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FM 4–188

WAR DEPARTMENT

ANTIAIRCRAFT ARTILLERY FIELD MANUAL

SERVICE OF THE BALLOON AND BALLOON EQUIPMENT VERY LOW ALTITUDE

April 16, 1943

Capt H J Pollack

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CHAPTER 1

BALLOON AND BALLOON EQUIPMENT

SECTION I

PURPOSE AND PERFORMANCE

■ 1. PURPOSE.—The purpose of the VLA (very low altitude) balloon is to support an armed piano wire or an armed 1-ton cable in the air. One VLA balloon flown singly will raise an armed piano wire to a height of 2,000 feet, or an armed 1-ton cable to a height of 1,000 feet. Two VLA balloons, each carrying 2,000 feet of armed piano wire, may be flown in tandem one above the other to reach a maximum altitude of approximately 4,500 feet. The purpose of the armed piano wire or cable is to offer a physical and psychological deterrent to hostile aircraft. The balloon is used where economy in personnel and matériel is of primary moment, as in oversea operations, and where ease of handling and mobility are important, for example, in amphibious operations and in the protection of moving objects such as trains or motor convoys. VLA balloons flown singly offer protection against low altitude attack airplanes, torpedo-launching

airplanes, gliders, airborne troop carriers, parachute troop carriers, and mine-laying airplanes; to a limited extent, they are also effective against dive bombers. The effectiveness against dive bombers may be increased by using two VLA balloons in tandem to attain a maximum altitude of 4,500 feet. For a full discussion of the tactical employment of VLA balloons, see FM–181 (when published).

■ 2. PERFORMANCE.—The performance of the balloon is satisfactory in winds up to 60 miles per hour. When the balloon is towed from a moving object its performance is satisfactory if the balloon's wind speed is not greater than 60 miles per hour. Simplicity of design, ease of handling, and economy in personnel and matériel required for operation make the balloon practical for its intended use.

SECTION II

DESCRIPTION

■ 3. GENERAL.—The present type of VLA balloon is designated as the Mk. VI balloon. It is a dilatable pressure type balloon and may be operated safely to a height of 2,000 feet. For operation above 2,000 feet, the balloon should be modified by the addition of a gas valve.

■ 4. NOMENCLATURE.—Nomenclature of the Mk. VI balloon is shown in figure 1.

1. Envelope.
2. Front handling lines.
3. Foot ropes.
4. Expansion system.
5. Rigging patches.
6. Manometer connection.
7. Access slot.
8. Handling-line patches.
9. Rear handling lines.
10. Stabilizer bracing wires.
11. Rudder.
12. Fins.
13. Triangular stabilizer brace.
14. Appendix.

■ 5. CHARACTERISTICS.—Designed characteristics of the Mk. VI balloon are:

Basic volume (at 1.6 inches water pressure)	2,300 cubic feet
Maximum volume (at 3.6 inches water pressure)	2,700 cubic feet

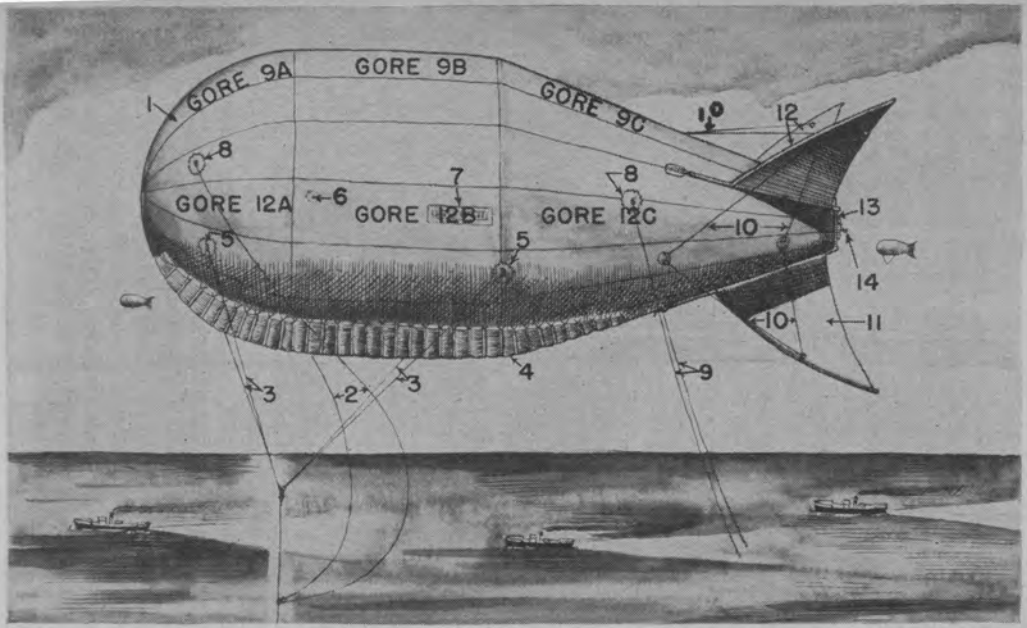


FIGURE 1.—Nomenclature of the Mk. VI balloon.

Length of envelope (at 1.6 inches water pressure)	33 feet 6 inches
Overall length, stabilizers erected	35 feet
Overall length, stabilizers furled	38 feet 6 inches
Diameter (at 1.6 inches water pressure)	11 feet 8 inches
Weight of each stabilizer	10 pounds
Total weight of balloon and stabilizers (approx.)	110 pounds
Length of front handling lines	39 feet 6 inches
Length of rear handling lines	15 feet
Length of front foot ropes	11 feet 9¾ inches
Length of rear foot ropes	15 feet 6¾ inches
Length of stabilizer bracing wire, rear	5 feet 2 inches
Length of stabilizer bracing wire, front	6 feet 10¾ inches

■ 6. PACKED BALLOON.—The balloon envelope comes packed in a canvas valise with dimensions of approximately 2½ by 2 by 1½ feet. The envelope and valise weigh approximately 90 pounds. The stabilizers are packed in a separate container 10 inches in diameter and 10 feet long. The total weight of the stabilizers and container is approximately 35 pounds. The ground cloth is packed in a cardboard box 25 by 13 by 10 inches and weighs approximately 34 pounds. The mooring net is tied in a bundle 12 inches in diameter and 40 inches long, and weighs approximately 30 pounds.

■ 7. PROMINENT FEATURES.—*a. Fabric.*—Fabric used on the balloon envelope is of cotton, two-ply, biased, rubber-proofed, and aluminized. The stabilizers are made of single-ply, aluminized, rubber-proofed cotton fabric.

b. Construction.—The shape of the envelope is designed to produce simplicity of construction and minimum waste in cutting panels. The envelope is cylindrical, with a hemispherical nose and conical tail. The gores of the envelope are numbered consecutively from 1 to 15, starting on the lower right side of the balloon. (See fig. 1.) Each gore consists of three panels, with the panels forming the nose

designated as panels A, those forming the cylindrical part of the envelope as panels B, and those forming the tail as panels C. The panels and gores are overlapped, cemented, and taped as described in FM 4–196 (when published).

c. Expansion system.—The expansion system is located on the under surface of the balloon. It is formed by using restraining cords to force tucks into gores 1 and 15. These restraining cords, made of cotton-covered rubber bands, are secured to a band of heavy fabric cemented to gores Nos. 2 and 14. The cords are numbered consecutively, starting at the nose of the balloon, and extend about three-fourths of the balloon's length. Since the cords are attached to the exterior of the balloon, they are subject to rapid deterioration and may require replacement. The expansion system allows for 15 percent increase in volume, which is sufficient for normal operations where changes in atmospheric pressure and superheat must be taken into account.

d. Stabilizers.—Each balloon is equipped with three detachable stabilizers set 120° from each other. One stabilizer is directly under the balloon and is referred to as the rudder. The other two are known as fins (left and right). The stabilizers are made of a collapsible wooden frame covered with fabric and are attached to the balloon by inserting the base of each stabilizer into two 6-inch fabric bands and buckling a strap to the envelope. A triangular wooden brace which fits over the bases of the stabilizers at the rear of the balloon helps to hold them in place. When flying, the stabilizers are kept extended by a wooden strut and two front and two rear bracing cables of 300-pounds breaking strength, attached to the stabilizers and to metal links on the envelope.

e. Volume.—The basic and maximum volumes are listed in paragraph 5. Because balloon fabric stretches as the balloon ages, a 5 to 10 percent increase in volume may be expected.

f. Lift.—A new balloon inflated to 1.6 inches water pressure, using hydrogen with a gas purity of 98 percent, should have a net lift of approximately 52 pounds under standard conditions. The age of the balloon and changes in gas purity will cause the lift to vary. When the gas purity drops to 88

percent, the lift will decrease to approximately 36 pounds and the angle of trim will increase considerably. The net lift will increase when superheat is present. (See FM 4–182 when published.)

g. Angle of trim.—Under normal conditions, the balloon is designed to fly without tail ballast. However, in regions of high temperatures, tail ballast may be required. In this case ballast may be added to the ballast pockets at the tail of the balloon. Tail ballast may also be required if the balloon is being flown from a moving object, since a sudden change in the direction of movement may cause the balloon to dive unless ballast is provided. The angle of trim may vary from 6° in still air with a gas purity of 98 percent to 22° in a high wind with a gas purity of 88 percent. As a balloon ages it has a tendency to become tail high. The desired angle of trim may be maintained under this condition by adding tail ballast.

h. Foot ropes.—The foot ropes are made of wire cable with a breaking strength of 500 pounds. At their upper ends, the foot ropes are attached to the rigging patches on the balloon by a thimbled eye splice; at their lower ends they are attached to a ¾-inch shackle by a soft eye splice.

i. Handling lines.—There are two handling lines on each side of the balloon. They are the front and rear handling lines, which are made of ¼-inch rope. A 6-inch eye is made in the lower end of each handling line and a 3-inch eye in the upper end. The upper end is lark's-headed to the rope eye of the handling-line patch. When the balloon is flying, the front handling lines are tied to the flying-wire assembly with a single bowline knot.

j. Access slot.—Each balloon is provided with an access slot approximately 30 inches long, located on the left side of the balloon in gore 12, panel B. When necessary, the access slot can be used by crewmen to enter the balloon for repairing. This slot is laced with cord and is sealed with a panel of fabric cemented to the balloon envelope.

k. Inflation appendix.—An inflation appendix, 4 inches in diameter and approximately 14 inches long, is located at the center of the tail cap of the balloon. It is secured with a

tie-off cord when the balloon is inflated. This appendix is used also for deflating the balloon.

l. Manometer connection.—The manometer connection is a rubber teat located on the left side of the balloon. This teat is sealed with a tight-fitting wooden peg. The connection is used to check the internal pressure, to sample gas, and may be used for topping up.

SECTION III

BALLOON BEDS AND MOORING EQUIPMENT

■ 8. BALLOON BEDS.—Balloon beds for the VLA balloon are of two types: two-way and eight-way. The two-way bed may be constructed on restricted sites or for temporary use. It is advisable to construct an eight-way bed when conditions permit.

a. Two-way bed.—The two-way bed is 13 feet 6 inches wide and 34 feet long, and is laid out as shown in figure 2. The bed area should be approximately level and free from obstructions. A $\frac{3}{16}$-inch or $\frac{1}{4}$-inch cable, 100 feet long, is reeved through screw picket eyes around the bed, then tightened and connected with three cable clips. The 100-foot cable allows for a 5-foot overlap, which is sufficient for tightening and clamping.

b. Eight-way bed.—The eight-way bed requires an area about 40 feet in diameter approximately level and free from obstructions. Twelve screw pickets, 390 feet of $\frac{3}{16}$-inch or $\frac{1}{4}$-inch cable, and three cable clips are needed. See figure 3 for dimensions and methods of construction.

■ 9. MOORING EQUIPMENT.—*a. Mooring net.*—A rectangular mooring net, 24 feet wide and 44 feet 8 inches long, is furnished with each balloon. This net is used to hold the balloon on the bed when it is bedded down, and to assist in holding the envelope on the bed when it is necessary to inflate during a high wind.

b. Heaving lines.—To assist the crew in hauling the net over the balloon, a heaving line made of $\frac{1}{4}$-inch rope about 30 feet long is attached to each front corner of the mooring net. After the net is completely over the inflated balloon, the

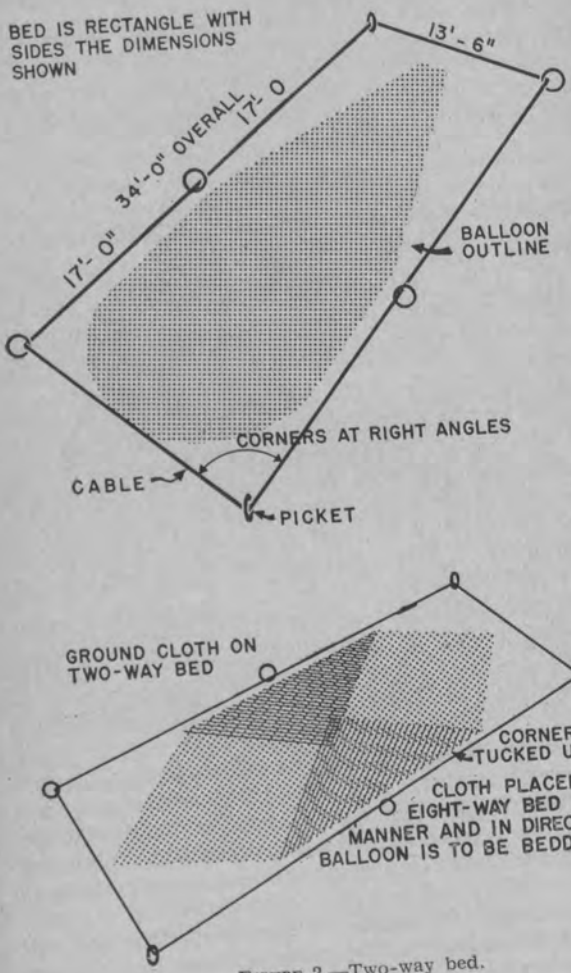
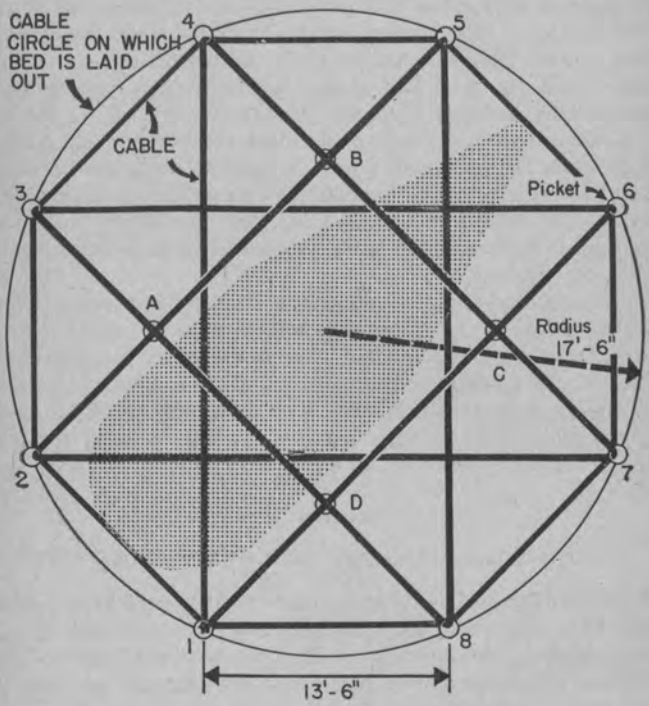


FIGURE 2.—Two-way bed.



REEVING PROCEDURE:

Start at Picket No.1, then 4, 3, 6, 5, 8, 7, 2, to 1 then thru D, C, 6, 7, C, B, 4, 5, B, A, 2, 3, A, D, 8, 1 and clamp.

FIGURE 3.—Eight-way bed.

heaving lines are removed, coiled, and placed under the tail of the balloon.

c. Ground cloth.—A 20- by 20-foot ground cloth is placed diagonally on the leg of the bed selected for bedding down the balloon. The corners of the ground cloth extending over the leg should be folded under even with the leg of the bed. (See fig. 2.) The ground cloth protects the balloon fabric when the balloon is bedded down.

d. Side-hook ropes.—Two side-hook ropes, made of ¼-inch rope, each 75 feet long, are used in bedding down the balloon. Each rope has a ground mooring hook-eye spliced in one end. Thirty-five additional ground mooring hooks are threaded on each side-hook rope with the hooks pointing alternately left and right.

e. Sandbags.—Six 40-pound canvas sandbags are needed for each site. Small brass grommets are made into the band around the top of each bag. A ¼-inch cotton rope is reeved through the grommets, and each end of the rope is eye-spliced to one ground mooring hook. The mouth of the sandbag is closed by passing the hook ends of the rope around the top of the bag and tying with a half hitch.

SECTION IV

FLYING-WIRE ASSEMBLY FOR STATIONARY SITES

■ **10. GENERAL.**—The flying wire assembly for stationary sites utilizes a bomb and parachute arming scheme. The flying cable assembly for balloons which are to be flown from moving objects utilizes a double parachute arming scheme, and is discussed in section V.

NOTE.—A balloon used to protect a beach during landing operations will be considered as a balloon which is flown from a stationary site and will use the flying wire assembly, even though this balloon may be flown from a landing craft while it is being transported to the beach.

■ **11. EQUIPMENT.**—*a. General.*—The equipment required for the flying wire assembly consists of strops, socket eyes and wedges, flying wire, a swivel, inertia links, lethal devices, a quick connector, and a winch leg. The complete flying wire assembly is shown in figure 4.

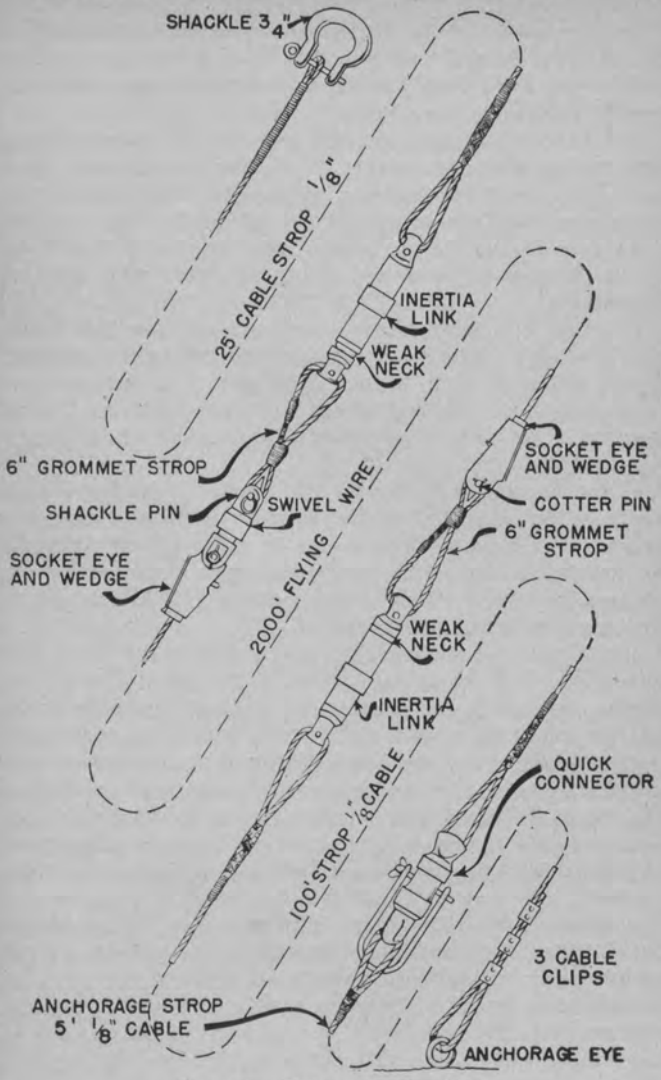


FIGURE 4.—Flying wire assembly.

b. Strops.—(1) A 25-foot strop is used on the upper end of the flying wire assembly. This strop is made of ⅛-inch cable with a 1¼-inch thimbled eye splice in one end and a soft eye splice in the other.

(2) A 100-foot strop is used between the lower inertia link and the quick connector. This strop is made of ⅛-inch cable with a soft eye splice in each end. The length of the strop may vary, but it should be sufficiently long to place the lower lethal device above any nearby obstructions. When ⅛-inch cable is not available, flying wire may be substituted.

(3) Two 6-inch grommet strops are used in the flying wire assembly. The strops are constructed by first making a wire grommet from ⅛-inch cable and then seizing a ¾-inch thimble in one end of the grommet to form a strop. See FM 4–196 (when published) for method of making a grommet.

c. Socket eyes and wedges.—(1) Socket eyes and wedges are used on each end of the flying wire to eliminate the necessity of forming eyes in the flying wire. Eyes should be formed in the flying wire only when socket eyes and wedges are not available. See appendix I for details of forming eyes in the flying wire.

(2) Socket eyes and wedges are attached to the flying wire by reeving the flying wire through the small end of the socket eye (see figure 5) and then through the hole in the narrow end of the wedge. The wire is bent around the short leg of the wedge and the wedge then is forced into the socket eye. After the socket eye and wedge have been secured to the end of the flying wire, the free end of the wire should be cut off flush with the bottom end of the socket eye to prevent entanglement when paying out and hauling in the flying wire assembly.

d. Flying wire.—The flying wire is a solid, single-strand wire .072 inch in diameter, with a breaking strength of 1,300 pounds, and weighing 14 pounds per 1,000 feet. It is not lethal unless armed. The main section of flying wire is approximately 2,000 feet long.

e. Swivel.—A swivel, which allows the balloon to turn in any direction without twisting the flying wire assembly, is connected to the lower end of the upper inertia link by means of a 6-inch grommet strop. The fixed end of the swivel is placed upward. (See fig. 6.)

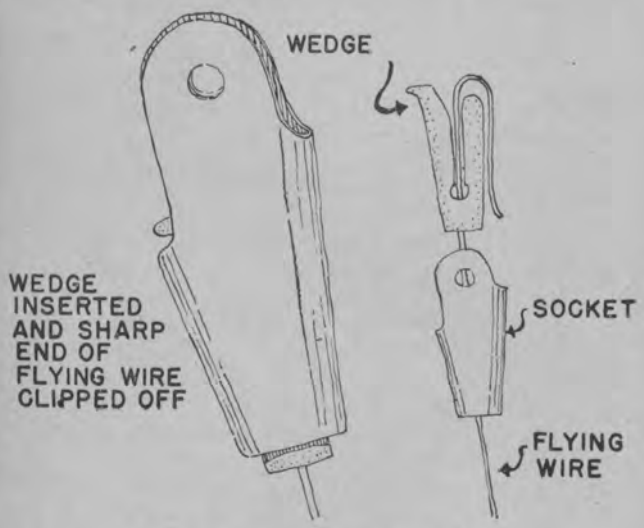


FIGURE 5.—Socket eye and wedge.

f. Inertia links.—(1) Two inertia links are used in the flying-wire assembly so that lethal devices can be attached. (See FM 4–191 when published.) There are two types of inertia links: double action and single action. Each type is made with a weak neck in one end. Normally, double action inertia links are used in the flying-wire assembly. When double action inertia links are used, their weak necks are turned in the direction of the lethal section of the flying-wire assembly, which is the 2,000 feet of flying wire. Sometimes double action inertia links are overly sensitive and fire the cartridge prematurely, thus freeing the balloon. When this happens, a double action inertia link can be converted to a

single action inertia link, which is less sensitive, by placing a wooden or plastic stop in the strong end of the inertia link with a brass screw. This stop replaces the strong spring in the inertia link. When a double action inertia link is converted to a single action inertia link, a fiber washer is placed between the strong end and the body of the link to identify

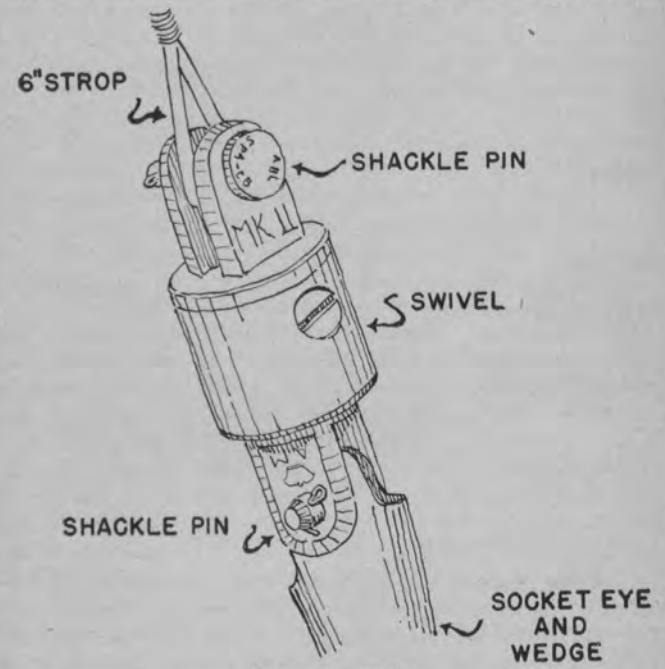


FIGURE 6.—Swivel.

it as a single action inertia link. When single action inertia links are used in the flying-wire assembly, the weak necks are turned in the direction away from the lethal section of the flying-wire assembly.

g. Lethal devices.—(1) The upper lethal device consists of a high-explosive bomb and a stabilizing parachute. This lethal device is attached to the upper inertia link, as shown in figure 7.

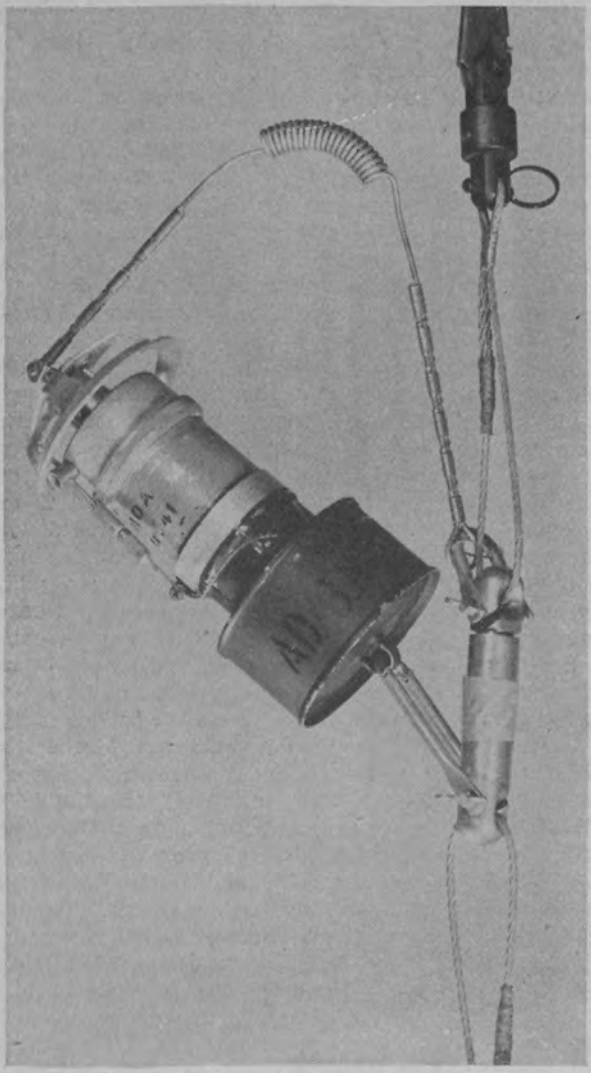


FIGURE 7.—Attachment of bomb to inertia link.

(2) The lower lethal device consists of a 54-inch parachute contained in a canister. This device is attached to the lower inertia link, as shown in figure 8.

(3) When the flying wire is struck by an aircraft, a cartridge fires in each inertia link and causes the link to be severed at the weak neck, freeing the section of the flying wire assembly between the inertia links. The bomb, which is attached to the upper end of the freed section, is drawn down to the wing of the airplane by the pull of the parachute at the lower end of the freed section as shown in figure 9. A detailed description of the lethal devices, together with servicing instructions, is contained in FM 4–191 (when published).

h. Quick connector.—A quick connector (see fig. 10) is used in the flying wire assembly to facilitate ease of operations in the transfer of the flying wire assembly from the winch leg to an anchorage strop. If the balloon is to be flown with the fair-lead as the ascension point, the quick connector will be used infrequently. However, if quick connectors are available, they should be included in the flying wire assembly to provide a means of transferring the balloon from the winch leg to an anchorage strop if the need arises. If the quick connector is omitted from the flying wire assembly, the winch leg will extend from the winch drum to the lower inertia link, and should be made long enough so that the lower parachute will be approximately 100 feet above the ground when the balloon is flying.

i. Winch leg.—The section of the flying wire assembly between the quick connector and the winch storage drum is called the winch leg. The winch leg is made of ⅛-inch cable with a soft eye splice in the outer ends. It varies in length from 25 to 100 feet, depending on the distance between the winch and the fair-lead. When ⅛-inch cable is not available, flying wire may be substituted. The winch leg is sufficiently long to allow several wraps to remain on the storage drum when the quick connector is about 4 feet above the fair-lead. The winch leg is attached to the storage drum by reeving the cable through a hole in the outer flange of the storage drum and attaching a cable clip

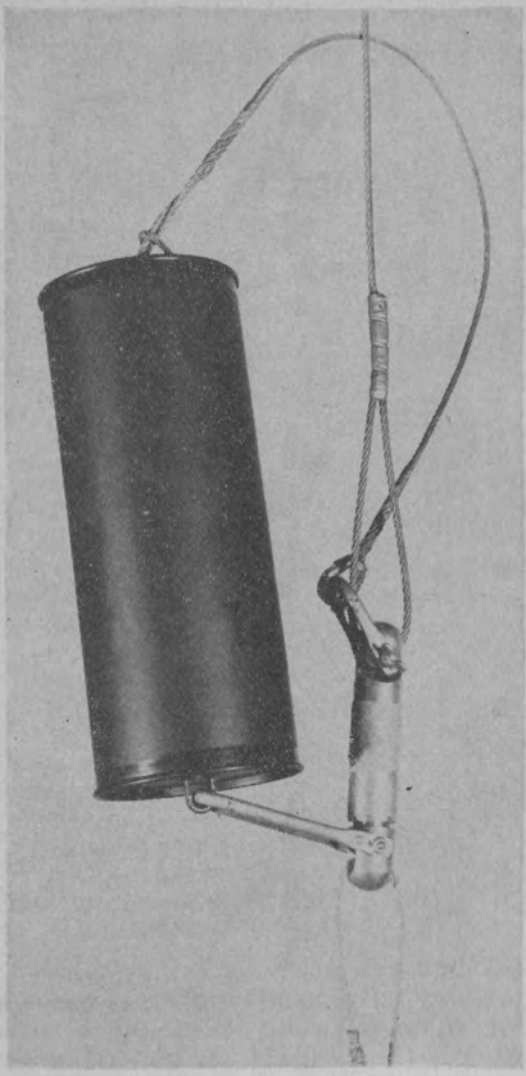


FIGURE 8.—Attachment of parachute to inertia link.

■ 12. ASSEMBLING FLYING WIRE.—The armorers and riggers are responsible for preparing the flying wire assembly and

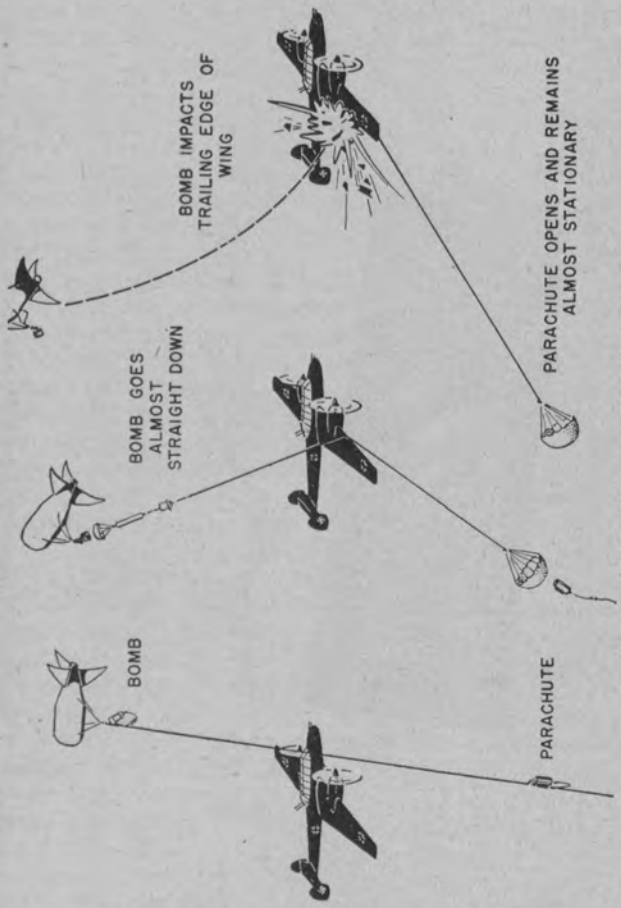


FIGURE 9.—Functioning of lethal devices.

reeling it on the storage drum. The entire purpose of the balloon will be defeated unless the flying wire is correctly assembled; therefore, extreme care must be exercised to

insure that the flying wire is assembled as shown in figure 4 and described in paragraph 11. The method of reeling piano wire onto a storage drum is discussed in appendix II.

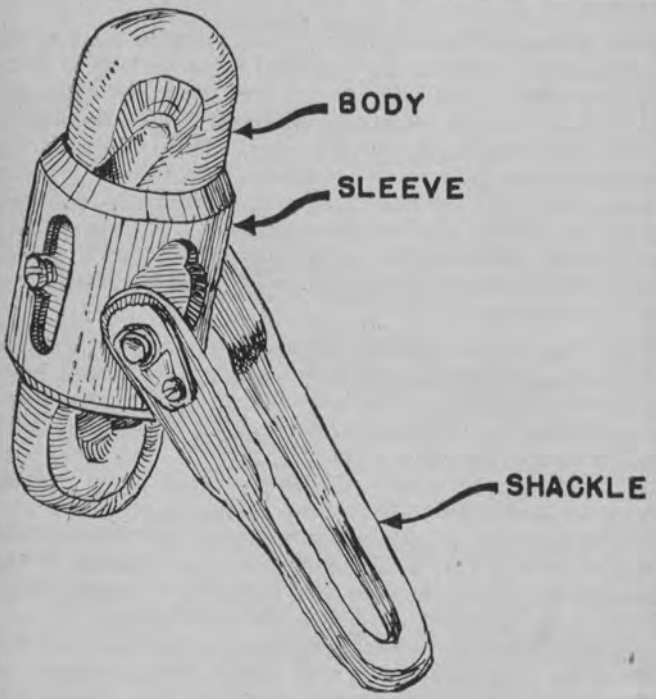


FIGURE 10.—Quick connector.

SECTION V

FLYING CABLE ASSEMBLY FOR BALLOONS FLOWN FROM MOVING OBJECTS

■ 13. GENERAL.—The flying cable assembly for balloons flown from moving objects differs from the flying wire assembly for stationary sites in that 1-ton cable and a double parachute arming scheme are used rather than piano wire

and a bomb and parachute arming scheme. The flying cable assembly will be used when the balloon is flown from any moving object, such as a large landing craft, truck, train, or tank.

■ 14. PURPOSE.—When the flying cable assembly is hit by an aircraft, the lethal devices function so as to leave a 1,000 foot section of 1-ton cable draped over the wing of the aircraft with a 54-inch parachute attached to each end of the cable. The parachutes and cable exert a drag of nearly 1 ton on the wing of the aircraft. Since the aircraft will be flying at an altitude of less than 1,000 feet when it hits the flying cable, the sudden and unexpected drag of the lethal devices on the wing may be sufficient to cause the aircraft to go out of control and crash before the pilot can regain control from this low altitude.

■ 15. FROM LARGE LANDING CRAFT.—*a. General.*—The flying cable assembly for a balloon flown from a large landing craft is shown in figure 11. This assembly provides for the operational control of the balloon by means of a winch mounted on the deck of the landing craft.

b. 25-foot cable strop.—The 25-foot cable strop extends from the foot ropes of the balloon to the upper inertia link.

c. Transfer strop.—The transfer strop is 2½ feet long and is used to hold the balloon while the upper shackle of the inertia link is being removed from the lower eye of the 25-foot cable strop to attach or detach the parachute.

d. Upper parachute and inertia link.—The attachment of the upper parachute and inertia link is shown in figure 11. The inertia link is of a heavier type than that used in the flying wire assembly, and is attached with the weak neck pointing toward the balloon. Both the upper inertia link and parachute are described in FM 4–191 (when published).

e. Swivel and safety hook.—The attachment of the swivel and safety hook is shown in figure 11. The purpose of the safety hook is to facilitate quick attachment of the upper inertia link.

f. Flying cable.—The 1,000 feet of flying cable is made from stranded cable with a breaking strength of 1 ton.

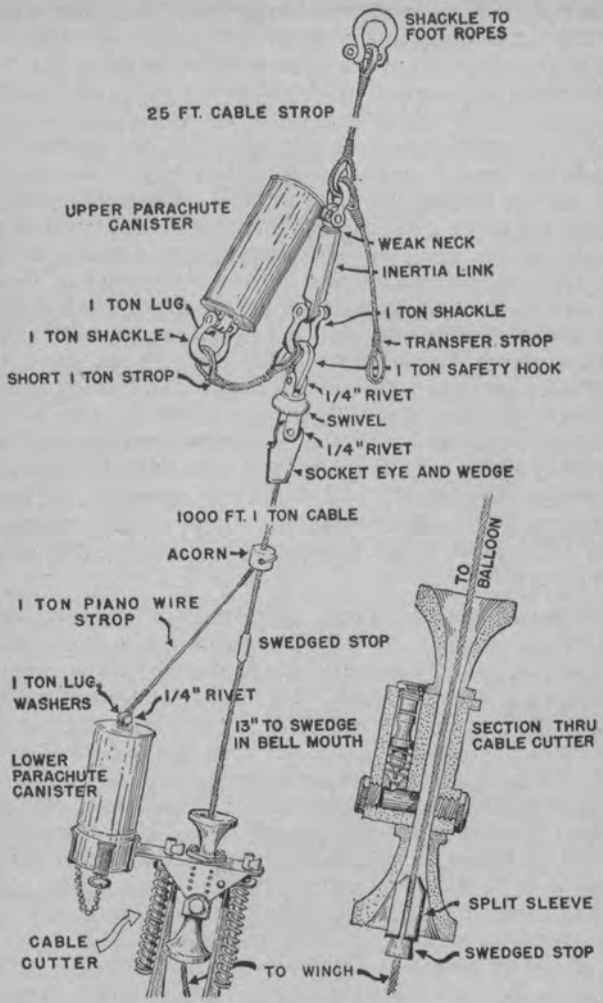


FIGURE 11.—Flying cable assembly for a balloon flown from a large landing craft.

g. Cable cutter and lower parachute.—The cable cutter (British Admiralty type or equal) used in lieu of an inertia link at the lower end of the cable is shown in figure 11. The cable cutter is mounted either above the winch so that the flying cable may run directly from the winch storage drum through the bell mouth of the cutter, or directly above a remote fair-lead, if there is room on the deck of the landing craft for the installation of a fair-lead. The upper swedged stop on the flying cable passes through the bell mouth of the cutter, but the lower swedged stop and split sleeve do not pass through the bell mouth. When the balloon is flying, the pull of the balloon is taken by the lower swedged stop and split sleeve bearing against the bell mouth. When the cable is struck by an aircraft, the cable is cut above the lower swedged stop. The cable is then pulled upward so that the upper swedged stop engages the acorn attached to the parachute strop and pulls the parachute from the canister. The cable cutter permits the balloon to be paid out or hauled in without the necessity of attaching or detaching the lower parachute. This arrangement results in a great saving of time. The cable cutter is described in detail in FM 4–191 (when published).

■ 16. FROM TRUCKS, TRAINS, OR TANKS.—*a. General.*—The flying cable assembly for a balloon flown from a truck, train, or tank is shown in figure 12. The baloon is shackled directly to the truck, train, or tank. No means for controlling the balloon from the object protected is provided. The balloon is flown at operating height at all times, and is hauled down for servicing and repair at servicing stations (see FM 4–181 (when published)). From the balloon down to the lower end of the 1,000 feet of flying cable, the flying cable is the same as that described in paragraph 15. Since it would not be practicable to install a cable cutter on every truck, train, or tank from which a balloon might be flown, an inertia link is used at the lower end of the flying cable.

b. Transfer strop.—A transfer strop 2½ feet long is attached to the lower end of the flying cable as shown in figure 12, and is used to hold the balloon while the upper shackle

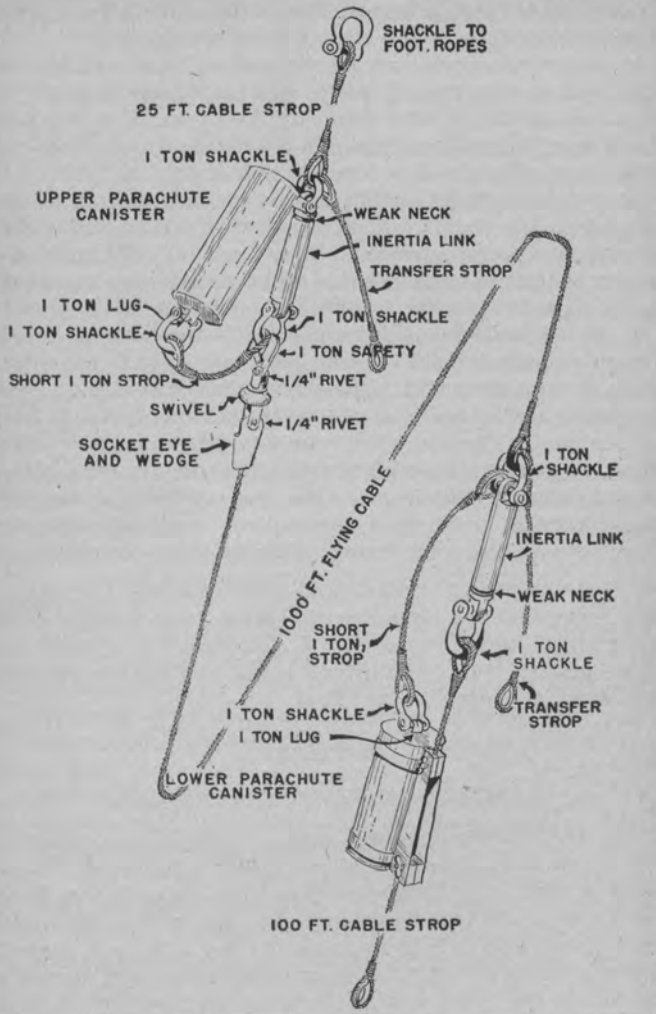


FIGURE 12.—Flying cable assembly for a balloon flown from a truck, train, or tank.

of the inertia link is being removed from the lower eye of the flying cable to attach or detach the parachute.

c. Lower parachute and inertia link.—The attachment of the lower parachute and inertia link are shown in figure 12. The inertia link is attached with the weak neck pointing away from the balloon. See FM 4–191 (when published) for a description of the lower inertia link and parachute.

d. 100-foot strop.—A 100-foot strop is attached to the shackle at the inertia link at its upper end, as shown in figure 12, and terminates at its lower end in a thimbled eye splice, which can be shackled to a suitable point on the truck, train, or tank (see FM 4–181 when published).

e. Winch leg.—A winch leg made of 1-ton cable is wound on the storage drum of the winch and has a safety hook eye-spliced to its outer end. The safety hook is attached to the eye splice at the lower end of the 100-foot strop to haul down the balloon. The winch leg should be long enough to allow several turns to remain on the storage drum after the safety hook is clear of the drum. Since the safety hooks will not pass through a fair-lead, the balloon must be raised or lowered with the cable leading directly off the winch drum.

■ 17. ASSEMBLING FLYING CABLE.—The armorers and riggers are responsible for preparing the flying cable assembly and reeling it on to the storage drum. All elements of the flying cable must be able to withstand a pull of 1 ton in order for the arming scheme to be lethal.

SECTION VI

MISCELLANEOUS EQUIPMENT

■ 18. INFLATION EQUIPMENT.—*a. Gas cylinders.*—Gas is stored at the site in standard cylinders. Either hydrogen or helium may be used. The cylinders will be color-coded so that those with olive-drab neck bands and caps will contain hydrogen, and those with yellow neck bands and caps will contain helium. Each cylinder is approximately 9 inches in diameter, 57 inches long, and weighs 120 to 130 pounds. When filled to a pressure of 2,000 pounds per square inch, a cylinder con-

tains approximately 190 cubic feet of gas. The cylinders are stacked about 60 feet from the center of the bed on the down-wind side. They are stacked in the form of a pyramid, on wooden dunnage, and properly grounded. (See FM 4–184.)

b. Manifold assembly.—The manifold assembly consists of three flexible, high-pressure hoses, a metal manifold bell, and three gas-cylinder valve fittings. One end of the hoses is attached to the manifold bell, and the other end to the gas-cylinder valve fittings. The assembly is used to conduct gas from the cylinders to the inflation tube. (See FM 4–182 when published.)

c. Inflation tube.—The inflation tube is made of biased, double ply, neoprene-proofed fabric. It is 5 inches in diameter and approximately 60 feet long. This tube is used to conduct gas from the manifold assembly to the inflation appendix of the balloon.

d. Thimble.—A metal thimble is inserted into the inflation tube, and the balloon appendix is pulled over the inflation tube and thimble. The thimble keeps the inflation tube and appendix open so that gas can flow into the balloon when the tube and appendix are secured with an elastic tie-off cord.

e. Elastic tie-off cord.—The elastic tie-off cord consists of multiple strands of rubber covered with cotton fabric. The cord is approximately ⅜ inch in diameter and 4 feet long. Elastic tie-off cords are used to tie the inflation tube over the manifold bell and the inflation appendix over the inflation tube and thimble.

f. Topping-up hose.—A topping-up hose is used to conduct gas from the gas cylinder directly into the balloon through the manometer connection. It has a gas-cylinder valve fitting attached to one end and a manometer connection fitting at the other end. This hose is similar to the hoses of the manifold assembly, and is about 12 feet long.

g. Flying-wire assembly transfer strop.—The flying-wire assembly transfer strop is 10 feet long and made of ½-inch sisal rope with a one-ton safety hook spliced in one end. The other end is served to prevent fraying. This strop is

used in transferring the flying wire from the winch to the anchorage strop.

■ 19. MANOMETER.—A manometer is an instument used to measure the internal gas pressure of a balloon. For details and operation of the manometer see FM 4–182 (when published).

■ 20. EFFUSION APPARATUS.—An effusion apparatus is used to determine the purity of gas in a balloon. For details and operation of the effusion apparatus see FM 4–182 (when published).

CHAPTER 2

WINCHES, FAIR-LEAD, AND ANCHORAGES

SECTION I

GENERAL

■ 21. CLASSIFICATION.—Winches used in flying the VLA balloon are of two general classifications: power-operated and hand-operated.

SECTION II

MK. VI WINCH

■ 22. DESCRIPTION.—*a. General.*—The Mk. VI winch (fig. 13) differs from those used with the low altitude balloons in that it has no traction drums or lead-off gear as integral parts of the winch. The absence of traction drums places the entire tension of the flying wire directly on the storage drum. The storage drum is detachable from the winch. Since the winch does not have a lead-off gear, it must be used with a separate fair-lead.

1. 15-tooth driving sprocket.
2. 20-tooth jockey sprocket.
3. 50-tooth driven sprocket.
4. Friction pinion shaft.
5. Friction pinion.
6. Friction disk.
7. Clutch.
8. Disk spindle.
9. 15-tooth duplex sprocket.
10. 16-tooth jockey sprocket.
11. 76-tooth driven sprocket.
12. 19-tooth hand-winding sprocket.
13. Hand power shaft.
14. Storage drum.

b. Power unit.—A commercial type, single-cylinder, air-cooled gasoline engine is used for the power unit. The engine develops 5½ horsepower at 2,000 revolutions per minute. The unit is equipped with a magneto, which gives a high-

density spark for starting, and a hand crank. The speed is controlled by an overriding governor which operates on the carburetor throttle. The governor limits the engine speed to 2,000 revolutions per minute.

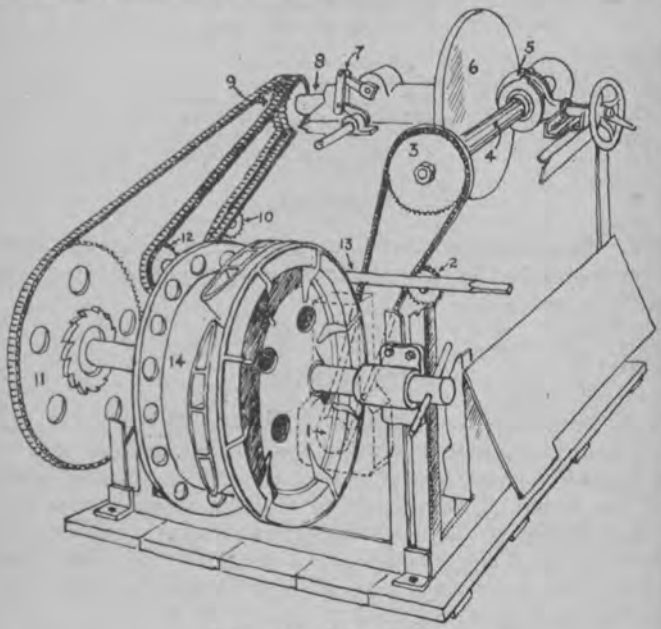


FIGURE 13.—Mk. VI winch

c. Dimensions.—The winch is 3 feet 11½ inches long, 2 feet 10½ inches wide, and 3 feet 1 inch high. Including the hand-winding cranks and serving gear, the length is 4 feet 11¾ inches, and the width is 4 feet 6¾ inches. The total weight, including hand-winding cranks and an empty storage drum, is approximately 700 pounds.

■ 23. POWER TRANSMISSION.—*a. Primary chain drive.*—The primary chain drive transmits power from a 15-tooth driving sprocket mounted on the engine crankshaft to a 50-tooth driven sprocket mounted on the friction pinion shaft. The

chain drive may be adjusted by changing the position of a 20-tooth jockey sprocket.

b. Variable ratio friction drive.—(1) The variable ratio friction drive has the function of a gear box and clutch. It consists of a friction pinion with a composition bearing surface and a steel friction disk.

(2) The friction pinion is 5 inches in diameter and 1½ inches thick. It is mounted on a splined friction shaft which is driven by the primary chain drive. The pinion may be moved along this shaft and locked at any point by means of a locking lever.

(3) The friction disk is 16 inches in diameter and ⅞ inches thick. It is mounted on the friction disk spindle and may be disengaged from the friction pinion.

(4) For hauling in, the position of the fricton pinion may be varied from 2¾ inches to 7$^{7}/_{16}$ inches from the center of the friction disk. In reverse, the position may be varied from 1$^{11}/_{16}$ inches to 2⅛ inches. The nearer the friction pinion is set to the center of the friction disk, the faster the cable is hauled in or paid out.

c. Secondary chain drive.—The secondary chain drive transmits power from the inner set of teeth on a 15-tooth duplex sprocket, mounted on the friction disk spindle, to a 76-tooth sprocket on the storage-drum driving spindle. The chain drive may be adjusted by changing the position of a 16-tooth jockey sprocket.

24. PARTS AND EQUIPMENT.—*a. Storage drum.*—The storage drum (see fig. 14) is 9½ inches wide, with an inner diameter of 12.37 inches and an overall diameter, including the flanges, of 18 inches. It weighs 108 pounds without the flying wire assembly. The drum is divided by a flange having two inlet and two outlet gates into a storage space for the flying wire and a parking space for attachments which normally remain on the flying wire assembly. The drum is designed to store 8,000 feet of flying wire. The drum is mounted on the driving spindle, which is provided with a ratchet and pawl mechanism and a brake.

b. Serving gear.—A hand-operated serving gear is used to insure level winding of the flying wire. The flying wire

passes between two deflector plates on the serving gear, which may be traversed across the storage drum. The serving gear is swung out of the way by hinges when the flying wire is paid out.

c. Hand-power shaft.—The winch is provided with a hand-winding shaft which has detachable handles. A chain drive connects a 19-tooth hand-winding sprocket with the 15-tooth duplex sprocket on the friction disk spindle. From there power is transmitted through the secondary chain drive to a 76-tooth sprocket on the storage-drum driving spindle.

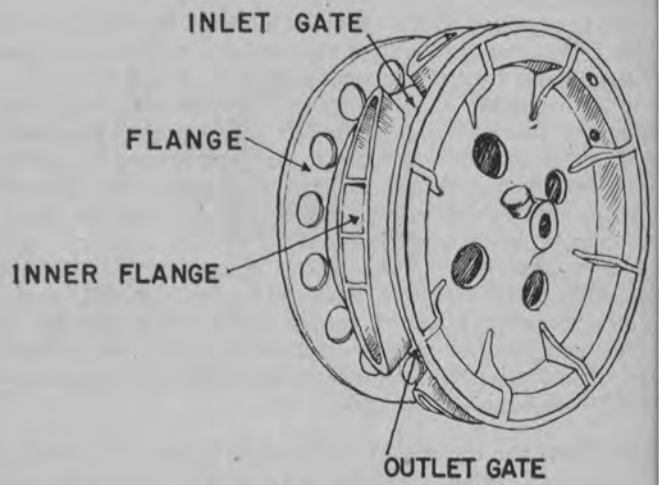


FIGURE 14.—Storage drum.

d. Controls.—The controls are all located on the left side of the winch. They are listed below as they are placed from left to right:

(1) Hand lever for serving gear.

(2) Hand lever, ratchet control for pay-out brake.

(3) Weighted throw-over lever for the pawl release of the ratchet on the drum drive.

(4) Friction engagement lever with a locking device and a twist-grip throttle control.

(5) Stop button on the magneto.

(6) Operating handwheel, with locking lever, for changing the ratio of the friction drive.

e. Covers and guards.—The winch is enclosed with a cover, except for the storage drum and serving gear. The top section is hinged and may be raised for access to the variable ratio friction drive. The engine is accessible on the left side through a hinged door with dimensions of 11½ by 22 inches. On the opposite side is a sliding panel with dimensions of 6½ by 5 inches for access to the oil spout. External chain drives are covered with removable guards.

f. Tools.—(1) Tools for the engine are listed below:

3 each tappet wrenches.
1 each ⅜-inch single-end wrench.
1 each ¼- by 5/16-inch double-end wrench.
1 each 2½- by ⅝-inch bolt for withdrawing cooling fan.
1 each 14-mm spark plug box wrench.
1 each ⅜-inch box wrench.

(2) Tools for the winch are listed below.

1 each crew key.
1 each 3/16- by ¼-inch double-end wrench.
1 each 5/16- by ⅜-inch double-end wrench.
1 each 7/16- by ½-inch double-end wrench.
1 each ½-inch chain connecting link.
1 each ⅝-inch chain connecting link.

■ 25. LUBRICATION.—Heavy oil, grease, and a mixture of tallow and graphite are used for lubricating the Mk. VI winch. Oil is used to lubricate the winch at seven points. Grease is used at eleven points, seven of which have fittings, one of which has a grease cup, and three of which are bearings. The bearings may require periodic packing. A mixture of tallow and graphite is used on chain drives. All places for lubrication are readily accessible.

SECTION III

MK. VII WINCH

■ 26. DESCRIPTION.—The Mk. VII winch (see fig. 15) is a hand-operated winch consisting of a steel frame, a shaft, and

a removable storage drum. Handles may be attached at either end of the shaft for a direct drive, or to a second shaft which provides a 3 to 1 reduction through a chain drive. The winch is equipped with a hand brake, hand-operated serving gear, and a ratchet and pawl. A separate fair-lead must be used with this winch.

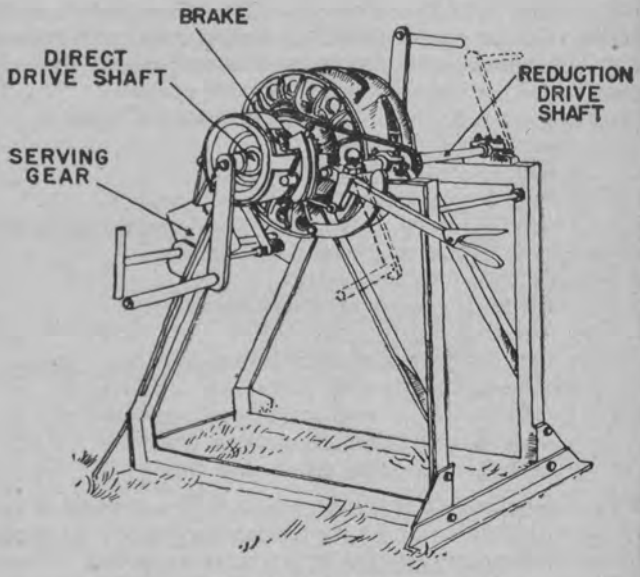


FIGURE 15.—Mk. VII winch.

■ 27. CHARACTERISTICS.—The characteristics of the Mk. VII winch are tabulated below.

Weight (without drum)	250 pounds
Weight of storage drum	108 pounds
Length	4 feet 5 inches
Width	2 feet 8 inches
Width with both handles	3 feet 9 inches
Height	3 feet 9 inches

■ 28. OPERATIONS.—*a.* The winch storage drum is allowed to free wheel when paying out the flying wire assembly. The speed of the pay-out will vary directly with the lift of the balloon.

b. The average time to haul down the balloon when it is flying at 2,000 feet, using the direct shaft with a 200-pound tension on the flying wire assembly, is about 11 minutes. When the flying wire assembly tension is over 200 pounds, the use of the direct shaft is not recommended, because of the strenuous work imposed on the crew.

c. The average time required to haul down the balloon using the reduction gearing with 400 pounds of tension on the flying wire assembly is about 25 minutes. The reduction gearing should be used only when the tension on the flying wire assembly is greater than 200 pounds.

SECTION IV

FAIR-LEAD, ANCHORAGES, AND GROUNDING

■ 29. FAIR-LEAD.—The fair-lead consists of a sheave and counterweight mounted on a base frame. A lead-off guide is provided to prevent the flying wire from leaving the sheave. The sheave is 14½ inches in diameter with a groove 1 inch deep and 2½ inches wide so that the flying wire assembly attachments may pass over it freely. (See fig. 16.)

■ 30. WINCH ANCHORAGE.—A method of anchoring the Mk. VI winch is shown in figure 17. The winch is mounted on timbers to keep it off the ground and to raise it to a height for convenient operations. It is held in position by cables running over the base of the winch and attached to screw pickets on either side. The Mk. VII winch may be anchored in a similar manner.

■ 31. FAIR-LEAD ANCHORAGE.—A method of anchoring the fair-lead is shown in figure 16. The fair-lead anchorage should be able to resist a vertical pull of 1,500 pounds.

■ 32. SEPARATE ANCHORAGE.—In some cases, it may be desired to detach the flying wire assembly from the winch leg by means of the quick connector and fly the balloon from a separate anchorage. This separate anchorage should be

located directly adjacent to the fair-lead, and should b able to resist a vertical pull of 1,500 pounds. A 3-foot screw picket with a 6-inch screw and ¾-inch shaft is satisfactory in hard ground. In loose ground, a deadman anchorag should be installed (see FM 4–182 when published). A anchorage strop 5 feet long made of ⅛-inch cable with 3-inch soft eye in the upper end is attached to the eye o the anchorage with cable clips. An eye may be formed i

FIGURE 16.—Fair-lead.

the bottom end of the strop so that the strop can be shackle to the anchorage eye. A 10-foot transfer strop made o ½-inch rope with a 1-ton safety hook spliced in one en is hooked to the shackle of the quick connector, reeve through the eye of the anchorage, and held so that it take the pull of the balloon while the balloon is being transferre to the anchorage strop.

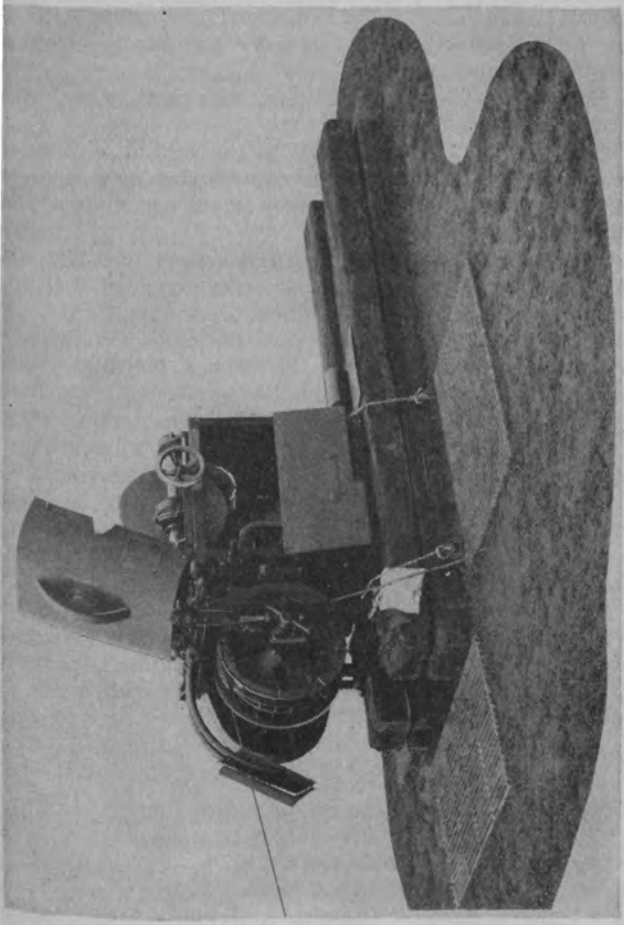


FIGURE 17.—Winch anchorage.

■ 33. GROUNDING.—*a. Purpose.*—The flying wire assembly fair-lead, and winch must be grounded to conduct charges of static electricity into the ground. Grounding mats for personnel to stand on while working with the flying wire or winch must also be provided in order to protect personnel against static electricity.

b. Principles.—The following principles must be followed in establishing a grounding system:

(1) The grounding plate buried in the ground must be of sufficient size (a copper plate 2 by 3 feet or equivalent) to dissipate any static electricity which might accumulate, and must be kept moist.

(2) All connections in the grounding system must be tight.

(3) The grounding system must be so arranged that the grounding mat upon which personnel are to stand will be at the same potential as the flying wire assembly or the winch.

c. Grounding the flying wire assembly.—The flying wire assembly is grounded through the fair-lead. A ⅛-inch copper wire is bolted to the fair-lead, soldered or brazed to the grounding mat upon which personnel are to stand, and then soldered or brazed to the grounding plate buried in the ground. If the balloon is transferred to a separate anchorage, a copper wire is soldered or brazed to the anchorage strop, the grounding mat, and the grounding plate in series.

d. Grounding the winch.—A ⅛-inch copper wire is bolted to the winch frame, soldered or brazed to the grounding mat upon which personnel are to stand while operating the winch and then soldered or brazed to the grounding plate.

CHAPTER 3

OPERATIONS FROM STATIONARY SITES

SECTION I

BALLOON CREW

■ 34. SIZE AND COMPOSITION.—For all operations involving one balloon, the balloon crew is composed of four men, designated as Nos. 1, 2, 3, and 4. No. 1 is the balloon chief and is in charge of all operations. For all operations involving balloons flown in tandem the balloon crew is also composed of four men, except under gusty wind conditions, when five men may be required (see par. 55).

SECTION II

INFLATING THE BALLOON

■ 35. GENERAL (see drill table I).—If the balloon is inflated in a high wind, or when other adverse weather conditions prevail, it is advisable to cover the balloon with a mooring net. If the weather is normal, use of the mooring net is omitted. A four-man crew is used for inflating the balloon. A careful check should be made to see that all equipment is laid out properly at the site before inflation begins.

■ 36. PREPARING THE SITE.—*a. Equipment.*—The following equipment is necessary for inflation: approximately fourteen cylinders of gas, six sandbags, three ground cloths, a manifold assembly, an inflation tube, a metal thimble, two elastic tie-off cords, a sufficient amount of water to wet down the bed, and the balloon envelope and stabilizers.

b. Laying-out equipment.—The entire crew spreads two ground cloths on that leg of the bed which will allow the nose of the balloon to point in the direction of the wind. No. 4 spreads a ground cloth over the area in front of the gas cylinders. No. 1 attaches the gas-cylinder valve fittings of the manifold assembly to the three gas cylinders on the lower left side of the stack, while Nos. 2 and 3 connect one end of the inflation tube over the manifold bell with an elastic tie-off cord. No. 4 then unrolls the inflation tube toward the bed and places a sandbag over the open end to prevent air from entering. After these operations have been accomplished, the crew wets the ground cloths on the bed, the inflation tube, and the ground cloth in front of the gas cylinders to minimize the danger from static electricity.

■ 37. UNPACKING AND PREPARING FOR INFLATION.—The balloon envelope comes packed in a canvas valise. Unpacking is done on the downwind end of the ground cloths by inverting the valise and pulling it from around the envelope. The envelope is unrolled on the bed, with the nose into the wind, and the expansion system is turned upward. No. 1 ties off the inflation appendix to prevent air from entering, then inspects the envelope for defects. The crew makes any necessary repairs before continuing with the operation. The envelope comes with all metal parts taped or covered with fabric and the tape or fabric is removed by Nos. 2, 3, and 4. The crew then turns the envelope over, placing the expansion system downward. The three stabilizers are attached to the envelope as described in paragraph 38. Nos. 3 and 4 lark's-head the handling lines to the rope eye of the handling-line patches. Nos. 1 and 2 insert the metal thimble into the appendix and pull the inflation tube over the appendix and thimble. Then the connection is tied off with an elastic tie-off cord. Nos. 2, 3, and 4 attach sandbags to the handling lines about 6 feet from the balloon by means of a harness hitch.

■ 38. ATTACHING STABILIZERS.—The crew attaches the stabilizers to the envelope by inserting the front end of the stabilizer base into the front fabric band on the envelope.

The stabilizer is moved toward the front of the envelope until the rear end of the stabilizer base has cleared the rear fabric band. The rear end of the stabilizer base is inserted into the rear fabric band and moved toward the rear of the envelope until the rear of the stabilizer base extends about 3 inches over the tail. The strap on the stabilizer base is attached to the buckle on the envelope. After the three stabilizers are attached to the envelope, the wooden triangular brace is placed over the ends of the stabilizer bases and locked with wooden latches.

■ 39. INFLATION PROCEDURE.—*a. Inflating without a mooring net.*—When No. 1 has determined that the envelope is ready for inflation, he opens the gas-cylinder valves to which the manifold hoses are attached. As each cylinder becomes empty, he marks it "MT" and transfers the hose to another cylinder. When the envelope is approximately half filled with gas, Nos. 3 and 4 transfer the sandbags from the front handling lines to the front rigging patches. In making this transfer, each crewman maintains tension on the handling line with one hand while moving the sandbag with the other. The front handling lines are tied through the screw picket eyes at the right and left front of the envelope. In a similar manner, sandbags on the rear handling lines are transferred to the rear rigging patches and the lines are tied to the ground cable. Each handling line is tied with a picketing hitch, leaving sufficient slack in each line to allow for continued inflation. No. 2 stands by to supervise the work of Nos. 3 and 4, and to assist them when necessary. When thirteen cylinders of gas have been emptied, Nos. 1 and 2 take a manometer reading to determine the internal pressure which should be 1.6 inches of water. If the internal pressure is not up to 1.6 inches of water, No. 1 leaves the manometer with No. 2 and continues inflation until the proper pressure is reached. Nos. 3 and 4 tension the handling lines when the balloon is inflated to the proper pressure. Nos. 1 and 2 remove the inflation tube and thimble from the inflation appendix and tie the appendix off with a double-ply fabric strip 1 inch wide and about 30 inches long. A lark's-head knot is formed around the appendix close to

the envelope. The two ends of the fabric tie-off cord are wrapped tightly around the appendix four times in opposite directions. The end of the appendix is folded back on itself and four more wraps are made with the tie-off cord. Another fold is made with the appendix and four more wraps are made before the cord is tied with a square knot. The end of the tied-off appendix protrudes from the envelope.

b. Inflating balloon under a mooring net.—When the wind velocity is high enough to make inflation difficult, the balloon is unpacked and prepared for inflation as described in paragraph 37, and in addition a mooring net is placed lengthwise over the envelope before inflation begins. Three sandbags are hooked to each side of the mooring net. When No. 1 has determined that the envelope is ready for inflation, he opens the gas cylinder valves to which the manifold hoses are attached. Nos. 3 and 4 stand by on the right and left sides respectively to do whatever is necessary. No. 2 supervises the work of Nos. 3 and 4 and assists them in carrying out their operations. As the inflation progresses, the sandbags hooked to the mooring net are moved down the net as required. When the envelope is approximately half filled with gas, the sandbags are transferred to the rigging patches and the handling lines are tied in with sufficient slack to allow for complete inflation. The net is left over the envelope until inflation is completed. Nos. 3 and 4 remove the mooring net, straighten it, double it back end to end, and leave it in front of the balloon until the balloon is bedded down.

c. Replacing inflation equipment.—After the envelope has been inflated, the inflation tube is untied from the manifold bell and the inflation tube is rolled up. The manifold hoses are disconnected from the gas cylinders and the gas-cylinder caps are replaced over the gas valves. All inflation equipment is stored.

■ 40. SAFETY PRECAUTIONS.—All safety precautions pertaining to the handling of hydrogen gas, as listed in FM 4–187, must be strictly observed.

SECTION III

MANEUVERING AND MOORING

■ 41. GENERAL.—The balloon is handled by a four-man crew. Crewman No. 1 is responsible for giving commands and assisting crewmen Nos. 2, 3, and 4 in carrying them out. (For details of drills, see ch. 4.)

■ 42. PREPARING THE BED.—A ground cloth is placed diagonally on a leg of the bed as shown in figure 2. The leg selected should be one which will allow the nose of the balloon to point into the direction of the wind.

■ 43. MANEUVERING THE BALLOON.—The balloon is maneuvered by No. 1 at the junction of the foot ropes and controlled by Nos. 3 and 4, who man the front handling lines. No. 1 hooks enough sandbags to a rope grommet reeved through the lower eyes of the foot ropes to neutralize the lift of the balloon. The rudder must always be furled when the balloon is being maneuvered close to the ground. The nose of the balloon should be kept into the direction of the wind during maneuvering. Nearby obstacles which are likely to damage the balloon should be removed if possible. When the terrain is rough, the balloon may be maneuvered while flying from the 25-foot cable strop, if sufficient sandbags are attached to the lower end of the strop to neutralize the lift of the balloon.

■ 44. BEDDING DOWN BALLOON FROM FLYING (see drill table II).—To bed down the balloon from flying, No. 2 operates the winch to haul down the balloon. The balloon is hauled down until the lower lethal device is about 4 feet above the fair-lead, and Nos. 1 and 3 remove this lethal device from the flying wire assembly. The balloon is then hauled down until the upper lethal device is about 4 feet above the fair-lead, and Nos. 1 and 3 remove this lethal device. Nos. 3 and 4 then untie and man the front handling lines, and the balloon is hauled down until the junction of the foot ropes is just above the fair-lead. No. 1 hooks enough sandbags to the rope grommet at the junction of the foot ropes to neutralize the lift of the balloon. No. 2 furls the rudder. No. 1 unshackles the flying wire assembly from the foot ropes.

No. 2 hooks two sandbags to the upper 6-inch grommet strop in order to maintain tension on the flying wire assembly. The balloon is then maneuvered to the bed, where the procedure for bedding down is as follows:

a. The crew hauls the balloon down on the bed with the nose into the wind.

b. Nos. 3 and 4 keep tension on the front handling lines while Nos. 1 and 2 attach a sandbag to each of the rear rigging patches and tie the rear handling lines to the ground cable with a picketing hitch.

c. Nos. 3 and 4 release tension on the front handling lines, allowing the nose of the balloon to rise about 3 or 4 feet from the bed. Raising the nose of the balloon will lower the tail enough for Nos. 1 and 2 to reach and furl the fins.

d. Nos. 3 and 4 attach a sandbag to the front rigging patches and tie the front handling lines through the screw picket eyes, to the right and left front of the balloon, with a picketing hitch.

e. The mooring net, with the coiled heaving lines attached to the corners by a single bow knot, is flaked at the nose of the balloon. Nos. 3 and 4 throw the heaving lines diagonally over the balloon, and then pull the net over the balloon from nose to tail by pulling on the heaving lines. Nos. 1 and 2 help to work up the net over the nose of the balloon and watch the net to keep it from becoming entangled with any of the balloon parts. When the net is about half way over the balloon, Nos. 3 and 4 exchange heaving lines and continue to pull until the end of the net is just off the ground in front of the balloon. At the rear of the balloon, the net is folded forward so that it clears the front edge of the fabric on the stabilizers.

f. After the net is straightened on the balloon, the hooks, which are eye-spliced to the ends of the side-hook ropes, are attached (points outward) to the ground cable at the front center of the balloon by Nos. 3 and 4. These hooks are attached to the ground cable so that they interlock. Nos. 1 and 2 hold the coiled side-hook ropes and slide the hooks, which are reeved on the ropes, to Nos. 3 and 4, who attach them to the net and ground cable alternately on their respective sides of the balloon. There should be a minimum

of six hooks attached to the net and six hooks attached to the ground cable across the front of the balloon. The remaining hooks are attached about 2½ feet high on the net, except the last one on each side, which is attached about 6 feet high. Nos. 1 and 2 tie the ends of the side-hook ropes through the screw pickets eyes, to the right and left rear of the balloon, with picketing hitches. Then Nos. 1 and 2 adjust tension on the mooring net by raising or lowering the hooks on the net. While the tension on the net is adjusted, Nos. 3 and 4 untie the heaving lines, coil them, and place them under the tail of the balloon.

g. Nos. 3 and 4 remove the sandbags from the front rigging patches and slacken the front handling lines. Nos. 1 and 2 remove the sandbags from the rear rigging patches and slacken the rear handling lines. The handling lines should be slackened enough so that excessive tension will not develop on the handling-line patches if the balloon should shift on the bed. The balloon in a bedded-down position is shown in figure 18.

■ 45. BEDDING DOWN WITH FLYING-WIRE ASSEMBLY ATTACHED.—To permit the balloon to be bedded down with the flying-wire assembly attached to the junction of the foot ropes, the fair-lead and winch are placed as shown in figure 18. No. 2 operates the winch in hauling down the balloon. When the balloon is hauled down within reach, Nos. 3 and 4 man the front handling lines to control the balloon, and No. 1 furls the rudder. If required, No. 1 attaches a sandbag to the shackle at the junction of the foot ropes to neutralize the lift of the balloon. No. 2 releases the brake gradually so as to maintain tension on the flying wire assembly, and Nos. 1, 3, and 4 walk the balloon to its bed. When the balloon has been walked to the bed, No. 2 applies the winch brake and then attaches two sandbags to the eye in the upper 6-inch grommet strop. No. 1 maintains tension on the flying wire assembly until No. 2 attaches the two sandbags to the grommet strop as shown in figure 18. The crew hauls the balloon down and beds it as described in paragraph 44.

■ 46. STORAGE OF LETHAL DEVICES.—When not in use, the lethal devices are hung by means of a wire hook in a large

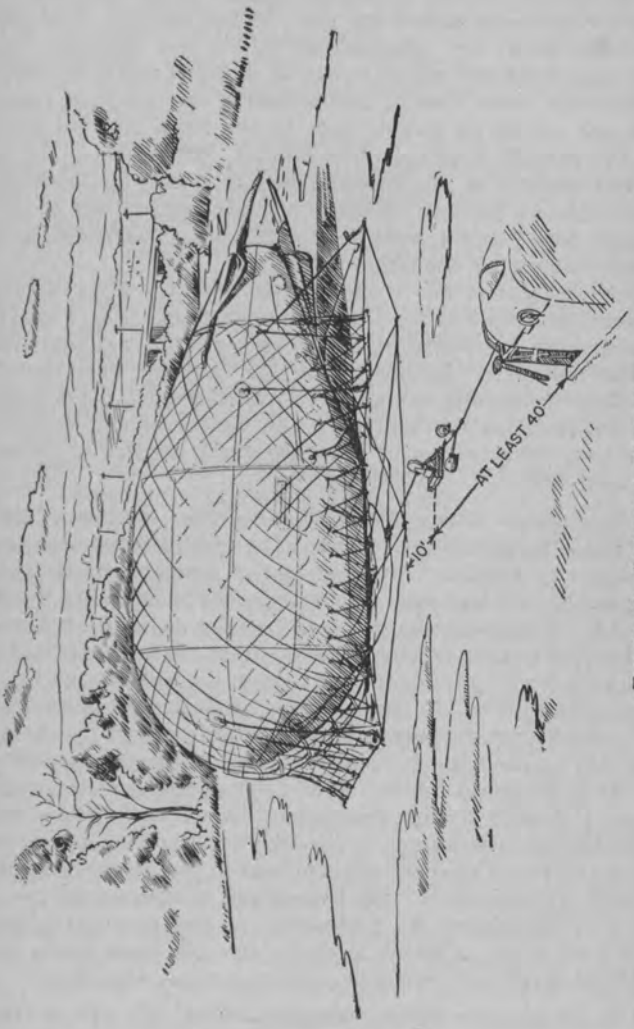


FIGURE 18.—Balloon bedded down.

watertight can, which is buried in the ground so that the top of the can is flush with the ground level. (See fig. 19.) The can is provided with a suitable cover and lock. This method of storing the lethal devices below the ground level will minimize the effect of the blast if they should explode inadvertently.

FIGURE 19.—Storage of lethal devices.

SECTION IV

FLYING THE BALLOON

■ 47. REMOVING BALLOON FROM THE BED (see drill table III).—The balloon is removed from the bed in reverse order of the bedding-down procedure described in paragraphs 44 and 45. In removing the mooring net from the balloon, it is important to pull it straight out in front of the balloon until the net is completely removed.

■ 48. PROCEDURE (see drill table IV).—After the balloon is removed from the bed, it is walked to the fair-lead. No. 1

attaches the flying wire assembly to the junction of the foot ropes and removes the sandbags used to neutralize the lift of the balloon. No. 2 unfurls the rudder, removes the sandbags used to maintain tension on the flying wire assembly, and then goes to the winch. (If the balloon is bedded down with the flying wire assembly attached to the balloon, No. 2 goes to the winch after the balloon is taken off the bed and hauls in the winch by hand to maintain tension on the flying wire while the balloon is being walked to the fair-lead. No. 1 unfurls the rudder). No. 2 pays out about 20 feet of the flying wire assembly, and Nos. 3 and 4 walk in on their handling lines, allowing the balloon to rise. Nos. 3 and 4 then attach the front handling lines to the flying wire assembly with a single bowline knot. The single bowline allows the front handling lines to move freely up and down the flying wire assembly, thus eliminating the possibility of the front handling lines becoming taut and imposing excessive tension on the front handling line patches. No. 2 again pays out the flying wire assembly until the upper inertia link is about 4 feet above the fair-lead.

■ 49. ATTACHING LETHAL DEVICES.—*a*. When No. 3 has completed attaching the handling line to the flying wire assembly, he gets the upper lethal device from its storage and carries it to the fair-lead. No. 3 holds the upper lethal device while No. 1 attaches the long shackle to the upper end of the inertia link and the shock absorber strop to the lower end, as shown in figure 7. Then No. 1 removes the safety clip from the inertia link, tapes the hole to prevent moisture from entering and removes the bomb safety plug.

b. No. 2 pays out the flying wire until the lower inertia link is about 4 feet above the fair-lead. No. 3 gets the lower lethal device and holds it while No. 1 attaches the long shackle to the upper end of the inertia link and the cable strop to the lower end. (See fig. 8.) No. 1 then removes the safety clip from the inertia link and tapes the hole. It is advisable to secure the parachute canister to the flying wire assembly with friction tape to prevent it from striking the inertia link and becoming damaged. No. 2 then pays

out the flying wire assembly until the quick connector is about 2½ feet above the fair-lead.

■ 50. TRANSFERRING FLYING WIRE ASSEMBLY TO AN ANCHORAGE STROP.—It is sometimes necessary to transfer the flying wire assembly to an anchorage strop and allow the balloon to fly from it. A transfer strop is used for this operation. No. 1 attaches the safety hook on the transfer strop to the long shackle of the quick connector, and then reeves the free end of the transfer strop through the anchorage eye. Nos. 3 and 4 keep tension on the transfer strop while No. 2 releases the winch brake to take tension off the winch leg. No. 1 disconnects the winch leg from the quick connector and connects the anchorage strop in its place. Nos. 3 and 4 release tension on the transfer strop and remove it from the flying wire assembly, thus allowing the anchorage strop to become taut. In transferring the flying wire assembly from the anchorage strop to the winch leg when the balloon is hauled down, this procedure is reversed.

SECTION V

TANDEM FLYING

■ 51. GENERAL.—Armed flying wire may be raised to a height of about 4,500 feet by using two VLA balloons in tandem. Each balloon carries 2,000 feet of armed flying wire, and the two balloons are flown from a common flying wire assembly. The arrangement of the flying wire assembly for tandem flying is shown in figure 20.

■ 52. EQUIPMENT.—*a. General.*—The equipment necessary for tandem flying consists of a gas valve, inertia links, socket eyes and wedges, swivels, quick connectors, strops, shackles, a safety hook, handling-line extensions, flying wire, outrigging poles, and lethal devices.

b. Gas valve.—Since the upper balloon may ascend to approximately 4,500 feet and is designed to fly at an altitude of approximately 2,000 feet, it is necessary to use a gas valve. If the balloon used as the upper balloon in the tandem has not been equipped with a gas valve by the

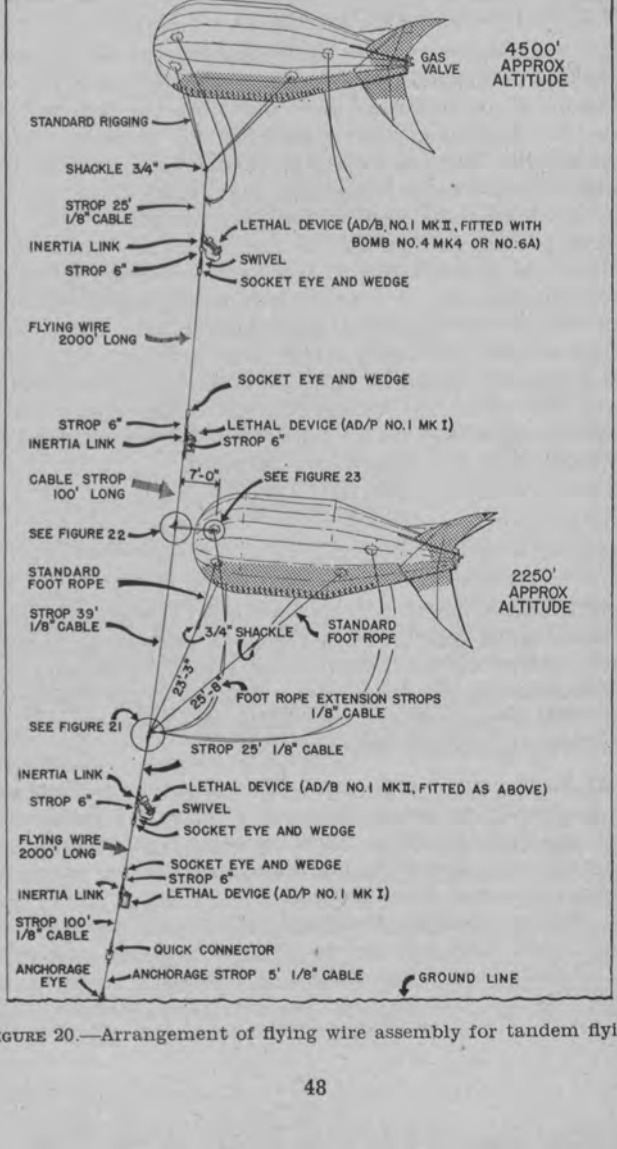


FIGURE 20.—Arrangement of flying wire assembly for tandem flying

manufacturer, the appendix sleeve is removed and a gas valve with a setting of 3.6 inches of water pressure and made into a fabric sleeve is cemented to the envelope in its place. When a gas valve is not available, the upper balloon should not be flown at an altitude greater than 3,000 feet.

c. Inertia links.—Four inertia links are used in the flying-wire assembly. They are placed in the flying-wire assembly at the following points:

(1) 100 feet above the fair-lead or anchorage eye.

(2) 25 feet below the attachment of the foot-rope extension of the lower balloon.

(3) 100 feet above the attachment of the outrigging poles.

(4) 25 feet below the attachment of the upper balloon.

d. Socket eyes and wedges.—A socket eye and wedge is used on each end of the 2,000-foot sections of flying wire. Thus there is a total of four socket eyes and wedges in the flying wire assembly.

e. Swivels.—It is necessary to use a swivel in the flying-wire assembly below the upper inertia link of each balloon.

f. Quick connectors.—Two quick connectors are placed in the flying-wire assembly for connecting the outrigging poles and the foot-rope extensions to the lower balloon. An additional quick connector is placed in the flying-wire assembly between the lower 100-foot strop and the winch leg, so that the balloons may be transferred to an anchorage eye when necessary.

g. Strops.—(1) Two foot-rope extension strops are necessary on the lower balloon when employed in tandem flying. These extension strops are used to attach the lower balloon to the flying-wire assembly. (See fig. 20.) They are made from ⅛-inch cable with a 1¼-inch thimbled eye-splice in each end. The extension strop for the front foot ropes is 23 feet 3 inches long, and the extension strop for the rear foot ropes is 25 feet 8 inches long. The upper end of the front foot-rope extension strop is attached to the two front foot ropes with a ¾-inch shackle; the lower end is shackled to the quick connector in the flying-wire assembly. The rear foot-rope extension strop is similarly attached. (See fig. 21.)

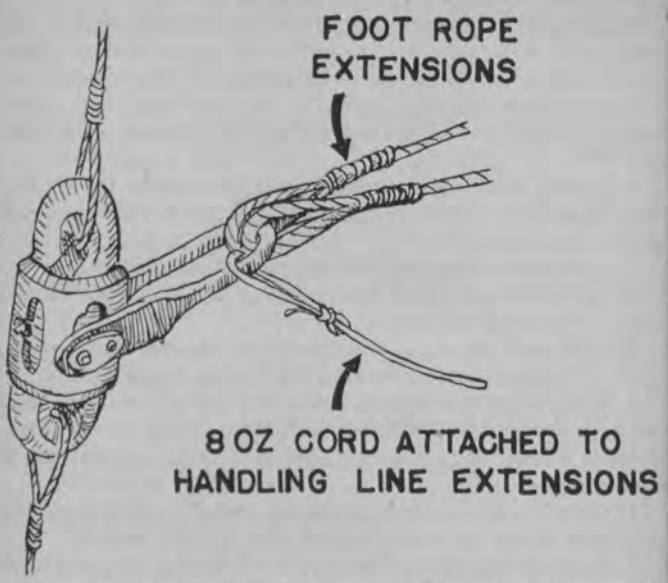


FIGURE 21.—Attachment of foot-rope extensions to flying-wire assembly.

(2) A 25-foot cable strop is used between the upper inertia link of each balloon and the point where the balloon is attached to the flying-wire assembly. (See fig. 20.) The strop for the upper balloon has a 1¼-inch thimbled eye splice made in one end and a soft eye splice in the other end. The strop for the lower balloon has a soft eye splice made in each end.

(3) A 39-foot cable strop is used between the quick connector for the attachment of the outrigging poles and the quick connector for the attachment of the lower balloon foot-rope extensions. (See fig. 20.) This strop is made of ⅛-inch cable with a soft eye splice in each end.

(4) A 100-foot cable strop is used between the lower inertia link of the upper balloon and the outrigging pole connection of the lower balloon. A similar strop is also used between the lower inertia link of the lower balloon and the winch leg.

(5) Four 6-inch grommet strops are used in the flying wire assembly. (See fig. 20.)

h. Shackles.—Three ¾-inch shackles are used to—

(1) Attach the upper balloon to the flying-wire assembly.

(2) Connect the front foot ropes of the lower balloon to the front extension strop.

(3) Connect the rear foot ropes of the lower balloon to the rear extension strop.

i. A 1-ton safety hook is used to connect the outrigging poles to the long shackle of the quick connector in the flying-wire assembly. (See fig. 22.)

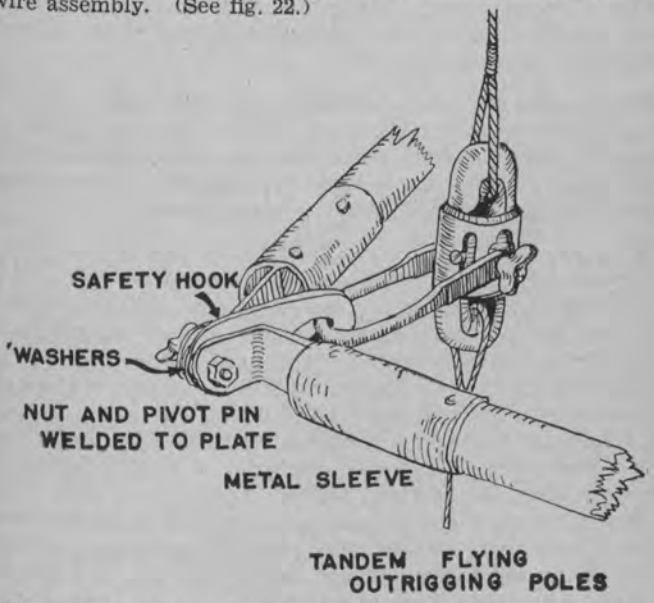


FIGURE 22.—Attachment of outrigging poles to quick connector.

j. Handling-line extension.—Handling lines on the upper balloon are of standard length. The front handling lines on the lower balloon require a 10-foot extension and the rear handling lines require a 35-foot extension. These extensions give an over-all length of 50 feet for each of the four handling lines.

k. Flying wire.—Two 2,000-foot sections of flying wire are placed in the flying wire assembly for tandem flying. These 2,000-foot sections are the lethal sections of the flying wire assembly, and each section functions as shown in figure 9.

l. Outrigging poles.—See figures 20, 22, and 23 for details of outrigging poles and their attachment to the balloon. The rear ends of the outrigging poles are securely attached to the rope eyes of the front handling-line patches on the lower balloon with ⅛-inch cord, as shown in figure 23. It is advisable to wrap the cord used for the attachment with friction tape when completed. The front ends of the outrigging poles are connected to the quick connector in front of the balloon with a 1-ton safety hook.

■ 53. INTERNAL PRESSURE OF BALLOONS.—Each balloon should have sufficient internal pressure to assure 50 to 52 pounds of net lift. Under normal conditions the upper balloon should be topped up to 1.6 inches water pressure. The lower balloon should be topped up to 1.8 inches water pressure.

■ 54. FLYING THE BALLOON IN TANDEM.—*a.* The drill for flying balloons in tandem is shown in drill table V.

b. The upper balloon is removed from its bed and attached to the flying-wire assembly. As the balloon ascends, the lethal devices are attached. The upper balloon is allowed to ascend until the quick connector attachment for the outrigging poles is about 7 feet above the fair-lead. The altitude of the upper balloon is approximately 2,250 feet at this point.

c. The lower balloon with outrigging poles attached is removed from the bed and walked to the flying wire. The winged nut on the outrigging poles is removed and the poles are spread apart slightly. The poles are then passed around the flying-wire assembly and the winged nut is replaced. The 1-ton safety hook is attached to the long shackle of the quick connector on the flying-wire assembly. Crewman No. 1 makes this connection.

d. Nos. 3 and 4 man the front handling lines and No. 2 mans the rear handling lines as the outrigging poles are connected to the flying wire assembly.

e. After making the connection, No. 1 goes to the rear handling lines and No. 2 returns to the winch and allows the balloons to ascend. Crewmen Nos. 3 and 4 keep tension on

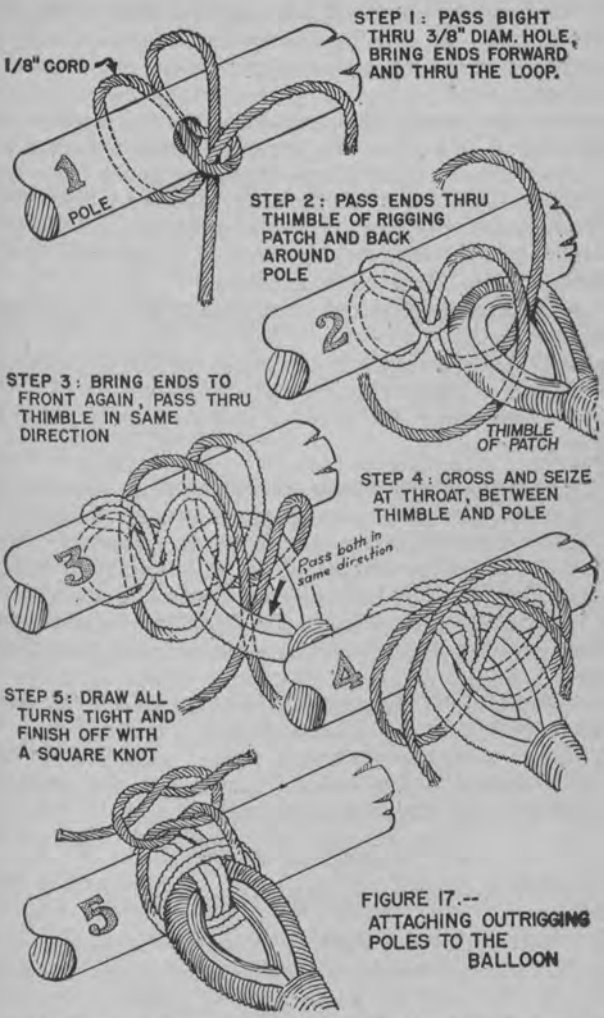


FIGURE 23.—Attachment of outrigging poles to balloon.

the front handling lines, and No. 1 keeps tension on the rear handling lines. They allow the balloon to ascend rapidly enough to keep the outrigging poles straight out in front of the balloon.

f. After the second quick connector reaches a point approximately 4 feet above the fair-lead, the winch operator stops the winch. The foot-rope extensions of the lower balloon are then connected to the long shackle of the second quick connector. The handling-line extensions are bunched and tied together with a ⅛-inch cord. The cord is tied to the long shackle of the quick connector.

g. Approximately 2,250 feet additional flying wire are paid out.

h. As the balloons ascend, the lethal devices are attached to the lower section of the flying-wire assembly.

i. When necessary, the balloons may be transferred to an anchorage strop.

■ 55. OPERATORS UNDER GUSTY WIND CONDITIONS.—*a. Crew.*—Under gusty wind conditions, five men may be required to attach the lower balloon to the flying wire assembly, or to detach it. The fifth member of the crew (No. 5) will man the rear handling lines on the lower balloon in place of No. 2, who will assist No. 1 in attaching or detaching the outrigging poles to or from the flying wire assembly. See Drill Table No. 5.

b. Redistribution of personnel.—In order to provide for a crew of five men on a site to handle the lower balloon, a redistribution of personnel must be made. The battery commander, assisted by the platoon commanders, will decide in advance the redistribution of personnel.

SECTION VI

MISCELLANEOUS OPERATIONS

■ 56. TESTING GAS FOR PURITY.—A sample of gas is taken from the balloon through the manometer connection every 48 hours and tested for purity with an effusion apparatus. (See FM 4–182 when published.) When the gas purity drops to 88 percent, the crew deflates the balloon and inflates with gas of a high purity. The net lift of a balloon inflated to 1.6

inches of water pressure, containing hydrogen gas with a purity of 88 percent, is about 36 pounds. Hydrogen gas with a purity lower than 88 percent is dangerous and does not provide sufficient lift to carry the weight of the flying wire assembly and lethal devices to an altitude of 2,000 feet, unless the balloon is overinflated.

■ 57. TOPPING UP THE BALLOON.—*a.* The internal pressure of the balloon is determined with a manometer. A manometer reading should be taken each morning before superheat is present to assure a minimum internal pressure of 1.6 inches of water without superheat. If topping-up is done with superheat present, the internal pressure should be increased, .2 inch of water for each estimated 10° of superheat. For example, if 20° of superheat is estimated at the time the balloon is topped up, the internal pressure should be 2 inches of water rather than 1.6 inches.

b. Topping up may be accomplished through the manometer connection by using a topping-up hose. The balloon may also be topped up through the inflation appendix in the same manner that inflation is accomplished. Since the balloon is not provided with a gas valve to expel gas when the maximum volume is reached, the crew should be careful not to overinflate the balloon when topping up.

c. If the gas purity approaches a purity of 88 percent, the balloon may be weighed off with a spring scale to assure sufficient lift to carry the flying wire assembly and lethal devices up to an altitude of 2,000 feet. In weighing off, the spring scale is attached to the junction of the foot ropes, and enough pressure is applied on the scale to neutralize the lift of the balloon. The weigh off is read on the scale when the neutralization point of the balloon lift is reached.

■ 58. DEFLATING THE BALLOON.—The balloon is deflated in reverse order from which it is inflated. Normally hydrogen is used in the balloon and no effort is made to save the gas when deflating. The appendix is untied and the hydrogen is allowed to escape into the air. All safety precautions must be observed. (See FM 4–187.) In case the balloon is inflated with helium for training or experimental purposes, the helium may be transferred to a nurse bag and carried to a plant to be purified. (See FM 4–182 when published.)

■ 59. PACKING THE BALLOON.—In case the balloon is to be packed after the deflation, the reverse procedure to unpacking is followed. If neoprene cement has been used in making repairs on the balloon, the repaired parts should be liberally sprinkled with French chalk or talc, to prevent accidental adhesions during storage.

CHAPTER 4

DRILLS

60. FORMING THE CREW.—The balloon crew is formed in front of the balloon. No. 1 takes his position five paces in front of and facing the nose of the balloon. Other members of the crew fall in three paces in front of the nose of the balloon facing crewman No. 1. The crew counts off from right to left. At the command: 1. DETAILS, 2. POSTS, the crewmen take their positions as designated in the drill tables.

61. DRILL TABLES.—The drills to be used in handling the VLA balloon are outlined in tables I to V, inclusive.

TABLE I.—*Drill to inflate balloon (four-man crew)*

Commands	Operations and individuals responsible
Prepare bed for inflation.	All crewmen—Lay out two ground cloths on the leg of the bed selected for inflation.
Lay out inflation equipment.	No. 4 —Spreads ground cloth in front of gas cylinders and unrolls inflation tube toward bed.
	Nos. 2 and 3—Connect inflation tube to manifold bell with an elastic tie-off cord.
	Nos. 2, 3, and 4. —Wet down bed and area in front of gas cylinders.
	No. 1 —Attaches manifold hoses to gas-cylinder valves.
Unpack balloon.	Nos. 2, 3, and 4. —Place valise on the down-wind edge of ground cloth and remove it from the balloon.
Roll balloon out on bed.	Nos. 2, 3, and 4. —Roll balloon out on the bed with the nose facing into the wind and the expansion system upward; remove tape and fabric from metal parts.
	No. 1 —Ties off inflation appendix with an elastic tie-off cord; inspects balloon envelope.
Turn balloon over.	All crewmen—Turn balloon over on the bed with expansion system downward.
Attach stabilizers.	All crewmen—Attach the stabilizers to the envelope and put on the triangular wooden brace.
Attach handling lines.	Nos. 3 and 4— Lark's -head handling lines to eyes in handling-line patches.
	Nos. 1 and 2—Connect inflation tube to inflation appendix with an elastic tie-off cord.
Attach sandbags to handling lines.	Nos. 2, 3, and 4. —Attach sandbags to handling lines about 6 feet from the balloon, using a harness hitch.
	No. 1 —Opens gas cylinder valves.

Transfer sandbags; tie in handling lines.	Nos. 3 and 4—*Transfer sandbags to rigging patches; tie in handling lines with a picketing hitch, leaving sufficient slack to allow for continued inflation (front handling lines to screw picket eyes, rear handling lines to ground cable).*
	No. 1 —Continues inflation.
	Nos. 1 and 2—Take manometer reading; disconnect inflation tube; tie off inflation appendix with an elastic tie-off cord when inflation is completed.
Tighten handling lines.	Nos. 3 and 4—Take slack out of handling lines.
Uncoil foot ropes.	All crewmen—Unwrap, uncoil, and straighten foot ropes.

NOTES

1. The balloon may be bedded down or flown after inflation is completed.
2. Inflation equipment is replaced after balloon is bedded down or flying.

TABLE II.—*Drill to bed down the balloon from flying (four-man crew)*

Commands	Operations and individuals responsible
(See note 1) Man front handling lines	Nos. 3 and 4—Untie and man front handling lines.
	No. 2 —Attaches two sandbags to the upper grommet strop in the flying wire assembly, if the balloon is not bedded down attached to the flying wire assembly; furls rudder.
	No. 1 —Attaches sandbag to junction of foot ropes; disconnects flying wire assembly, if the balloon is not beded down attached to the flying wire assembly.
(See note 2) Walk the balloon to the bed	All crewmen—Walk the balloon to the bed.
	No. 2 —Attaches two sandbags to the upper grommet strop in the flying wire assembly, if the balloon is bedded down attached to the flying wire assembly.

TABLE II.—*Drill to bed down the balloon from flying (four-man crew)*—Continued

Commands	Operations and individuals responsible
Haul down	Nos. 3 and 4—Pull down on front handling lines and hold balloon on bed. No. 1 —Pulls down on foot ropes and places sandbag on side of bed; attaches sandbag to left rear rigging patch; ties left rear handling line to ground cable with a picketing hitch. No. 2 —Pulls down on rear handling lines; attaches sandbag to right rear rigging patch; ties right rear handling line to ground cable with a picketing hitch.
Ease off on nose	Nos. 3 and 4—Release tension on front handling lines, allowing the nose of the balloon to rise about 3 or 4 feet. Keep the rudder from touching the ground. Nos. 1 and 2—Furl fins (No. 1, left; No. 2, right).
Attach sandbags; tie in front handling lines.	Nos. 3 and 4—Attach sandbags to front rigging patches; tie in front handling lines to screw picket eyes with a picketing hitch.
Put on net.	Nos. 3 and 4—Pull net to the nose of the balloon; throw heaving lines diagonally over balloon; pull net over balloon. Nos. 1 and 2—Keep net from becoming entangled with the manometer connection, or any parts of the balloon; assist Nos. 3 and 4.
Put on ground rigging, starting at the nose.	Nos. 3 and 4—Fasten side-hook ropes together; then hook to ground cable in front center of balloon; fasten rest of hooks alternately to the ground cable and to the net. Nos. 1 and 2—Assist Nos. 3 and 4; tie running end of side-hook ropes to screw picket eyes with a picketing hitch.
Tighten ground rigging, starting at the nose.	Nos. 1 and 2—Adjust tension on mooring net by raising or lowering hooks when necessary. Nos. 3 and 4—Remove, coil, and place heaving lines under tail of balloon.
Slacken handling lines; remove sandbags.	Nos. 1 and 2—Slacken rear handling lines; remove sandbags from rear rigging patches. Nos. 3 and 4—Slacken front handling lines; remove sandbags from front rigging patches.

1. No. 2 operates the winch in hauling down the balloon; Nos. 1 and 3 detach the lethal devices; Nos. 3 and 4 take posts to man the front handling lines.

2. If the balloon is bedded down with the flying wire assembly attached to the foot ropes, No. 1 furls the rudder; No. 2 remains at the winch to pay out the flying wire assembly as Nos. 1, 3, and 4 walk the balloon to the bed, maintaining tension on the flying wire assembly.

TABLE III.—*Drill to remove the balloon from the bed (four-man crew)*

Commands	Operations and individuals responsible
1. BALLOON CREW, 2. FALL IN.	No. 1 —Falls in 5 paces in front of and facing the balloon. Nos. 2, 3, and 4 —Fall in 3 paces in front of balloon, facing No. 1.
COUNT OFF:	Nos. 2, 3, and 4 —Count off from right to left.
1. DETAILS, 2. POSTS.	No. 1 —Remains at nose of balloon. No. 2 —Takes post at tail of balloon (right side). No. 3 —Takes post at right front of balloon. No. 4 —Takes post at left front of balloon.
Put on sandbags; tighten handling lines.	Nos. 3 and 4—Attach sandbags to front rigging patches; tighten front handling lines. Nos. 1 and 2—Attach sandbags to rear rigging patches; tighten rear handling lines (No. 1, left side; No. 2, right side).
Remove ground rigging, starting at the tail.	Nos. 3 and 4—Unfasten hooks from mooring net and ground cable, starting at the tail. Nos. 1 and 2—Untie side-hook ropes from screw picket eyes; coil and place them at the right and left front of the balloon.
Remove net.	Nos. 3 and 4—Pull net from balloon (over the nose). Nos. 1 and 2—Keep net from becoming entangled with the manometer connection, or any parts of the balloon; assist Nos. 3 and 4.

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TABLE III.—*Drill to remove the balloon from the bed (four-man crew)*—Continued

Commands	Operations and individuals responsible
Remove sandbags; untie front handling lines.	No. 2 —Attaches sandbag to junction of foot ropes. Nos. 3 and 4—Remove sandbags from front rigging patches; untie and remove front handling lines from screw picket eyes.
Ease off on nose.	Nos. 3 and 4—Release tension on front handling lines, allowing the nose of the balloon to rise about 3 or 4 feet; keep rudder from touching the ground. Nos. 1 and 2—Unfurl fins; remove sandbags from rear rigging patches; untie rear handling lines from ground cable (No. 1, left; No. 2, right).
Ease off slowly.	Nos. 3 and 4—Pay out front handling lines hand under hand, letting balloon rise clear of bed. No. 1 —Works at junction of foot ropes. No. 2 —Keeps tail of balloon from striking the ground.
(See notes 1 and 2.)	

NOTES

1. The balloon is now walked to the fair-lead.

2. When the balloon is bedded down attached to the flying wire assembly, No. 1 keeps tension on the flying-wire assembly; No. 2 removes the sandbags from the upper grommet strop and operates the winch by hand to haul in the flying wire assembly as Nos. 1, 3, and 4 walk the balloon to the fair-lead. No. 1 unfurls the rudder and No. 2 remains at the winch.

TABLE IV.—*Drill to fly the balloon (four-man crew)*

Commands	Operations and individuals responsible
(See note 1.)	
Keep tension on handling lines.	Nos. 3 and 4—Keep tension on front handling lines.
	No. 1 —Attaches flying wire assembly to junction of foot ropes, if the balloon is not bedded down attached to the flying wire assembly; removes sandbag from junction of foot ropes.
	No. 2 —Unfurls rudder; removes sandbags used to keep tension on the flying wire assembly, if balloon is not bedded down attached to the flying wire assembly; then moves to the winch.
Pay out winch.	No. 2 —Pays out about 20 feet of the flying wire assembly.
Attach front handling lines.	Nos. 3 and 4—Attach front handling lines to the flying wire assembly with a single bowline knot.
Pay out winch.	No. 2 —Pays out winch until the upper inertia link is 4 feet above the fair-lead.
	Nos. 1 and 3—Attach the upper lethal device.
	No. 1 —Removes safety clip from inertia link; tapes hole; removes the bomb safety plug.
Pay out winch.	No. 2 —Pays out winch until the lower inertia link is 4 feet above the fair-lead.
	Nos. 1 and 3—Attach the lower lethal device.
	No. 1 —Removes safety clip from inertia link; tapes hole.
Pay out winch.	No. 2 —Pays out winch until the quick connector is 2½ feet above the fair-lead; applies winch brake.
(See note 2.)	
Transfer to anchorage strop.	No. 1 —Attaches transfer strop to the long shackle of the quick connector; reeves loose end through anchorage eye.
	Nos. 3 and 4—Maintain tension on transfer strop.
	No. 2 —Releases winch brake to take tension off winch leg.

TABLE IV.—*Drill to fly the balloon (four-man crew)*—Continued

Commands	Operations and individuals responsible
	No. 1 —Removes winch leg from quick connector; attaches anchorage strop to quick connector. Nos. 3 and 4—Release tension on transfer strop, allowing the anchorage strop to become taut; remove transfer strop from quick connector.

NOTES

1. When the balloon is bedded down attached to the flying wire assembly, it is walked to the fair-lead as No. 2 hauls in the flying wire assembly; then No. 1 unfurls the rudder.
2. The balloon may be flown from the winch, unless it is necessary to transfer it to an anchorage strop.

TABLE V.—*Drill for tandem flying (four- (or five-) man crew)*

Commands	Operations and individuals responsible
(See note 1.) *Keep tension on handling lines.*	Nos. 3 and 4—Keep tension on front handling lines of lower balloon. No. 2 —Keeps tension on rear handling lines of lower balloon. No. 1 —Attaches the outrigging poles to the quick connector; then mans rear handling lines.
Pay out winch.	No. 2 —Unfurls rudder; returns to winch. No. 2 —Pays out winch until the second quick connector is 4 feet above the fair-lead.

	Nos. 1, 3 and 4—Pay out on handling lines, keeping the outrigging poles straight out in front of the balloon.
	No. 1 —Attaches foot-rope extension to the long shackle of the quick connector.
(See note 2.) Attach handling lines.	Nos. 3 and 4—Tie handling-line extensions together with a ⅛-inch cord; then tie the cord to the long shackle of the quick connector.
Pay out winch.	No. 2 —Pays out winch until the third inertia link is 4 feet above the fair-lead.
	Nos. 1 and 3—Attach the upper lethal device.
	No. 1 —Removes safety clip from inertia link; tapes hole; removes safety plug from bomb.
Pay out winch.	No. 2 —Pays out winch until the fourth inertia link is 4 feet above the fair-lead.
	Nos. 1 and 3—Attach the lower lethal device.
	No. 1 —Removes safety clip from inertia link; tapes hole.
Pay out winch. (See note 3.)	No. 2 —Pays out winch until the third quick connector is about 2½ feet above the fair-lead.

NOTES

1. The procedure to fly the upper balloon in tandem is identical to that for single flying until the first quick connector is about 7 feet above the fair-lead; therefore that part of the drill is omitted in this table.

2. In gusty winds, a fifth man (No. 5) will be provided in the balloon crew. No. 5 will man the rear handling lines of the lower balloon in place of No. 2, who will assist No. 1 in attaching the outrigging poles to the quick connector.

3. The balloons may be flown from the winch, unless it is necessary to transfer them to an anchorage strop. The transfer is accomplished as described in Table 4.

CHAPTER 5

AMPHIBIOUS OPERATIONS

SECTION I

GENERAL

■ 62. MISSIONS.—*a. General.*—The missions of VLA balloons in an amphibious (shore to shore) operation are to offer protection for landing craft against low-altitude air attack and to protect the beachhead against low-altitude air attack.

b. Protection of large landing craft.—Balloons used for the protection of large landing craft are kept on these craft at all times and are not intended to be removed to the hostile beach when the beach is reached.

c. Protection of beachhead.—Balloons to be used for the protection of a beachhead normally are flown from the 25-foot cable strop while being transported in landing craft. If, however, the operation is discovered by the enemy, balloons on flank landing craft are flown at operational height. When the beach is reached, all balloons are unloaded from the landing craft and flown at operational height from sites established on the beach.

d. Reference.—A full discussion of the tactical employment of VLA balloons in an amphibious operation is contained in FM 4–181 (when published).

SECTION II

PROTECTION OF LARGE LANDING CRAFT

■ 63. GENERAL.—Balloons used for the protection of large landing craft in amphibious operations will remain on the boat at all times during the initial and resupply phases of the operation. Provision must be made for topping-up the balloon from the craft. Provision must also be made for

close-hauling the balloon to prevent the balloon from giving away the position of the craft in the event of a low cloud cover. A balloon crew of two men must be provided on the craft to handle the balloon and armament and to top up the balloon.

■ 64. ARMING.—The arming scheme for a balloon which is used to protect a large landing craft is discussed in paragraph 15 and shown in figure 11.

■ 65. WINCH.—A hand winch will be used on board the craft to provide for the operational control of the balloon and to haul down the balloon for topping-up. The winch will be mounted on the deck as far from above-deck obstructions as conditions on the craft will permit.

■ 66. SERVICING STATION.—A servicing station will be provided at the embarkation point to inflate and place the balloons on outgoing craft, and to take the balloons off incoming craft and repair and top up these balloons as necessary.

■ 67. TRANSFERRING THE BALLOON.—The balloon is inflated on a shore bed, on the dock or beach at the embarkation point. Before inflation begins, the 25-foot cable strop of the flying wire assembly is attached to the foot ropes of the balloon, and the lower eye of the cable strop is attached to three or more sandbags about 25 feet from the balloon. After the balloon is inflated, the fins are unfurled and the balloon is eased off the bed. The rudder is then unfurled, and the balloon is allowed to rise until it is flying from the 25-foot strop. Flying from the 25-foot strop, the balloon is walked aboard the landing craft. Sufficient sandbags to take the pull of the balloon are left in the lower eye of the 25-foot cable strop while the balloon is being walked aboard.

■ 68. FLYING THE BALLOON.—When the balloon is walked aboard the ship, it is taken to a point adjacent to the winch or fair-lead, if a fair-lead is provided. A safety strop, consisting of about 15 feet of ½-inch rope with a safety hook eye-spliced in one end, is snapped into the lower eye of the transfer strop (see fig. 11). The lower end of the safety strop is made fast to a suitable point on the deck, and the sandbags are removed from the lower eye of the 25-foot cable

strop so that the pull of the balloon is taken by the safety strop. The inertia link and upper parachute, which are attached to the flying cable assembly reeled on the drum of the winch, are then attached to the lower eye of the 25-foot cable strop (see fig. 11). The safety strop is then eased off until the balloon is flying from the flying cable assembly. During all of the above operations, it may be necessary to man the front handling lines to steady the balloon. After the upper inertia link and parachute are attached, the front handling lines are tied to the 25-foot cable strop; and the winch is payed out to allow the balloon to rise until the swedged stop and split sleeve are bearing against the lower bell mouth of the cable cutter to take the pull of the balloon (see fig. 11).

■ 69. CLOSE-HAUL.—In order to prevent the balloon from flying above a low cloud cover and thus giving away the position of the craft to hostile aircraft, the balloon is close-hauled. The safest position for the balloon at close-haul is flying about 100 feet above the deck. If the balloon must be put up to operating height within a short time, it is hauled down until it is flying about 100 feet above the deck, and the upper inertia link and parachute are left on the flying cable assembly. If the tactical situation permits, the upper lethal device is removed to fly the balloon at close-haul in order to prevent the inertia link from firing inadvertently and freeing the balloon. To remove the upper lethal device, the following procedure is used:

a. The balloon is hauled down until the inertia link is just above the bell mouth of the cable cutter. It may be necessary to man the front handling lines when they come within reach.

b. The safety strop is attached to the lower eye of the transfer strop and made fast to a point on the deck so that the pull of the balloon is taken by the safey strop.

c. The inertia link and parachute are removed from the flying cable assembly, and the safety hook at the upper end of the flying cable assembly is attached to the lower eye of the 25-foot cable strop.

d. The safety strop is detached from the lower eye of the transfer strop so that the pull of the balloon is again taken by

the flying cable assembly. The winch is then paid out until the balloon is flying about 100 feet above the deck.

e. To replace the upper inertia link and parachute, the procedure described above is reversed.

■ 70. TOPPING-UP ON LANDING CRAFT.—*a.* If the landing craft is to be at sea for several days, provision is made for topping up the balloon on board the landing craft. The topping-up requirements of the balloon are about 150 cubic feet of gas per day. Sufficient gas to meet these requirements is taken aboard the landing craft. To top up the balloon, the balloon is hauled down with the winch until the upper inertia link and parachute are just above the bell mouth of the cable cutter. The balloon is then hauled down the remainder of the way by means of the handling lines.

b. After the balloon is hauled down on the deck, it is held down by tying off the handling lines to any suitable points on the deck and hanging sandbags on the rigging patches.

c. The balloon is topped up as described in paragraph 57.

SECTION III

PROTECTION OF BEACHHEAD

■ 71. GENERAL.—The balloons which are to be used for the protection of a beachhead are inflated at the point of embarkation and are loaded on a landing craft and transported to the hostile beach, where they are unloaded and flown from sites on the beach.

■ 72. ARMING.—The arming scheme for a balloon which is used to protect a beachhead is discussed in paragraph 11 and shown in figure 4.

■ 73. WINCH.—A hand winch is provided for each balloon. This winch is loaded on a landing craft and transported to the hostile beach along with the balloon.

■ 74. PREPARATIONS FOR DEPARTURE.—The battery and platoon commanders will determine to which boats the balloons will be assigned and will assign the balloon crews to boats. So far as practicable, each balloon crew is instructed as

to the position its balloon will occupy on the hostile beach. The platoon commander will be on hand at the hostile beach to direct the balloon crews to positions in order to establish a good defense, but if some unforeseen circumstance prevents the platoon commander from arriving, the balloon crews must be able to locate the balloons so that a good defense will be established. Reserve balloons, winches, and other equipment which are to be transported to the beachhead during the resupply phases of the operation are inspected and packed. The balloons which are to be used in the operation are inflated, and the flying-wire assemblies are reeled onto the winch storage drums of the winches which are to be used in the operation.

■ 75. INFLATION AND LOADING OF BALLOONS AND WINCHES.—Simple, two-way beds are constructed upon which to inflate the balloons and bed the balloons down prior to departure. The balloon is inflated and walked aboard the landing craft as described in paragraph 67. The sandbags hooked into the lower eyes of the 25-foot cable strop are left attached during the journey to the hostile beach. In order to provide a margin of safety and to prevent the sandbags from shifting, a ¼-inch rope may be reeved through the eye and made fast to a suitable point on the boat. The winch with the flying wire assembly reeled on the storage drum is loaded on the boat with the balloon. The lethal devices are stored in a dry place on the boat.

■ 76. JOURNEY TO HOSTILE BEACH.—A minimum of two crewmen must accompany each balloon to the hostile beach. Other balloon crewmen for each balloon will make the journey in succeeding waves of the operation. The majority of the balloons used in the operation will normally be flown from the 25-foot cable strop until the hostile beach is reached. The plan may call for some of the balloons to be flown at operating height prior to landing. In this case, the balloons which are to be flown at operating height are attached to the flying wire assembly at the appointed time, and the sandbags are removed one by one from the lower eye of the 25-foot cable strop until the pull of the balloon is taken by the flying wire assembly. The bomb is attached to the upper inertia link, and the balloon is allowed

to rise until the lower inertia link comes off the storage drum; then the parachute is attached to the lower inertia link. The balloon is allowed to rise still further until the quick connector comes off the storage drum. Sandbags are attached to the lower eye of the 100-foot cable strop and the quick connector is disconnected so that the pull of the balloon is taken by the sandbags.

■ 77. UNLOADING.—When the hostile beach is reached, all balloons and winches are unloaded and transported to sites on the beach. The platoon commander should be on hand to direct the crews to sites, but if the platoon commander does not arrive, balloon crews should use their best judgment in locating sites in accordance with previous instructions. The balloons flying from the 25-foot cable strops in the boats are taken ashore with the sandbags attached to the lower eye of the cable strop and are left flying from the sandbag anchorages while the crew returns to the boat to obtain the winch and lethal devices. The balloon is attached to the flying wire assembly and is put up to operating height without delay. When the balloons reach operating height, sandbags are attached to the eye in the lower end of the 100-foot cable strop and the winch leg is detached at the quick connector. The sandbags are then buried below the surface of the ground to provide additional resistance as an anchorage. The balloons which are flying at operating height in the boats are taken ashore with the sandbags attached to the lower eye of the 100-foot cable strop, and when the site is reached the sandbags are buried as described above. The crew then returns to the boat to obtain the winch.

■ 78. CONTINUOUS OPERATIONS.—Reserve matériel will arrive in the resupply phases of the operation, together with matériel to establish balloon beds on the beaches and provide for operational control of the balloons.

CHAPTER 6

PROTECTION OF TRUCKS, TRAINS, AND TANKS

■ 79. GENERAL.—Balloons may be shackled to trucks, trains, or tanks as a protection against low-altitude attack where there are no overhead obstructions to interfere with the operation of the balloons. The tactical use of balloons in this connection is discussed in FM 4–181 (when published).

■ 80. ARMING.—The arming of balloons used for the protection of trucks, trains, or tanks is discussed in paragraph 16 and shown in figure 12.

■ 81. SERVICING STATIONS.—No provision is made for controlling a balloon flown from a truck, train, or tank. The balloons are put up to operating height at a servicing station established for the purpose, and are then shackled to the truck, train, or tank, where they remain until another servicing station is reached. Servicing stations are established along a railway or convoy route to haul down the balloons for inspection and topping-up at least every 2 days.

■ 82. WINCH.—The various shackles in the flying cable assembly will not pass through a fair-lead; therefore, the flying cable must be led directly off the winch storage drum. To wind the flying cable assembly on the storage drum, the upper end of the 100-foot cable strop is shackled to the lower eye of the transfer strop at the lower inertia link, and the safety hook at the upper end of the flying cable is hooked to the lower eye of the transfer strop at the upper inertia link. (See fig. 12.) This allows the flying cable assembly to be wound on the storage drum with the inertia links and parachutes completely removed.

■ 83. FLYING THE BALLOON.—The balloon is inflated on the bed as described in paragraph 39. The balloon is taken off the bed and walked to the winch, where the upper end of the 25-foot cable strop is shackled to the foot ropes. The balloon

is eased off until the pull of the balloon is taken by the flying cable assembly, and the winch is paid out until the swivel and safety hook come off the storage drum. A safety strop, consisting of a 15-foot length of ½-inch rope with a safety hook eye-spliced in one end, is attached to the lower eye of the transfer strop and made fast to an anchorage so that the pull of the balloon is taken by the safety strop. The upper inertia link and parachute are attached as shown in figure 12. The safety strop is eased off until the pull of the balloon is taken by the flying cable assembly, and the winch is paid out until the lower end of the 1,000 feet of flying cable comes off the storage drum. The safety strop is attached to the lower eye of the transfer strop and made fast to an anchorage so that the pull of the balloon is taken by the safety strop. The lower inertia link and parachute are attached as shown in figure 12. The safety strop is eased off until the pull of the balloon is taken by the flying cable assembly, and the winch is paid out until the lower end of the 100-foot cable strop comes off the storage drum. The safety strop is attached to the eye at the lower end of the 100-foot cable strop and made fast to an anchorage so that the pull of the balloon is taken by the safety strop. Sufficient sandbags are attached to the lower eye of the 100-foot cable strop to take the pull of the balloon, and the safety strop is unfastened from the anchorage. The balloon is now flying at operating height and is ready to be walked to the truck, train, or tank and shackled on.

■ 84. PASSING.—When trucks, trains, or tanks armed with balloons pass one another, care must be exercised so that the balloons do not become entangled. Since trucks and tanks flying balloons can be operated in the desert, ample space will be available for maneuvering to prevent entangling. When two trains flying balloons pass one another, the balloon is unshackled from one of the trains and walked far enough to one side of the railway to prevent entangling.

CHAPTER 7

DESTRUCTION OF MATÉRIEL

■ 85. SITUATIONS REQUIRING DESTRUCTION.—When capture is imminent and limitations of time or transportation make it impossible to evacuate equipment, it is imperative that such equipment be destroyed. The destruction of such equipment should be sufficiently complete to render it unserviceable to the enemy, should it be captured. Destruction will be undertaken only upon authority delegated by the division or higher commander.

■ 86. PLANS FOR DESTRUCTION.—Plans for destruction should be thorough, uniform, and applicable to field conditions. Personnel should be thoroughly acquainted with their duties and assignments under the plan.

■ 87. MATÉRIEL TO BE DESTROYED.—Matériel to be destroyed in event capture appears imminent includes—

a. Balloons.
b. Winches.
c. Flying-wire assembly.
d. Gas cylinders.
e. Site equipment.
f. Hydrogen generator.
g. Motor transportation equipment.
h. Lethal devices.

■ 88. METHODS.—*a. Balloons.*—(1) Bedded-down balloons are destroyed by burning. Gasoline is poured on the balloon and a trail of gasoline is run on the ground away from the balloon and ignited. By this method, crewmen are not exposed to the danger of burning hydrogen. A rope saturated in gasoline leading to the balloon may be used when a trail of gasoline on the ground is not satisfactory.

(2) When the balloon is flying and limitation of time will not allow the crew to haul down the balloon, the flying wire assembly is cut, setting the balloon free.

b. Winches.—(1) *Method No. 1.*—Puncture the fuel tank. Place a 2-pound TNT charge between the engine and the storage drum. Insert a tetryl nonelectric cap with at least 5 feet of safety fuze. Ignite the fuze and take cover.

(2) *Method No. 2.*—Puncture the fuel tank. Smash all vital elements (such as carburetor, magneto, governor, control levers, storage drum, gears, etc.) with a heavy ax, pick, or sledge. Pour gasoline on the winch and ignite.

c. Fair-lead.—The fair-lead should be destroyed with an ax, pick, or sledge.

d. Flying-wire assemblies.—If the flying-wire assembly is reeled on the storage drum it may be cut into short sections with an ax, or fuzed to the drum by use of thermit. When the flying-wire assembly is attached to a flying balloon and time does not permit the crew to haul down the balloon, the flying-wire assembly is cut and allowed to ascend with the balloon.

e. Gas cylinders.—For gas cylinders filled with hydrogen, the valves are opened to allow the gas to escape, and the valves are smashed. No steps should be taken to demolish the cylinders until they are emptied of gas.

f. Site equipment.—All inflammable site equipment is destroyed by saturating it with gasoline and burning.

g. Hydrogen generator.—The gages, moisture separators, drying bottles, cooling radiator, water pump, air compressor, gasoline engine, caustic pump and sludge valves are destroyed with a sledge hammer. If time is available, the hydrogen generator is further destroyed by use of TNT. The wooden trailer floor and tires are destroyed by saturating with gasoline and burning. (See FM 4–187.)

h. Motor transportation equipment.—(1) *Vehicles.*—(*a*) *Method No. 1.*—Remove and empty portable fire extinguishers. Puncture the fuel tanks. Place a 2-pound TNT charge on top of the clutch housing (the hood must be opened to do this properly). If time is available, place another 2-pound TNT charge on the left side of the engine as low as possible. Insert tetryl nonelectric caps with at least 5 feet of safety fuze in each charge. Ignite the fuzes and take cover.

(*b*) *Method No. 2.*—Remove and empty the portable fire extinguishers. Puncture the fuel tanks, if readily accessible. Smash all vital elements (such as distributor, carburetor, radiator, engine block, air and oil cleaners, generator, control

levers, crankcase, and transmission) with a heavy ax, pick, or sledge. Pour spare gasoline, oil, or distillate over entire unit and ignite.

(2) *Pneumatic tires.*—(*a*) *Method No. 1.*—Ignite an incendiary grenade under each tire. Be certain that the incendiary fires are well started before detonating the TNT as in (1) (*a*) above if that method is used.

(*b*) *Method No. 2.*—Damage the tires with an ax, pick, or heavy machine-gun fire (deflate tires before doing this, if possible). Pour gasoline on tires and ignite.

i. Lethal devices.—Lethal devices are piled and all available inflammable material placed upon it. The inflammable material is then saturated with gasoline to produce a hot flame. Personnel take cover when the gasoline is ignited.

■ 89. SAFETY PRECAUTIONS.—Demolition, to be accomplished safely, requires a close following of fundamental rules for the handling of explosives and incendiary material. FM 5–25 sets forth these rules fully, and they should be strictly observed.

APPENDIX I

FORMING AN EYE IN FLYING WIRE

When socket eyes and wedges are not available, an eye may be formed in the flying wire as a substitute. The method of making an eye is shown in figure 24. The eye is formed in the wire by using eye-forming pliers. The width of the eye will vary with the use for which it is intended. The binding should be well soldered, using a heavy iron. The wire should not be overheated, and the solder should be allowed to cool slowly.

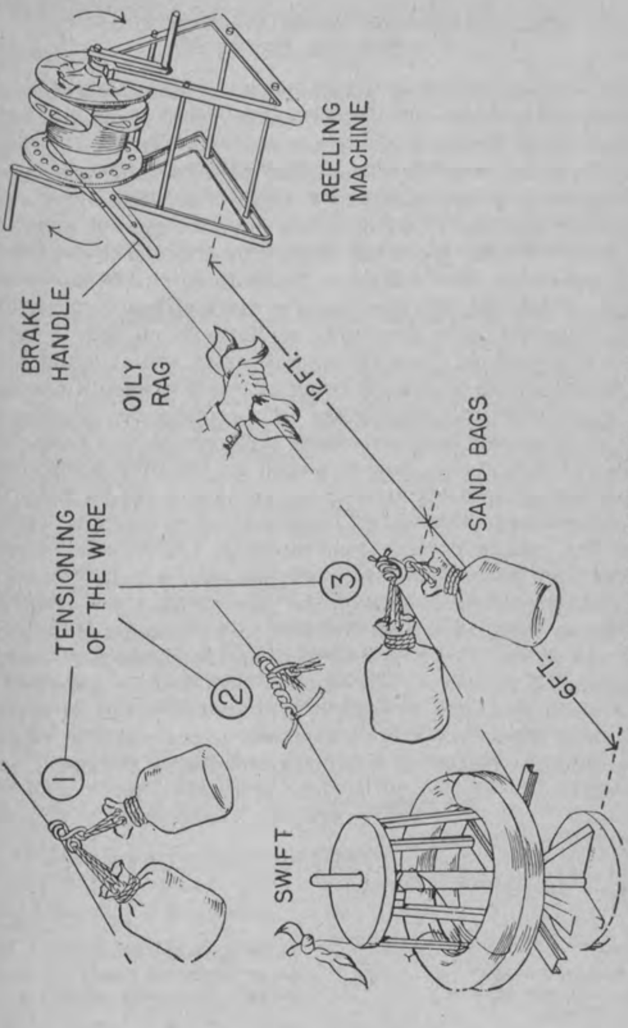

FIGURE 24.—Eye in flying wire.

APPENDIX II

REELING FLYING WIRE ASSEMBLY ONTO STORAGE DRUM

The storage drum is attached to a reeling machine, as shown in figure 25. The winch leg is reeved through a hole in the outer flange of the drum, then secured with a cable clip. The other parts of the flying wire assembly are added in the order shown in figure 4, Chapter 1. The flying wire assembly should be reeled tightly onto the storage drum as parts are added. When the flying wire is added to the flying wire assembly, care should be taken to eliminate the possibility of kinking it. The use of a swift, to assist in reeling the flying wire onto the drum, is advisable. A coil of flying wire is placed on the swift, and an extra coil of flying wire is placed on top of the one being unreeled to keep the wraps of flying wire from leaving the coil prematurely. If a spare coil of flying wire is not available, a piece of wood 4 x 4 inches and about 30 inches long is placed on top of the wire coil, then lashed loosely to the center spindle of the swift. The swift is placed about 18 feet from the reeling machine. During the reeling process, two sandbags are hooked on the flying wire between the swift and the reeling machine; then a cloth is wrapped around the wire behind the sandbag hooks to keep tension on the wire. The amount of tension on the flying wire is determined by the number of wraps made with the cloth. The wire is oiled as it is reeled onto the drum by means of a cloth saturated with oil. A length of about 100 feet of wire on each end of the coil is inspected carefully for defects as it is being reeled onto the drum.

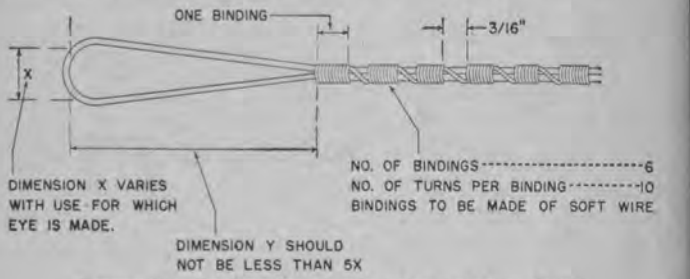

FIGURE 25.—Reeling flying wire onto a storage drum.

APPENDIX III

PRESSURE MEASUREMENT WITH GAGE CORD OR BAND, MK. VI BALLOON

■ 1. GENERAL.—A manometer should be used to read the pressure of a Mk. VI balloon, if one is available. However, a gage band or a gage cord may be used as an alternate method. Since balloon fabric will stretch permanently as the balloon ages, pressure measurements with a gage band or a gage cord are accurate only with a new balloon. The gage band or cord should be calibrated frequently with a manometer as the balloon ages.

■ 2. GAGE CORD.—The gage cord is attached to the left side of the balloon so that it can be stretched around the under surface of the balloon parallel to expansion cord No. 25. The cord is graduated at intervals of 5 inches. The free end is considered as the zero mark and the numbers 5, 10, and 15 may be considered as being 5, 10, and 15 inches respectively beyond the end of the cord. The distance between the free end of the cord and the near edge of the right fabric band is the gage-cord reading. (See par. 4.)

■ 3. GAGE BAND.—The gage band is located in the same relative position as the gage cord. One end is attached to a gage band securing patch on the left side of the balloon and the free end is attached to a securing patch on the right side by means of a bungee strop. Beginning at the free end of the band (and attached to the bungee strop) the numbers 15, 10, 0, and −5 are marked at intervals of 5 inches. The band reading is taken at the point where the fore end of the band crosses the inner edge of the fabric band to which the expansion cords are attached. (See par. 4.)

■ 4. GAGE CORD OR BAND READINGS.—The relations between the gage cord or gage band readings and the pressure in a new balloon are as follows:

Gage cord or gage band reading	*Pressure in inches of water*
15	2.2
10	2.0
5	1.8
0	1.6
−5	1.4
−10	1.2
−15	1.0

APPENDIX IV

INSPECTION SCHEDULE, MARK VI BALLOON

■ 1. GENERAL.—This schedule is issued as a guide for checking the condition of the very low altitude balloon and balloon equipment. The schedule gives the extent, frequency, and sequence of inspections. Unless local conditions and special requirements of the balloon necessitate slight modifications in the inspecting procedure, this schedule should be followed closely. The schedule, however, does not relieve the inspector of the responsibility for making additional inspections when circumstances make them necessary.

■ 2. GROUPS.—To facilitate making the inspections, the balloon and balloon equipment are divided into groups. The items are listed within each group in the order in which they are to be inspected.

■ 3. DIVISIONS.—Three divisions are made in the inspections as follows:

a. Inspection 1.—Prior to and during gas inflation.

b. Inspection 2.—Inflated balloon in service.

c. Inspection 3.—Prior to storing or packing the balloon.

■ 4. RECORD.—A record of each inspection made should be dated and initialed by the inspecting officer. Any form used for making such an inspection should be readily available.

■ 5. INSPECTION 1.—Prior to and during gas inflation.

a. Inspect balloon visually for holes; patch immediately as necessary.

b. Make as many inspections of the items under Inspection 2 during inflation as possible.

NOTE.—Under war conditions, inflation should not be slowed down to carry out these inspections, but all repairs must be made. Walking on the balloon envelope should be avoided.

■ 6. INSPECTION 2.—Inflated balloon in service.

NOTE.—1. If for any reason the balloon is not bedded down, as much of the appropriate inspection as possible will be carried out visually. A note that only a partial inspection was made should then be indicated on the form that is used.

2. In training centers, the appropriate inspection will be carried out before the first flight of the day.

a. Daily inspection.

Items	*Inspection procedure*
RIGGING	
Rigging and handling-line patches.	Check for secure attachment.
Thimbles	See that thimbles are sound and seizings are secure.
Foot ropes	Check for kinks, corrosion, or any damage; check length, security of seizing and soldering on loops.
Quick-release pin	See that pin holds securely and is free from corrosion.
ENVELOPE	
Envelope fabric	See that fabric is free from chafing.
Inflation appendix	Check for correct tie-off, also signs of wear at the junction with the envelope.
Manometer teat	See that stopper is firmly inserted.
Fabric band	Check for wear.
Expansion cords	Check attachment and extent of deterioration.
STABILIZER	
Fabric	Check for chafing, deterioration, and slackness.
Fins and rudder	Check for proper fitting into fabric bands. See that bracing wire is taut and free from kinks.
Bracing wire hooks	See that hooks are sound and straight.
Triangular wooden braces.	Check for soundness.
Stabilizer wire-bracing patches.	See that patches are sound and metal fittings free from corrosion and distortion.

Items	*Inspection procedure*
INFLATION GAS	
Gas	Test for purity. Take a manometer reading. Top up when pressure is less than 1.6 inches of water.
FLYING-WIRE ASSEMBLY	
Socket eyes and wedges	Check for wear and for secure attachment.
Flying wire	See that all sections are free from kinks and corrosion.
Strops	See that strops are securely attached and fastened together properly.
Inertia links	See that links are securely attached and free from defects.
LETHAL DEVICES	
Parachute	See that shackles are straight and operating properly.
Bomb	See that safety plug is in proper position, insure that rim, plug, and shock-absorber are in proper order.
GENERAL	

b. Weekly inspection:

NOTE.—The following items are in addition to the items listed in *a* above.

RIGGING	
Rigging and handling patches.	Check for wear and for signs of peeling.
Thimbles	See that fabric around thimbles is free from signs of wear.
ENVELOPE	
Seams	Check taping for peeling and seams for damage.
Stabilizer fabric bands	Check for chafing and damage.

Items	*Inspection procedure*
Brass grommets	Check for soundness.
Heavy fabric bands	See that bands are firmly attached and free from signs of rot and wear.
Gage cord or band	Check for security of attachment and deterioration.

STABILIZERS

Frames	Check for distortion, deterioration, or other damage.

■ 7. INSPECTION 3.—Prior to storing or packing.

NOTE.—1. This inspection must be carried out on clean, dry ground, cloths, or, if advisable, on a clean linoleum floor.
2. The procedure for packing described in paragraph 59 must be followed closely.
3. The balloon must be handled carefully at all times.

RIGGING

Rigging and handling patches.	See that patches are securely attached to envelope and free from signs of wear.
Thimbles	See that thimbles are sound and seizings secure; that fabric around thimbles is free from signs of wear.
Foot ropes	Check for corrosion, kinks, and other damage. Insure that attachment of the ends of the foot ropes is secure. Check length.
Handling lines	See that lines are free from knots and signs of wear.

ENVELOPE

Maintenance of pressure	Air inflate balloon to 1.6 inches of water. This pressure should be maintained for 15 minutes. The inspection should not be made in direct sunlight. The handling lines should be slack.

Items	*Inspection procedure*
Seams	Examine seams for damage and the taping for peeling.
Fabric bands	Check for signs of undue wear, stickiness, and small holes.
Inflation appendix	Check for signs of undue wear, stickiness, and small holes.
Expansion system	See that cords are securely attached, and examine for signs of deterioration and wear.
Stabilizer fabric bands	Check for wear and stickiness.
Stabilizer bracing wire patches.	See that patches are sound and metal fittings free from corrosion and distortion.
Gage cord or band	Check for security of attachment and for deterioration.

STABILIZER

Frames	Check for distortion, deterioration, and other damage.
Fabric	Check undue wear and slackness.
Bracing wire	Check for kinks and corrosion.
Triangular wooden braces.	See that braces are sound and free from damage.

GENERAL

Valise	See that valise is free from tears, chafes, and other damage, and is clean and dry.
Metal fittings	Check that all are serviceable and covered with old fabric or tape before packing the balloon.
Fabric	See that fabric is perfectly dry before packing. Also cordage must be dry.
Stabilizers and triangular frames.	Insure correct packing in their containers.
Handling lines	See that lines are placed in top of envelope valise.

APPENDIX V

LIST OF REFERENCES

Organization and Tactics------ FM 4–181 (to be published)
Technique---------- FM 4–182 (to be published)
Service of the Balloon and Balloon Equipment, Low Altitude---------- FM 4–187
Service of Cable Armament---- FM 4–191 (to be published)
Rigging and Fabric Repair----- FM 4–196 (to be published)

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