cylinder is to be stored for a period of 4 months or more, water collected in the cylinder should be removed. The cylinder should then be rinsed three times with dried hydrogen at 50 pounds pressure. To prevent rust inside the cylinder, it should be filled to 30 pounds pressure with hydrogen which has been dried by being passed through calcium chloride.

SECTION II

DURING INFLATION

■ 58. GENERAL.—*a.* All precautions to prevent igniting the hydrogen gas should be observed.

b. Neoprene causes skin irritation. In order to prevent irritations, all men working with neoprene balloons during inflation, deflation, or topping-up must be fully clothed.

■ 59. INSPECTION.—*a.* Before inflation, the area around the balloon bed should be thoroughly inspected and all sharp objects removed. The ground cloth should then be thoroughly cleaned, inspected, and wet down to prevent fire.

b. A balloon should never be gas-inflated unless all air is completely exhausted.

c. All connections in the inflation system from the gas cylinders to the balloon must be inspected for leaks before the inflation starts. Manifold hose and gas cylinder connections must be carefully protected when not in use.

■ 60. INFLATION.—*a.* The inflation tube should be rolled up to force out all air, attached to the manifold, rolled out flat, and attached to the balloon appendix.

b. When the inflation starts, each gas cylinder valve must be "cracked" (opened very slightly) before the full volume of gas is released. This prevents freezing of the valve.

c. A line of sandbags, a rolled-up ground cloth, or other weight must be placed across the balloon about one-third of the balloon length back from the nose. As the balloon fills with gas the sandbags are gradually moved from front to rear. The bags or weight must not be dragged over the balloon fabric, but must be picked up and set down where required.

d. While inflating the balloon, the men should walk on the fabric as little as possible. Those men walking on the fabric should be in their stocking feet or should wear soft rubber-soled shoes.

e. The balloon fabric must not be dragged or pulled.

f. While the balloon is being inflated, the inflation tube must not be allowed to become kinked or twisted. If there is a wind, the tube should be staked down.

g. When the inflation is completed, the appendix must be tied off before the inflation tube and thimble are removed.

h. A balloon should not be inflated in a wind of more than 20 miles per hour unless it is absolutely necessary.

i. Men working with the balloon should not wear or carry rings, sharp tools, or any metallic objects which might tear the balloon fabric.

j. Men working with the balloon must wear leather gloves or keep their fingernails closely trimmed.

k. If inflation takes place inside a building, ample ventilation is essential.

l. The electric bonding must be grounded during inflation.

SECTION III

DURING ROUTINE OPERATION

■ 61. CLOTHING WORN BY CREW.—Members of a balloon crew, gas-generating detail, and cylinder-handling or storage detail, should not wear woolen outer clothing. If

woolen clothing is worn, cotton coveralls should be worn as an outer garment. Caps or some other head covering should always be worn.

■ 62. USE OF SANDBAGS WHEN BALLOON IS BEDDED DOWN.—When the balloon is bedded down, sandbags hung on catenary curtain grommets or on the bridges should be equally distributed around the balloon.

■ 63. CHECKING CABLE TERMINAL ASSEMBLY.—Excessive and rapid deterioration of the cable may occur as the result of corrosion and chafing action between the steel cable and the bronze cable terminal assembly. In order to prevent failure of the cable at the cable terminal assembly, the following inspection procedure will be carried out:

a. Before each ascension, an inspection will be made of the cable terminal assembly and the cable adjacent thereto to discover any corrosion of the cable or the bronze bearing surfaces of the assembly, breaks in the wires, or chafed surface of the cable.

b. In case any of the above defects are noted on inspection, and after each 7 days of flying operations, approximately 22 inches of cable will be removed at the free end as follows:

(1) The U-bolt clamp at the cable terminal assembly and the U-bolt clamp on the free end of the cable will be loosened.

(2) The cable will be threaded through the opening of the cable terminal assembly until fresh cable only is in contact with the cable terminal assembly.

(3) The U-bolt clamp will be tightened on the cable terminal assembly and on the free end of the cable, and the excess cable will be cut off.

■ 64. CHECKING APPENDIX AND DEFLATION PORTS.—When the balloon is inflated, frequent inspection must be made to see that the appendix and deflation ports in the fins are properly fastened and that gas is not escaping.

■ 65. CHECKING VALVES.—Valve settings must not be changed without instructions from the platoon or battery

commander. Frequent inspections must be made to see that the valves are in order.

■ 66. RIGGING.—a. The rigging must be inspected regularly to insure that the ropes are in good condition and that they have not become kinked or twisted.

b. Ropes and fabric must be tested and inspected before shipment or storage.

c. Wire brushes should not be used to roughen fabric surfaces to be cemented, as static electricity may be generated and cause an explosion.

■ 67. HANDLING ROPE.—a. Members of the crew should not allow ropes or rigging to become entangled around their bodies, as severe burns or other injuries might result.

b. Ropes should be payed out hand under hand, and should not be allowed to slide through the hands, as burns might result.

c. When handling the cable or ropes, the men should wear gloves.

d. When placing in flight or hauling down a balloon, men should keep both feet on the ground and should not jump for ropes or allow themselves to be carried off the ground.

■ 68. ELECTRIC BONDING.—Because the balloon and crew may be endangered by static electricity, an inspection of the electric bonding must be made each time a balloon is brought down, as well as when it is first inflated. The balloon chief should personally see that the electric bonding from the balloon is attached to the cable before ascension, and that it is also grounded when the balloon is bedded down or being inflated. Electric bonding should be repaired with an electric soldering iron or with a soldering iron heated by a blowtorch. If a blowtorch is used, it must be kept at least 150 feet away from the balloon. The hot iron may be carried to the balloon bed.

■ 69. POSITION OF SQUAD DURING FLIGHT OF BALLOON.—While the balloon is flying, unless otherwise directed, members of the squad should remain on the windward side of the balloon to avoid being hit by possible falling cable.

SECTION IV DURING DEFLATION

■ 70. GENERAL.—When the purity of the gas within a balloon falls below 85 percent the balloon must be deflated. Except when rain is falling, deflation will take place between sunset and sunrise. Ground cloths and the surface of the envelope must be wet down before the deflation starts. When deflating a balloon, all equipment and all personnel not required for the deflation will be not less than 200 feet from the balloon bed. Deflation is accomplished by pulling the rip cord and allowing the gas to escape. More than one opening at a time in a balloon that is being deflated should not be permitted, as more than one opening may permit a surge of air through the balloon, and a dangerously explosive mixture of hydrogen and air may result.

SECTION V WINCH OPERATION

■ 71. ELECTRICAL PRECAUTIONS.—The winch and snatch block must be grounded at all times to prevent static electricity from building up a high enough potential (voltage) to cause damage to equipment or injury to personnel; and to provide a ground for lightning. The wire connected to the grounding device must be clamped to the balloon cable when the balloon is not being raised or lowered. Under all weather conditions, the following grounding precautions should be observed:

- a. The grounding rod or mat, wire, and connections should be in good order and in perfect metallic contact with each other.
- b. In concrete, asphalt, or similar material, a hole should be drilled through the hard surface and the rod should be driven into the earth and wet down.
- c. In rocky or stony soil, the grounding rod or mat should be placed on the ground and tamped with wet, loose soil.

The grounding rod or mat should be in wet contact with the ground until flying operations are completed.

- d. All connections should be frequently inspected.

- e. Members of the crew should stay away from the winch, except in line of duty.

■ 72. CLOSE APPROACH OF THUNDERSTORMS.—Because of the danger from lightning around the winch and cable, the following precautions should be observed when a thunderstorm approaches the balloon position:

- a. The winch operator should remain on the winch ready for immediate action. There is no danger to him as long as he is wholly on the winch and not in contact with the ground.

- b. No other member of the crew should approach closer than 50 feet to the winch or grounding wire, unless duty requires his presence there.

- c. If the cable has to be touched for any reason, the operator should stand completely on the winch chassis before touching the cable.

- d. The operator should jump on and off the winch to avoid coming in contact with the ground and winch at the same time.

- e. Under training conditions, balloons should be bedded down at once.

- f. When the balloon is hauled down, the crew should refrain from approaching the winch, or from touching the handling lines until these have touched the ground and discharged any static electricity.

■ 73. CRANKING ENGINE.—The hand should be placed under the crank handle with the thumb and fingers extended and joined, and the handle should then be grasped with the fingers. If the crank is grasped in this manner, there will be less danger of a broken arm if the engine "kicks."

■ 74. FREE WHEELING WINCH.—To avoid undue wear and tear on the foot brake, the cable should not be payed out by free wheeling except in emergency. When in free wheeling, the paying out of cable must be stopped by the foot

brake because the action of the snatch brake is too sudden and is liable to snap the cable or damage the balloon.

■ 75. PAYING OUT CABLE.—a. To keep the cable from jumping off the surge drums while the balloon is in flight, the surge drum guard, the surge drum cable guide, and the cable guide must be in place.

b. In order to prevent the loss of balloons through failure to stop the winch before the end of the cable is reached, one man is detailed to watch the cable paying out and to report when the last layer on the storage drum is in view. The first 200 feet of cable is painted red when reeved on the storage drum.

c. The snatch brake should never be applied while cable is being payed out. The snatch brake or foot brake lock should be applied only after the balloon has been brought to a stop.

d. The main winch cover may be removed in fair weather to familiarize personnel with the functioning of the winch and to enable the winch operator to observe the condition of cable slackness. Whenever the winch is operated with the cover removed, personnel will be cautioned as to the danger of coming in contact with the chain or sprockets which drive the spooling device. Under rainy or dusty conditions, the main cover will be kept in place to reduce formation of rust, grit, and grime on the moving parts.

SECTION VI

BREAK-AWAY

■ 76. WARNINGS.—Because break-away balloons constitute a danger to friendly aircraft, notice of a break-away balloon must be sent immediately to the barrage commander, who will cause the necessary warning to aircraft to be given.

■ 77. DANGER FROM ELECTRICITY.—Military and civilian personnel must be cautioned against touching a balloon cable found on the ground, as the cable may be resting across an electrical transmission line. In that event, as in other potentially dangerous situations, pending the re-

moval of the cable, guards should be posted to warn persons away.

SECTION VII

FIRST AID

■ 78. GENERAL.—a. The observance of safety precautions prescribed in this chapter should reduce to a minimum any serious injuries or fatalities. No injuries, however slight, should be permitted to go unattended. It is the duty and responsibility of every man, and of every unit commander to take the steps necessary to prevent loss of life, limb, or services. In all cases, first aid properly administered will reduce mental and physical suffering, and will place the patient in the medical officer's hands in a better condition to receive further treatment. Very often, the only action that is necessary is to prevent further injury to the patient by well-meaning but ignorant meddlers.

b. Complete first-aid information may be found in Chapter 10, FM 21-10. Copies of this Manual are available to personnel. While no specific reference is made in that Manual to treatment for rope burns and asphyxiation from hydrogen gas, the Manual does prescribe treatment for all types of burns, asphyxia, suffocation, and cessation of breathing.

CHAPTER 7
DRILL TABLES

Drill for gas inflation	Table No.
Drill for ascension, descension, and bedding down	I
	II

TABLE I.—*Drill for gas inflation*

Details	SPREAD THE BALLOON	PREPARE FOR GAS INFLATION	INFLATE WITH GAS	TRIM	WEIGH-OFF
Balloon chief	Gives command and supervises operation.	Gives command and supervises preparation.	Gives command and supervises inflation and adjustment of handling and mooring lines; orders removal of sandbags and manhandling of lines through pickets as inflation progresses; when sufficient cylinders are injected, commands: CEASE INFLATION.	Insures that balloon has proper pressure, orders inflation tube disconnected and appendix tied off; then commands: ATTACH AIR SCOOP, and after attachment, EASE OFF (NUMBER) SANDBAGS ON JUNCTION ASSEMBLY, HOLD IT. With help of side chiefs, measures distances of junction assembly and rudder from ground and adjusts ballast to proper trim.	Commands: TAKE OFF (NUMBER) SANDBAGS or ADD (NUMBER) SANDBAGS and EASE OFF until balloon is held in equilibrium by sandbags on junction assembly; then calculates net lift from number of sandbags on junction assembly.
Side chiefs (Nos. 1)	Repeat commands and supervise operation; also see that rigging is properly laid out.	Repeat command and supervise respective sides; inspect external rigging and fabric.	Supervise adjustment of handling and mooring lines on respective sides; supervise removal of sandbags and manhandling of lines through pickets as inflation progresses.	Supervise operations on respective sides; at command HOLD IT, assist balloon chief measure angle of trim and remove or add ballast to sand pockets as ordered.	Supervise their respective sides.

Winch operator	Assists crew in spreading balloon on bed.	Rolls out inflation tube from gas cylinders to balloon nose, and assists gas workers attach tube to balloon appendix.	Takes post at appendix of balloon and sees that inflation at this point progresses properly.	With help of Nos. 7, disconnects inflation tube at appendix and ties off appendix; assists gas workers replace gas equipment.	Takes post at junction assembly and assists in removing or adding sandbags.
Gas worker	Spreads fins and rudder on bed so that they lie flat.	Together with assistant gas worker, installs gas valve, attaches inflation tube to inflation manifold, attaches inflation manifold to cylinders, and attaches tube to balloon appendix by means of thimble and elastic tie-off cord. (See note 2a.)	At command, opens valves on cylinders attached to inflation manifold, and as cylinders empty, closes them, marks them "MT.," and substitutes full cylinders successively until the order CEASE INFLATION is given; then attaches manometer and takes reading to insure proper pressure. (See note 2b (1) and (2).)	Disconnects inflation manifold, procures air scoop, unfurls rudder and installs air scoop as directed; at command HOLD IT, he takes post with assistant gas worker at junction assembly to steady it during measurement of angle of trim.	Takes post at junction assembly to assist winch operator and assistant gas worker in steadying junction assembly and in adding or removing sandbags as ordered; also assists balloon chief with weigh-off calculations.
Assistant gas worker	Assists gas worker with fins and rudder.	Assists gas worker in all duties; fastens electric bonding to grounding post.	Assists gas worker in all duties. (See notes 2b (1) and (2).)	Assists gas worker; unfastens electric bonding from ground post; replaces gas equipment.	Assists winch operator and gas worker in steadying junction and assembly and in adding or removing sandbags as directed.

TABLE I.—Drill for gas inflation—Continued

Details	SPREAD THE BALLOON	PREPARE FOR GAS INFLATION	INFLATE WITH GAS	TRIM	WEIGH-OFF
Nos. 2 and 4	Spread balloon on bed so that fabric lies flat.	Extend front handling lines and adjacent mooring lines to the sides and attach sandbags to them.	As inflation progresses, detach sandbags from adjacent mooring lines; detach sandbags from front handling lines and man lines through screw pickets when directed.	Remove front handling lines from screw pickets and man them; at command EASE OFF, walk toward balloon with even tension on lines until command HOLD IT.	Ease off on front handling lines as directed to get balloon in equilibrium so weigh-off can be made.
Nos. 6	Spread balloon on bed so that fabric lies flat.	Extend front-center handling lines and adjacent mooring lines to the sides and attach sandbags to them.	As inflation progresses, detach sandbags from adjacent mooring lines; also detach sandbags from front-center handling lines and man lines through screw pickets when directed.	Remove front-center handling lines from screw pickets and man them; at command EASE OFF, walk toward balloon with even tension on lines until command HOLD IT.	Ease off on front-center handling lines as directed to get balloon in equilibrium so weigh-off can be made.
Nos. 8	Spread balloon on bed so that fabric lies flat.	Extend rear-center handling lines and adjacent mooring lines to the sides and attach sandbags to them.	As inflation progresses, detach sandbags from adjacent mooring lines; detach sandbags from rear-center handling lines and man lines through screw pickets when directed.	Remove rear-center handling lines from screw pickets and man them; at command EASE OFF, walk toward balloon with even tension on lines until command HOLD IT.	Ease off on rear-center handling lines as directed to get balloon in equilibrium so weigh-off can be made.

Nos. 9	Spread balloon on bed so that fabric lies flat.	Extend rear handling lines and adjacent mooring lines to the sides and attach sandbags to them.	As inflation progresses, detach sandbags from adjacent mooring lines; detach sandbags from rear handling lines and man lines through screw pickets when directed.	Remove rear handling lines from screw pickets and man them; at command EASE OFF, walk toward balloon with even tension on lines until command HOLD IT.	Ease off on rear handling lines as directed to get balloon in equilibrium so weigh-off can be made.
Nos. 3, 5, and 7	Spread balloon on bed so that fabric lies flat.	Place sandbags as directed across balloon one-third of the balloon length from nose.	Take positions on balloon envelope astern of sandbags and move them toward tail as inflation progresses; remove them when ordered; attach sandbags to first bridles at direction of balloon chief.	Nos. 3 and 5 take positions at front and front-center handling lines and assist there as directed. Nos. 7 assist winch operator at appendix; then place sandbags on junction assembly grommets when and as directed.	Nos. 3 and 5 assist on front and front-center handling lines as directed. Nos. 7 man front mooring lines and operate them as directed.

NOTES

1. After weigh-off is completed, balloon is either bedded down or maneuvered to ascension point and flown as described in table II.
2. If a ballonet balloon is being inflated, the following additional duties must be performed by the crew:
 - a. At the command PREPARE FOR GAS INFLATION, gas workers install the air valve in the ballonet.
 - b. After the command CEASE INFLATION, the following duties are performed:
 - (1) Winch operator procures blower, and starts blower when inflation tube is attached.
 - (2) Gas workers attach inflation tube to blower and to appendix of ballonet and inflate with air until diaphragm is properly extended.
 - (3) Manometer attached and pressure reading taken at this point instead of immediately after command CEASE INFLATION.

TABLE II.—Drill for ascension, descension, and bedding down

Details	Ascension				Descension		Bedding down	
	DETAILS, POSTS	PREPARE FOR ASCENSION	ATTACH CABLE	FLY THE BALLOON	(a) WINCH OPERATOR, HAUL DOWN (b) LANDING FORMATION, FALL IN	DETACH CABLE	HAUL DOWN	(a) FASTEN GROUND RIGGING (b) FASTEN MOORING AND HANDLING LINES
Balloon chief	Gives command; takes post facing nose of balloon so he can supervise operation of crew; receives reports from side chiefs.	Gives necessary commands such as RELEASE MOORING LINES, RELEASE HANDLING LINES, RELEASE GROUND RIGGING, SANDBAGS OFF, EASE OFF, HOLD IT (NUMBER), SANDBAGS ON (OFF) JUNCTION ASSEMBLY; directs maneuvering of balloon to ascension	Gives such commands as EASE OFF, and HOLD IT; assists gas worker and Nos. 7 attach cable to junction assembly; then orders: SANDBAGS OFF JUNCTION ASSEMBLY.	When both sides, junction assembly, and winch are in order, gives commands: ONE MAN TO HANDLING LINE, EASE OFF, FLY THE BALLOON AT (ALTITUDE).	(a) Gives command. (b) Gives command and receives reports from side chiefs that sides are in order.	Commands: HOLD IT, when he desires descent of balloon to stop; then, (NUMBER) SANDBAGS ON JUNCTION ASSEMBLY; then directs maneuvering of balloon to balloon bed.	Gives command and supervises operation, giving such commands as SANDBAGS ON BRIDLES (RIGHT), (LEFT), (ALL AROUND), etc.	(a) Gives command and supervises operation to insure that balloon is properly bedded down. (b) Same as (a).

Side chiefs (Nos. 1)	Take positions on respective sides where they can supervise duties of the men and are able to hear commands of balloon chief and repeat commands; they also inspect rigging on respective sides, directing any necessary adjustments.	Repeat commands of balloon chief and are responsible for execution; report. "Right (Left) side in order" when commands have been executed. One side chief unfastens electric bonding. Side chief on rip cord side unfastens rip cord and carries free end during ground maneuvers. One side chief checks junction assembly and sees that sandbags remain attached.	Supervise respective sides and repeat commands. Side chief with rip cord hands free end of rip cord to gas worker so it can be fastened to cable.	Supervise respective sides and report when in order.	(a) No duties. (b) Supervise position crew has taken on respective sides and report "Right (Left) side in order" when men are in positions.	Supervise respective sides. Side chief on respective side takes free end of rip cord from gas worker and carries it during ground maneuvers.	Repeat all commands of balloon chief. Supervise and give assistance where needed on respective sides.	(a) Repeat all commands. Supervise respective sides and see that balloon is properly bedded down. (b) Check and inspect rigging and fasten electric bonding and rip cord.
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TABLE II.—Drill for ascension, descension, and bedding down—Continued

	Ascension				Descension		Bedding down	
	DETAILS, POSTS	PREPARE FOR ASCENSION	ATTACH CABLE	FLY THE BALLOON	(a) WINCH OPERATOR, HAUL DOWN (b) LANDING FORMATION, FALL IN	DETACH CABLE	HAUL DOWN	(a) FASTEN GROUND RIGGING (b) FASTEN MOORING AND HANDLING LINES
66 Winch operator	Takes post at winch by most direct route; checks winch and prepares it for use.	Starts winch engine and reports, "Winch in order"; also acts as telephone operator.	At the command HOLD ON, he has engine running and puts transmission in reverse gear with clutch out and brake on.	Eases off brake and engages clutch simultaneously to pay out cable and allow balloon to ascend.	(a) Starts engine; hauls down balloon. (b) Continues hauling down until handling lines touch the ground.	Stops hauling down at command HOLD ON. Stops winch engine after cable is detached. Assists crew in ground maneuvering as directed.	Assists Nos. 7 in keeping rigging out from under balloon as it is being hauled down.	(a) Covers cable at winch. (b) Same as (a).
Gas worker	Takes post at manometer.	Reads manometer when belly of balloon is off bed; reports pressure read-	Together with balloon chief and Nos. 7, attaches cable to junction assembly;	When balloon reaches height at which it is to fly, fastens grounding wire to cable.	(a) Unfastens grounding wire from cable. (b) Takes position so as to	Unfastens rip cord from cable and hands free end to side chief. Un-	With assistant gas worker detaches rudder and keeps rudder clear of	(a) Attaches tube and manometer and takes gas pressure reading. Furls
67		ing; detaches and replaces manometer and tube; with assistant gas worker unfurls rudder, closes slide fastener of rudder, and reports, "Rudder in order"; keeps rudder clear of ground.	fastens electric bonding and rip cord to cable below junction assembly; attaches lethal device used; slides safety disk to position.		be at junction assembly when balloon is hauled down. NOTE: When lethal devices are used, they are removed as necessary.	fastens electric bonding from cable, and with Nos. 7 detaches cable from junction assembly.	der clear of ground.	rudder with help of assistant gas worker. (b) Assists crew where directed.
	Assistant gas worker	Takes post at manometer.	Assists gas worker in reading manometer, and with rudder.	Keeps rudder clear of ground.	No duties.	(a) Cranks engine for winch operator. (b) Takes position so as to be at rudder when balloon is hauled down.	Keeps rudder clear of ground.	Assists gas worker with rudder.
	Nos. 2 and 4	Take post at front handling lines.	Operate front handling lines as directed, by first releasing lines and then easing off as commands are given.	Operate front handling lines as directed.	Release front handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension to man front handling lines.	Operate front handling lines as directed.	Haul in on front handling lines as directed.
								(a) Operate front handling lines as directed. (b) Fasten front handling lines to screw pickets.

TABLE II.—Drill for ascension, descension, and bedding down—Continued

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	Ascension			Descension		Bedding down
	DETAILS, POSTS	PREPARE FOR ASCENSION	ATTACH CABLE	FLY THE BALLOON	(a) WINCH OPERATOR, HAUL DOWN (b) LANDING FORMATION, FALL IN	(a) FASTEN GROUND RIGGING (b) FASTEN MOORING AND HANDLING LINES
Nos. 6	Take posts at front-center handling lines.	Operate front-center handling lines as directed, by first releasing lines and then easing off as commands are given.	Operate front-center handling lines as directed.	Release front-center handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension to man front-center handling lines.	(a) Operate front-center handling lines as directed. (b) Fasten front-center handling lines to screw pickets.
Nos. 8	Take posts at rear-center handling lines.	Operate rear-center handling lines as directed, by first releasing lines and then easing off as commands are given.	Operate rear-center handling lines as directed.	Release rear-center handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension to man rear-center handling lines.	(a) Operate rear-center handling lines as directed. (b) Fasten rear-center handling lines to screw pickets.

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Nos. 9	Take posts at rear handling lines.	Operate rear handling lines as directed, by first releasing lines and then easing off as commands are given.	Operate rear handling lines as directed.	Release rear handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension prepared to man rear handling lines.	(a) Operate rear handling lines as directed. (b) Fasten rear handling lines to screw pickets.
Nos. 3	Take posts at front mooring lines.	Release mooring lines and rigging, and re-move sandbags; work down to junction assembly by handling forward bridle. At command, HOLD IT, move to and assist on front handling lines.	Assist in operating front handling lines as directed.	Release front handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension to assist Nos. 2 and 4 man the front handling lines.	(a) Fasten ground rigging. (b) Fasten front mooring lines.

	Ascension			Descension	Bedding down
	DETAILS, POSTS	PREPARE FOR ASCENSION	ATTACH CABLE	FLY THE BALLOON	(a) WINCH OPERATOR, HAUL DOWN FORMATION, FALL IN (b) FASTEN GROUND RIGGING, MOORING AND HANDLING LINES
Nos. 5	Take posts at center mooring lines.	Release mooring lines and ground rigging, and re-move sandbags; work down to junction assembly by handling forward bridles. At command move to and assist on front-center handling lines.	Assist in operating front-center handling lines as directed.	Release front-center handling lines when and as directed.	(a) No duties. (b) Fall in at same positions held at ascension to assist Nos. 6 man front-center handling lines.
					(a) FASTEN GROUND RIGGING (b) FASTEN MOORING AND HANDLING LINES

Nos. 7	Take posts at rear mooring lines.	Release mooring lines and ground rigging, and re-move sandbags; work down to junction assembly by handling forward bridles; then add or remove sandbags on junction assembly grommets as directed.	No. 7 on right side brings cable out to junction assembly. Both assist in attaching cable; then remove sandbags as directed.	No duties	(a) No duties. (b) Place at least 15 sandbags convenient to ascension point and wait for junction assembly to descend.
					Assist gaffer in detaching cable from junction assembly. They then place number of sandbags ordered on junction assembly.
					Work up rigging to catenary curve by side of balloon bed, and attach sandbags to junction assembly bags where directed. (b) Fasten rear mooring lines.

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