# TM 11-2610

**WAR DEPARTMENT TECHNICAL MANUAL**

# ANTENNA ASSEMBLY AS-51/MRQ-2 AND AUXILIARY ANTENNA ASSEMBLY AS-93/MRQ-2

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*WAR DEPARTMENT* *15 JULY 1944*

*WAR DEPARTMENT TECHNICAL MANUAL*

*TM 11-2610*

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*WAR DEPARTMENT* *15 JULY 1944*

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WAR DEPARTMENT,

WASHINGTON 25, D. C., 15 July 1944.

TM 11-2610, Antenna Assembly AS-51/MRQ-2 and Auxiliary Antenna Assembly AS-93/MRQ-2, is published for the information and guidance of all concerned.

[A. G. 300.7 (4 March 44).]

BY ORDER OF THE SECRETARY OF WAR:

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*Major General,*
*The Adjutant General.*

DISTRIBUTION:

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

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# DESTRUCTION NOTICE

**WHY** — To prevent the enemy from using or salvaging this equipment for his benefit.

**WHEN** — When ordered by your commander.

**HOW** — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

**USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.**

**WHAT** — 1. Smash — Reel Assembly RL-104/MRQ-2, transit compass. Use hammer provided with equipment.

2. Cut — Antenna and counterpoise wire, transmission line.

3. Burn — Balloon fabric, after hydrogen has been carefully exhausted; stabilizer fins, kite, and mooring net; bags, cases, and boxes. If time will not permit complete exhaustion of hydrogen from balloon, cut shrouds letting it fly away.

4. Bury or scatter — Remaining parts.

# DESTROY EVERYTHING

# SAFETY NOTICES

1. HYDROGEN GAS USED IN THE BALLOON IS HIGHLY INFAMMABLE. NO SMOKING OR FIRE SHOULD BE PERMITTED IN THE VICINITY WHEN THE BALLOON IS NEAR THE GROUND BEING INFLATED, DEFLATED, OR MOORED.

2. PERSONNEL MUST NOT WEAR OUTER WOOLEN CLOTHING OF ANY SORT WHEN INFLATING OR DEFLATING THE BALLOON. STATIC ELECTRICITY PRODUCED BY THE RUBBING OF WOOL MAY IGNITE LEAKING HYDROGEN GAS.

3. DURING THUNDERSTORMS PERSONNEL SHOULD STAND CLEAR OF ANTENNA WIRES. ANTENNAS A AND B WILL CARRY STATIC DISCHARGES TO GROUND THROUGH THEIR TERMINATING RESISTANCE, BUT THE ANTENNA WIRE IS NOT HEAVY ENOUGH TO CARRY A DIRECT LIGHTNING STROKE SAFELY TO GROUND. THE ANTENNA WIRE MAY BE FUSED BY THE STROKE WHICH MAY THEN JUMP TO NEARBY OBJECTS OR PERSONNEL. USE CAUTION.

4. DO NOT GRASP OR HOLD BALLOON OR KITE FLYING LINE DURING A THUNDERSTORM IF WINCH IS MOUNTED IN A TRUCK. THE LINE IS AN INSULATOR WHEN DRY BUT MAY BECOME A CONDUCTOR WHEN WET. IF WINCH IS STAKED TO GROUND NO DANGER EXISTS AND LINE MAY BE GRASPED.

5. DO NOT TOUCH ANTENNA WIRES WHEN THE TRANSMITTER IS IN OPERATION. RADIO-FREQUENCY VOLTAGE PRESENT ON THE WIRE MAY CAUSE BURNS.

6. BE CAREFUL NOT TO INSTALL ANTENNAS A OR B NEAR OVERHEAD HIGH TENSION LINES. WIND MAY CAUSE THE BALLOON OR KITE TO CARRY ANTENNA WIRES ACROSS THESE HIGH TENSION LINES, CAUSING THE ANTENNA AND ENTIRE RADIO STATION TO ASSUME POTENTIAL OF THE LINES. INSTALL AT LEAST 2000 FEET FROM ALL HIGH TENSION LINES.

7. FOLLOW DIRECTIONS CAREFULLY WHEN INSTALLING OR USING THESE ANTENNA ASSEMBLIES.




*Figure 1. Typical installation of Antenna Assembly AN-SA1 MRQ-2 showing radio beam-steering antenna*

# *PART ONE*

# *DESCRIPTION*

## SECTION I
## GENERAL

**1. USE.** Antenna Assembly AS-51/MRQ-2 and Auxiliary Antenna Assembly AS-93/MRQ-2 consist of a group of components for the installation of either of two powerful radio-beam antennas and a general purpose, lance-pole supported antenna. Also treated in this manual for purposes of comparison is the 5-section whip antenna used with Radio Transmitter T-55 MRQ-2. These four antennas are designated as A, B, C, and D respectively (fig. 2).

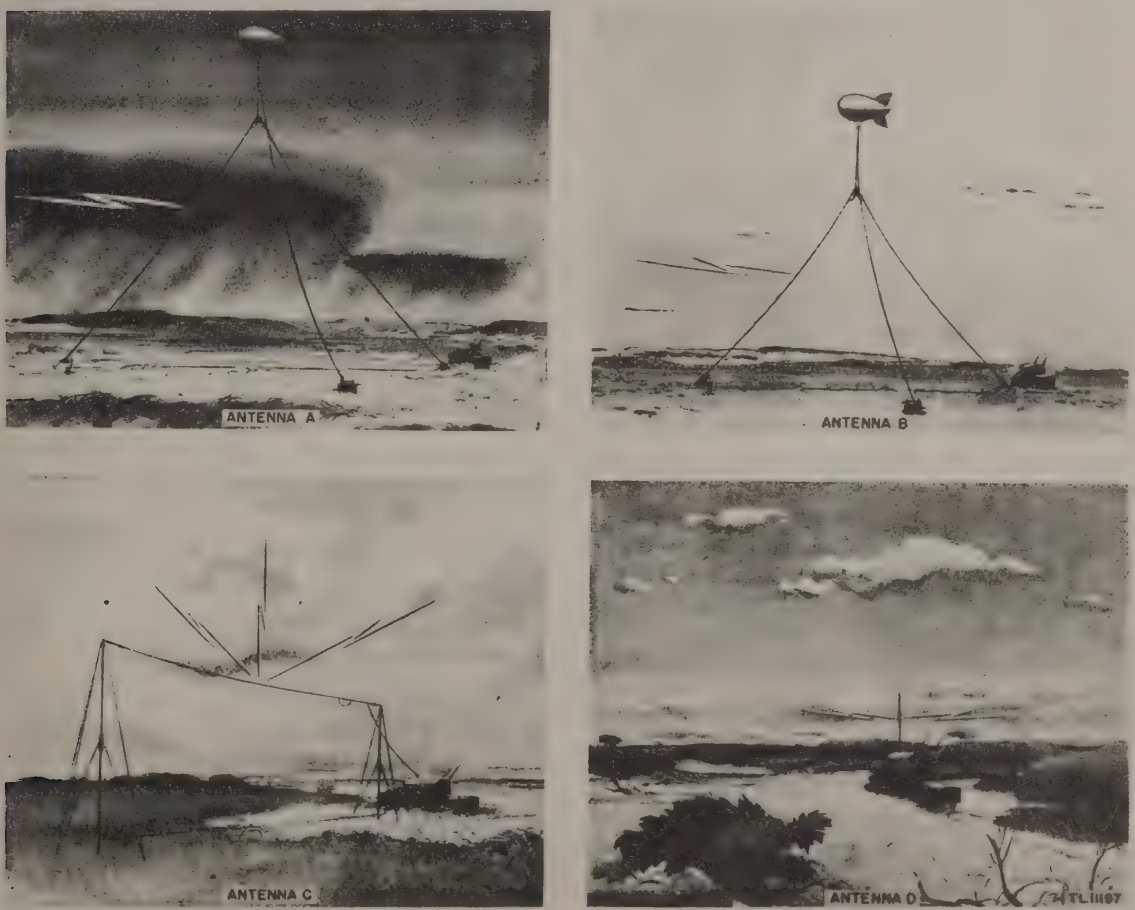



*Figure 2. Antennas A, B, C, and D used with Radio Set AN/MRQ-2.*

**2. ANTENNA A.** Antenna A consists of Antenna Wire Assembly AS-92/MRQ-2 and Counterpoise AT-55/MRQ-2 which, used together, form a powerful, vertically polarized, half-rhombic antenna for transmitting or receiving radio signals between 0.95 and 8.0 megacycles. Antenna A will give signal gains on transmitting and receiving up to 29 decibels or 794 times over and above antenna D, the 5-section whip antenna. A typical installation of antenna A is shown in figure 1, frontispiece of this manual. It is either balloon-supported or kite-supported and comprises:

***a. Antenna Wire Assembly AS-92/MRQ-2.*** This assembly is made up of two Reels RL-103/MRQ-2, each wound with 984 feet of No. 16 AWG copperweld steel wire and coupled together by a triangular terminal insulator. When installed, the wire on these two reels forms the two equilateral legs of the antenna triangle, supported at their apex by Balloon MX-93/MRQ-2 or Kite VKS-1.

***b. Counterpoise AT-55/MRQ-2.*** This counterpoise is made up of Reel RL-103/MRQ-2 wound with 1,612 feet of No. 14, 6-strand, phosphor-bronze wire. When installed, this wire forms the base of the antenna triangle.

***c. Cable RG-61/MRQ-2.*** This cable is a 2-wire, webb-belt transmission line which connects the antenna triangle to the two external binding posts provided on Shelter HO-17, which houses Radio Set AN/MRQ-2. It is 12 feet long and has an r-f impedance of 500 ohms.

***d. Resistance Box MX-105/MRQ-2.*** This box contains the antenna-terminating resistance which is connected between the far end of the antenna and the counterpoise, completing the electrical circuit of the antenna.

**3. ANTENNA B.** Antenna B is similar to antenna A in design but has smaller dimensions designed for use at frequencies between 3 and 18 megacycles. It consists of Antenna Wire Assembly AS-91/MRQ-2 and Counterpoise AT-56/MRQ-2. Like antenna A, it is either kite-supported or balloon-supported. Antenna B will give signal gains on transmitting and receiving up to 24 decibels or 250 times over and above antenna D. It comprises:

***a. Antenna Wire Assembly AS-91/MRQ-2.*** This assembly is made up of two Reels RL-103/MRQ-2, each wound with 392 feet of No. 16 AWG copperweld steel wire and coupled together by a triangular terminal insulator. When installed, the wire on these reels forms the equilateral legs of the antenna triangle as in antenna A.

***b. Counterpoise AT-56/MRQ-2.*** This counterpoise is made up of Reel RL-103/MRQ-2 wound with 625 feet of No. 14 6-strand, phosphor-bronze wire. When installed, it forms the base of the antenna triangle.

***c. Cable RG-61/MRQ-2 and Resistance Box MX-105/MRQ-2.*** This cable and resistance box make up the transmission line and terminating resistance used for antenna A. It is similarly used for antenna B.

**4. ANTENNA C.** Antenna C consists of Antenna Assembly AS-93/MRQ-2, a single-wire antenna and counterpoise combination, the antenna proper being supported 30 feet from the ground by four lance Poles PO-2 and suitably guyed by ropes. Antenna C is used where the installation of antennas A or B is impractical for concealment or tactical considerations, or for reasons of terrain. It will give gains on transmitting and receiving up to 13 decibels or 20 times over and above the 5-section whip, but is inferior in directional gain to antennas A and B by an average of 12 decibels or 16 times. Antenna C comprises:

***a. Antenna Wire Assembly AT-57/MRQ-2.*** This assembly contains 134.5 feet of No. 16 AWG copperweld steel wire secured to insulators.

***b. Counterpoise AT-58/MRQ-2.*** This counterpoise is made up of 125 feet of the same wire secured to insulators and a 6-foot length of wax-impregnated sashcord served to each insulator.

***c. Two Mast Caps MP-8.*** They have three 35-foot top guys permanently attached. Each guy end is served to a cast-iron thimble.

***d. Lower Guy Ropes.*** These guy ropes are each 25 feet long, each permanently served to an "S" hook.

***e. Four Lance Poles PO-2.*** These poles are each fifteen feet long for support of antenna C.

***f. Two Mast Sections MS-25.*** These mast sections are used for clamping lance poles together.

**5. ANTENNA D.** Antenna D, not supplied as a part of Antenna Assembly AS-51/MRQ-2 or AS-93/MRQ-2, is the 5-section whip used with Radio Transmitter T-55/MRQ-2, and comprises Mast Sections MS-49, MS-50, MS-51, MS-52, and MS-53, supported by Mast Base MP-47. This antenna is treated

in this manual for comparison with the performance of antennas A, B, and C.

**6. AUXILIARY COMPONENTS.** The following auxiliary components are used with antenna A and B installations:

***a. Balloon MX-93/MRQ-2.*** This balloon of the non-rigid low-pressure type, 27 feet long, with a gas capacity of 1,150 cubic feet. Deflated, it weighs 29 pounds. When hydrogen-inflated it has a lifting capacity of 38 pounds in a dead calm, slightly more in a wind. It is stowed in Bag CW-20/MRQ-2. Eight fin stabilizers equipped with guy strings and snap fasteners are provided and stowed in Case CY-62/MRQ-2. They are marked PORT, STARBOARD, TOP, and BOT to indicate their correct position when secured to the balloon.

***b. Tarpaulin Ground Cloth.*** This cloth is provided as a bed for the balloon to guard against rips and punctures resulting from briars or sharp objects encountered on the ground when the balloon is inflated, moored, or deflated. Used in conjunction with the ground cloth are ten 30-pound sandbags for mooring the balloon, and 12 Stakes GP-25 for securing the bed and staking down the antenna triangle corners.

***c. Case CY-72/MRQ-2.*** This case contains Hose Assembly MX-136/MRQ-2 for inflating the balloon, shackles for balloon line coupling, a wrench, hardware bag, rubber bands for securing the balloon appendix, a transit compass for azimuthal alinement of the radio beams, two Technical Manuals TM 11-2610, and Repair Kit MK-15/MRQ-2 for patching the balloon. This kit includes a wooden roller, horsehair brush and 1-pint cans of naphtha, rubber cement, talcum, and patching fabric.

***d. Steel Cylinders.*** These hydrogen-filled cylinders are provided for inflating the balloon. For each inflation approximately six to seven cylinders are required.

***e. Kite VKS-1.*** This is provided, complete with spare parts, for the support of antennas A and B in winds over 20 miles per hour. The kite and spare parts are stowed in Case CY-73/MRQ-2.

***f. Reel Assembly RL-104/MRQ-2.*** This hand-operated winch is provided for flying the balloon or kite. It is equipped with "U" rings through which four Stakes GP-25 are driven to secure the winch to the ground. Or it may be mounted in the rear of a ¼-ton truck, if available, using two wooden cross members attached to the body of the truck by hardware provided in Maintenance Box CY-72/MRQ-2.

# SECTION II

# COMPONENTS, WEIGHTS, AND DIMENSIONS

**7. COMPONENTS, WEIGHTS, AND DIMENSIONS OF ANTENNA ASSEMBLY AS-51/MRQ-2 (ANTENNAS A AND B).**

| *Quantity* | *Component* | *Dimensions per unit, unassembled (ft)* | *Packing space required per unit (cu ft)* | *Weight per unit (lb)* |
|---|---|---|---|---|
| 3 | Bag CW-20/MRQ-2 containing:<br>1 Balloon MX-93/MRQ-2<br>1 bridle Bag CW-19/MRQ-2. | 2 x 1.5 x 1.5 | 4.5 | 30 |
| 3 | Case CY-62/MRQ-2 containing:<br>8 balloon stabilizers. | 5 x 7 x 0.5 | 17.5 | 35 |

## 7. COMPONENTS, WEIGHTS, AND DIMENSIONS OF ANTENNA ASSEMBLY AS-51/MRQ-2 (ANTENNAS A AND B). (Contd)

| *Quantity* | *Component* | *Dimensions per unit, unassembled (ft)* | *Packing space required per unit (cu ft)* | *Weight per unit (lb)* |
|---|---|---|---|---|
| 1 | Case CY-72/MRQ-2 containing: 1 Hose Assembly MX-136/MRQ-2 1 wrench, steel, 1-1/8" and 1-1/4" jaws. 2 shackles, brass 1 Repair Kit MK-15/MRQ-2. | 0.7 x 1.2 x 1 | 0.8 | 20 |
| 2 | Bag BG-102 containing: 1 Antenna Wire Assembly AS-92/MRQ-2 1 Counterpoise AT-56/MRQ-2 1 Cable RG-61/MRQ-2 (used for antenna A). | 1 x 1 x 1.5 | 1.5 | 35 |
| 1 | Bag BG-102 containing: 1 Resistance Box MX-105/MRQ-2 10 sandbags, 30-lb capacity 1 Reel RL-103/MRQ-2 wound with 2,000 feet square No. 16 copperweld wire. | 1 x 1 x 1.5 | 1.5 | 25 |
| 1 | Case CY-72/MRQ-2 containing: 1 Kite VKS-1 | 10 x 1 x 1 | 10 | 40 |
| 14 | Stake GP-25. | 3 x 2 x 1.5 | 0.9 | 8 |
| 1 | Tarpaulin | 1.5 x 1 x 1.5 (folded) | 2.25 | 30 |
| 1 | Reel Assembly RL-104/MRQ-2, hand winch, wound with 1,150 ft nylon flying line and thimble. | 2.5 x 1.5 x 2 | 8.0 | 60 |
| 12 | Hydrogen cylinders. | 4 x 0.8 x 0.8 | 2.4 | 150 |
| 1 | Mooring net. | 1.5 x 1 x 1 | 1.5 | 10 |

Total cubic volume = 135.95 cu ft
Total weight = 2,392 lb

## 8. COMPONENTS, WEIGHTS, AND DIMENSIONS OF AUXILIARY ANTENNA ASSEMBLY AS-93/MRQ-2 (ANTENNA C).

| *Quantity* | *Component* | *Dimensions per unit, unassembled (ft)* | *Packing space required per unit (cu ft)* | *Weight per unit (lb)* |
|---|---|---|---|---|
| 4 | Lance Pole PO-2 | 15 x 0.5 x 0.5 | 3.75 | 3 |
| 2 | Mast Section MS-25. | 5 x 0.5 x 0.5 | 1.25 | 6 |
| 1 | Bag BG-102 containing:<br>1 Antenna Wire Assembly AT-57/MRQ-2<br>1 Counterpoise AT-58/MRQ-2<br>6 rope, Guy GY-8, 25 ft<br>6 rope, Guy GY-8, 35 ft<br>2 pulley rope Guy GY-24-A<br>1 guide rope, 15 ft<br>2 Mast Cap MP-8. | 1 x 1 x 1.5 | 1.5 | 5 |
| 6 | Stake GP-25. | | 0.9 | 8 |

Total cubic volume = 19 cu ft
Total weight = 29 lb

# *PART TWO*

# *INSTALLATION*

## SECTION I
## CHOOSING AN ANTENNA SITE

**9. INITIAL PROCEDURE.** Before unloading or unpacking equipment for Antenna Assembly AS-51/MRQ-2, an antenna site must be chosen which will provide a location favorable for strong, forward, radio-beam propagation in the direction required.

**10. REQUIREMENTS OF THE SITE.** For maximum propagation using half-rhombic antennas A or B, sites where these antennas are to be erected should be carefully studied. Proceed as follows:

*a.* First, tentatively select a spot; then survey the terrain which will lie directly in the path of the proposed beam. To fix this direction use the transit compass contained in Case CY-72/MRQ-2.

*b.* Remove this compass from the case and with it determine the direction the proposed beam would take. Take the bearing at least 100 feet from trucks and metal objects which will deflect the compass needle if the bearing is taken closer to them.

*c.* For maximum radio propagation with antennas A and B, terrain in the direction of the beam should meet the following requirements if possible:

(1) It should be flat, gently rolling, or sloping downwards in the beam direction to provide a clear and unimpeded path to outgoing and incoming radio signals. Good locations are shown in figure 3 and figure 1, frontispiece of the manual.

(2) Terrain in the direction of the beam should not include a nearby mountain or high hill. These obstacles will obstruct outgoing and incoming radio signals, causing poor radio performance (fig. 4).

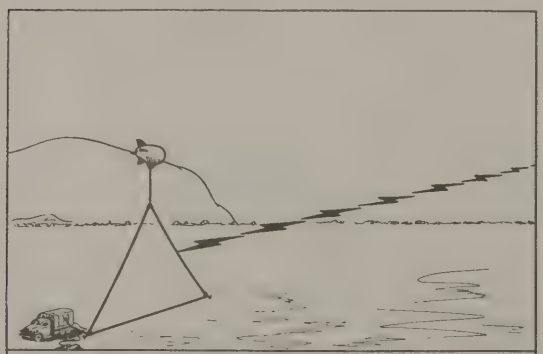



*Figure 3. Right choice of site.*

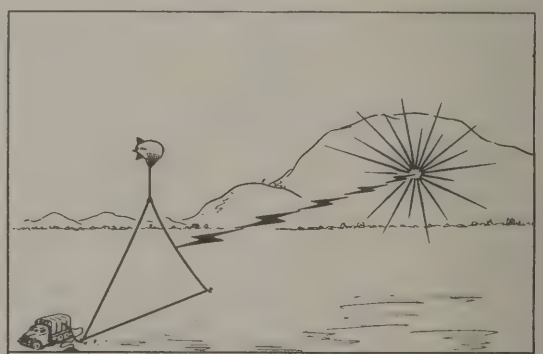
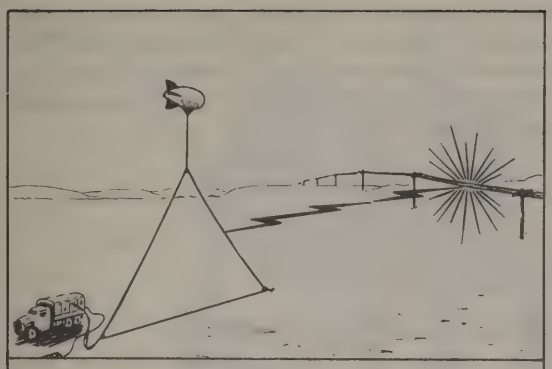



*Figure 4. Wrong choice of site.*



WRONG

Don't choose a site where nearby overhead wires lie in the beam path. They may absorb power and distort the beam direction, also cause noisy reception.

TL11184

*Figure 5. Wrong choice of site.*

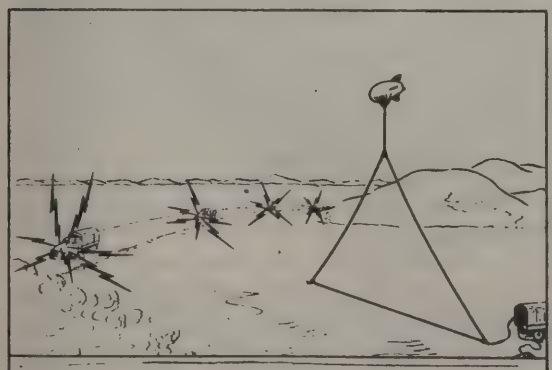
(3) Avoid sites where nearby overhead high-tension or telegraph lines lie directly in the beam path. They will absorb and reduce the power of the transmitted beam, and may warp or refract its direction from that indicated by the compass. They may also cause bad interference on radio reception (fig. 5).

(4) Avoid sites where the beam path must cross a nearby heavily-traveled highway. Ignition noise from passing vehicles, suppressed or not, may blanket reception (fig. 6). Sites where beam must cross a nearby electrified town or village, a motor pool, or a collection of operating battery chargers, dynamotors, and electric equipment must also be avoided. These equipments may prove noisy and cause blanketing of reception. Half-rhombic antennas A and B, providing signal voltage gains of 50 times over and above a typical installation such as antenna C, are proportionately sensitive to electrical noise and will amplify it considerably if the antenna site is carelessly chosen.

(5) Avoid installations on the far side of a hill away from the direction of the desired beam path (fig. 7). Signals from half-rhombic antennas A and B installed in such a location will travel skyward at a high vertical angle, radiating little power at low angles or those angles effective for ground-wave coverage of terrain up to 75 miles. Sites on the near side of a hill toward the beam path and radio target, however, will accentuate this lower angle transmission and are therefore satisfactory.

(6) When it is desirable, for tactical considerations, to use the lance-pole supported antenna C, somewhat less attention may be given to installation sites in favor of concealment or speed of installation. It must be kept in mind, however, that the effective range and power of antenna C is far less than that of half-rhombic antennas A and B, even when installed at ideal sites.

(7) In choosing a site for antennas A, B, and C, keep in mind that radio communication between Radio Control Central AN/TRQ-1 and Radio Set AN/MRQ-2 may be necessary. When Radio Sets

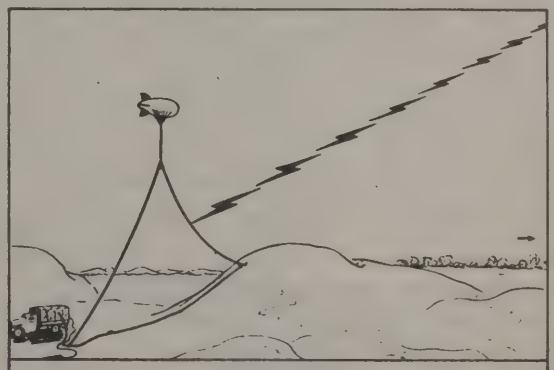


WRONG

Don't choose a site where beam crosses a nearby heavily travelled highway. Ignition noise from vehicles may blanket reception.

TL11182

*Figure 6. Wrong choice of site.*



WRONG

Don't choose a site on the side of a hill away from the radio target. Signals will travel skyward, producing little ground wave.

TL 11181

*Figure 7. Wrong choice of site.*

SCR-808-A are used for this contact, the normal 15-mile line-of-sight range of this set must be considered. For further information regarding the range and operation of Radio Set SCR-808-A, see Technical Manual TM 11-601, provided with these sets.

(8) *For purposes of clarity, illustrations in this manual do not show necessary camouflage and concealment precautions. These precautions must be closely followed at installations of Antenna Assembly AS-51/MRQ-2.*

# SECTION II

## Inflation and Deflation of Balloon MX-93/MRQ-2

**11. CHOICE BETWEEN USE OF BALLOON OR KITE SUPPORT.** Balloon support of antennas A and B may be used when winds are under 20 miles per hour. In winds over 20 miles per hour the balloon may sideslip, dive, and fly at such an angle that the antenna will no longer be supported vertically.

*a. Advantages of the Kite.*

(1) Less visibility.

(2) Ease and speed of installation.

(3) Limited equipment required.

(4) No hydrogen hazard.

*b. Disadvantages of the Kite.*

(1) No support in a dead calm.

(2) Uncertain support in low and changing wind velocities.

(3) Danger of crashing and consequent loss of kite.

*c. Advantage of Balloon.*

(1) It offers good support in low and uneven wind velocities.

*d. Disadvantage of Balloon.*

(1) Hydrogen hazard.

(2) Unwieldly equipment needed for installation.

(3) Time and care required for inflation, bedding, mooring, and disassembly.

**12. DESIRABILITY OF A SUBSTITUTE SUPPORT.** It is often desirable at antenna installations to prepare both kite and balloon support. If one fails, the other will be instantly available, causing a minimum interruption to service. This should be considered at all installations.

**13. UNLOADING WINCH, REEL ASSEMBLY RL-104/MRQ-2, AND PREPARING IT FOR USE.** When either balloon or kite support is used for antennas A and B, Reel Assembly RL-104 MRQ-2 must be used. At no time should attempts be made to fly either the kite or balloon by hand without the aid of the winch. In a gust of wind both will lift a man from the ground, causing possible injury. The winch may be employed in either of two fashions: secured to the ground by three Stakes GP-25 driven through the "U" rings welded to the base of the winch frame; or mounted in a ¼-ton, 4x4 truck. The winch is supplied with 1,150 feet of $\frac{3}{16}$-inch, 3-strand nylon, flying line wound on the winch. A brass thimble is served to the end of the flying line for attachment to the bridle lines of the kite or balloon.

*a.* When the winch is to be used staked to the ground, unload it from the carrying vehicle and tentatively place it in a convenient spot. When the antenna proper is later installed, place the winch in proper flying position.

*b.* If a ¼-ton, 4x4 truck is available, a far more maneuverable and useful installation may be made by securing the winch to the inside body of the truck. Figure 9 shows a practical mounting method where two 2 x 4-inch wooden cross members are secured by through-bolts to inside body of the truck. Mount the winch so that the brake handle (fig. 8) faces forward, in easy reach of the driver. See figure 10.

*c.* Whether ground- or truck-mounted, the winch is simply-operated. The two handles are removable and are stowed by two chains indicated in figure 8. The ratchet and pawl (lock) permit the flying line to be reeled in, paid out, or locked at a fixed length. Only the slightest hand pressure is necessary to operate the brake.

**14. UNLOADING BALLOON MX-93/MRQ-2.** If the balloon is to be used for the support of Antenna A or B, unload the following from the carrying vehicle:

*a.* Bag CW-20/MRQ-2 containing Balloon MX-93/MRQ-2.

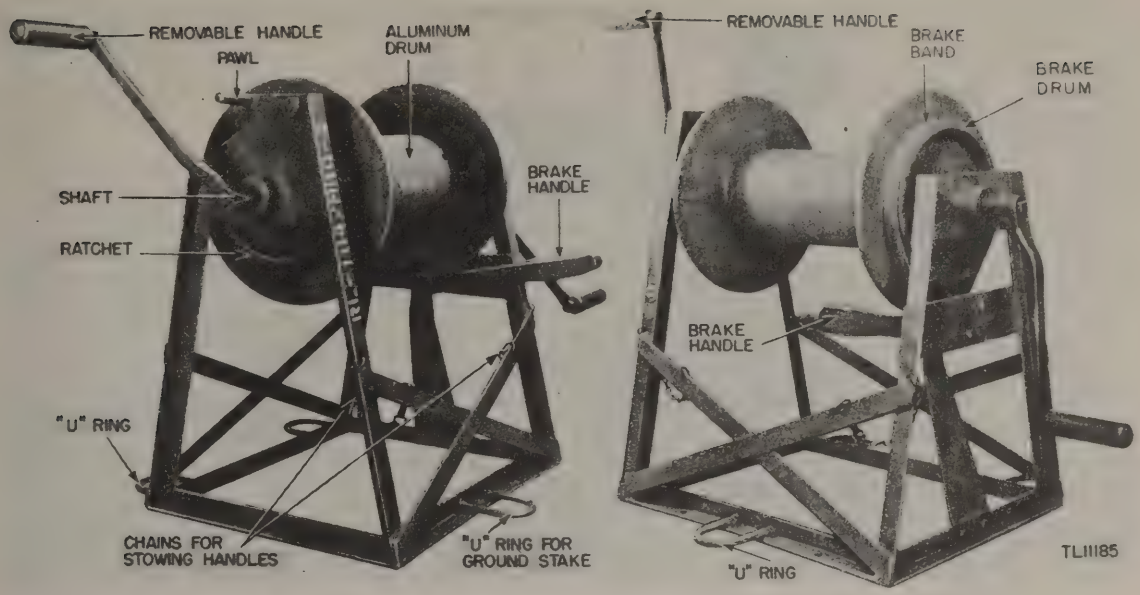



*Figure 8. Reel Assembly RL-104/MRQ-2, left and right views, flying line removed.*

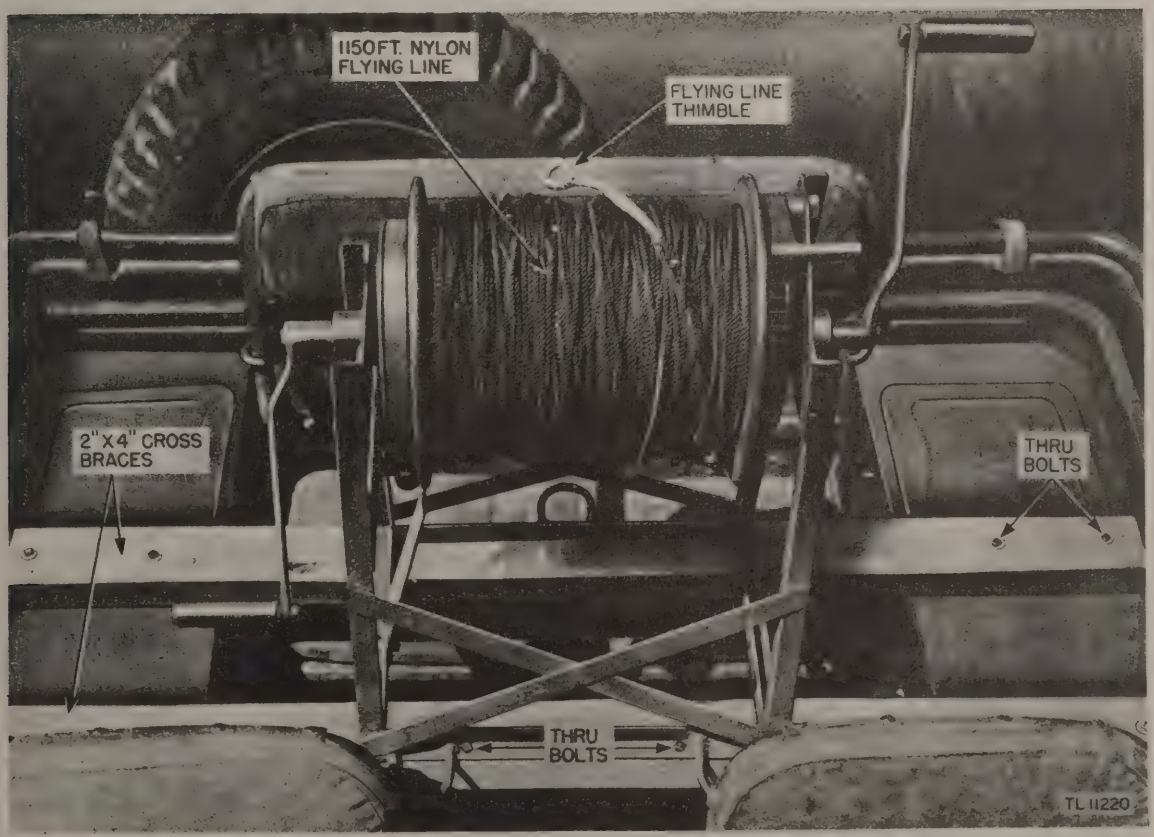



*Figure 9. Reel Assembly RL-104/MRQ-2 mounted in ¼-ton, 4 x 4 truck, close-up view.*



TL11174

*Figure 10. Reel Assembly RL-104/MRQ-2 mounted in ¼-ton, 4 x 4 truck, exterior side view.*

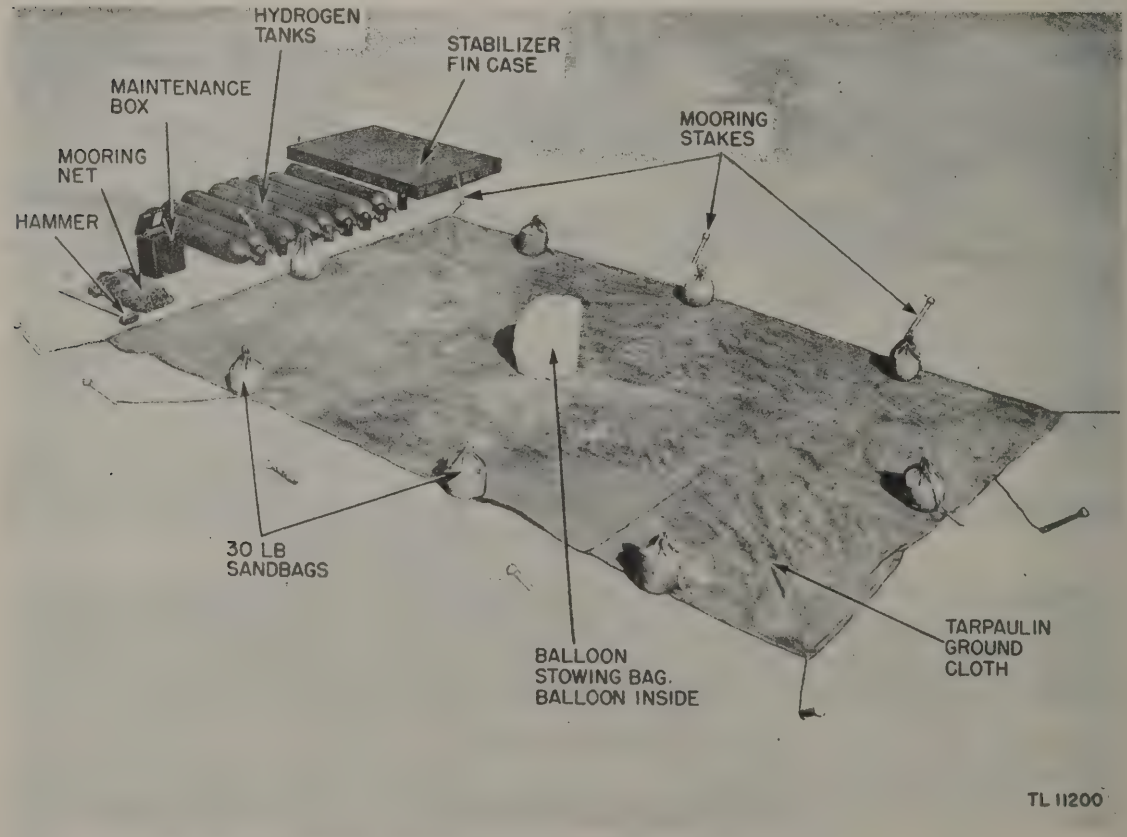



*Figure 11. Balloon bed prepared, equipment layout.*

**b.** Case CY-62 MRQ-2 containing 4 fin stabilizers for the balloon.

**c.** Bag CW-19 MRQ-2 containing the balloon bridle.

**d.** Canvas tarpaulin ground cloth for balloon bed.

**e.** Eight sandbags, empty, 30-pound capacity, for mooring the balloon.

**f.** Mooring net for balloon.

**g.** Case CY-72 MRQ-2 containing maintenance and repair equipment and Repair Kit MK-15 MRQ-2.

**h.** Twelve Stakes GP-25 for securing balloon bed and anchoring antenna apexes.

**i.** Hammer HM-3 for driving these stakes.

**j.** Eight hydrogen cylinders.

**15. PRECAUTIONS BEFORE INSTALLING BALLOON MX-93/MRQ-2.** Hydrogen gas, the lifting agent used in the balloon, is highly explosive. Before unloading or inflating the balloon, carefully check the following:

***a.*** *Personnel making the installation must not wear outer woolen clothing. The friction caused by the rubbing of wool produces tiny sparks which may ignite the hydrogen gas.*

***b.*** *Be careful when using metal tools in the vicinity of an inflating or deflating balloon. Sparks caused by striking these metal tools together may ignite escaping gas.*

***c.*** *Absolutely no smoking should be permitted in the vicinity when the balloon is being inflated, moored, deflated, or near the ground.*

***d.*** *Vehicles with motors running should not be permitted within 100 feet of the inflation site or of a moored balloon.*

**16. INSTALLATION PROCEDURE.** Having unloaded balloon equipment as outlined in paragraph 14*a* to 14*j* and rechecked the safety precautions in paragraph 15, proceed as follows:

***a.*** Select a portion of ground for preparing the balloon bed (fig. 11). It should be level and contain no sharp, small tree or bush stumps which might rend or tear the balloon fabric. A clearing may be made in a nearby wooded area, if available, to provide concealment for the bedded balloon when not in use. Do not prepare a balloon bed near overhead wires with which the balloon might tangle or become fouled.




*Figure 12.* Removing balloon from stowing bag.

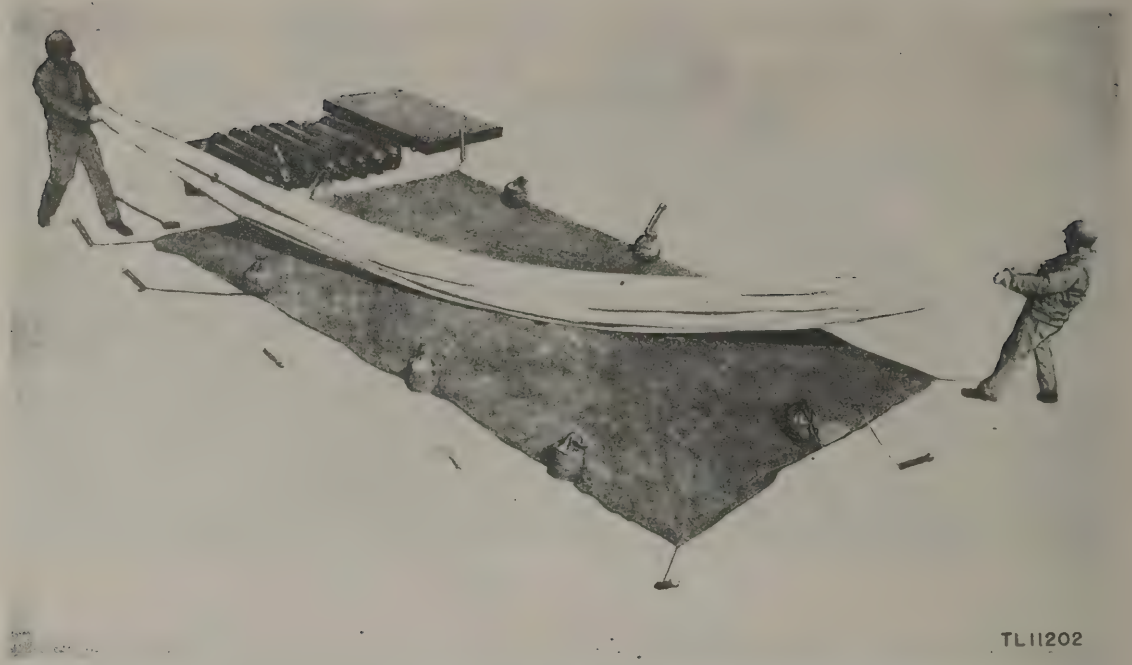



*Figure 13. Extending balloon its full length over balloon bed. Bow should face into the wind.*




*Figure 14. Rolling bow and stern of balloon fabric toward appendix to expel trapped air.*




*Figure 15. Freeing trapped air from envelope after second rolling.*

**b.** Having selected the site, lay out the ground cloth tarpaulin to its full size (fig. 11). Be sure that a long diagonal of the tarpaulin faces into the wind. Check the topside of the tarpaulin to see that no briars, thorns, or sharp objects adhere to it which might puncture the balloon fabric. Sweep off the tarpaulin.

**c.** Hammer in ground stakes, fill sandbags, and secure the tarpaulin to ground stakes as shown in figure 11. Arrange equipment as shown in this figure.

**d.** Remove Balloon MX-93/MRQ-2 from its stowing bag by turning the bag upside down. Do not pull it out by hand. This may tear fabric (fig. 12). In handling the balloon fabric do not wear sharp rings or sharp edged insignia which may pierce the fabric. Fingernails should be clipped short. A small rip or puncture in the balloon fabric may not be discernable at once but will cause the balloon to lose gas, reducing its lifting power. If only a limited amount of hydrogen gas is available, this loss may cause antennas A and B to become inoperative with serious consequences.

**e.** Extend the balloon fabric its full length across the long diagonal of the tarpaulin ground cloth (fig. 13).

**NOTE: The bow end of the balloon should be pointed into the wind.**

**f.** Place the extended balloon fabric on the ground cloth and roll bow and stern ends toward the center (fig. 14). Rolling should be carefully and tightly done to push air toward center and out the appendix opening. See figure 25 for location of appendix. If air remains in the envelope when it is inflated, the lifting power of the balloon will be materially decreased. To avoid cutting of the fabric by the sharp brass thimble attached to the balloon shroud line (fig. 25), place the bridle bag over thimble as shown in figure 15.




*Figure 16. Final expulsion of the air and sealing of appendix.*

*g.* When the balloon envelope is rolled from both sides as far as the appendix, tightly seal the appendix sleeve with two elastic bands provided in maintenance Box CY-72/MRQ-2.

*h.* Then extend the balloon envelope to its full length and gently shake to release any air which may have been captured in the folded panels inside the envelope.

*i.* Again, roll the envelope tightly and exhaust the remaining air by expanding the rubber bands on the appendix sleeve. In figure 15 note the collection of air trapped by the second rolling, and the right hand of man reaching into the appendix to free this trapped air.

*j.* Replace the elastic band over appendix while the tight rolling pressure (Note knee action in figure 15) is maintained. See figure 16. The balloon is now ready for inflation.

*k.* Remove inflation Hose Assembly MX-136/MRQ-2 and the double-ended wrench from maintenance Case CY-72/MRQ-2. Attach the brass adapter at the end of the hose to the first cylinder to be used as shown in figure 17. The adapter turns counterclockwise when the hose is to be secured, clockwise when removed. This reverse direction is peculiar to hydrogen cylinders to prevent confusion with tanks containing other gases.

*l.* Insert the other end of the inflation hose into the envelope appendix as shown in figure 18. Be sure that the elastic bands are tightly secured as in figure 19. Note that two elastic bands No 1 and 2, each folded three times, are used on the upper portion of the appendix; and that a single elastic band No. 3 having two folds is used on the lower portion of the appendix. These three elastic bands are sufficient to keep hydrogen in the balloon during average flights. More sealing action is not desirable for the




*Figure 17. Attaching hose assembly to cylinder.*

balloon must "breathe" at high altitudes allowing a small amount of gas to escape due to decreased atmospheric pressure and consequent gas expansion. These elastic bands likewise permit "breathing" of the balloon during a transition from darkness to sunlight.

***m.*** Feed gas into the balloon by slowly opening the valve until a rushing sound is heard. The balloon will unroll itself as gas is fed to it, as shown in figure 20.

***n.*** While the first tank is discharging itself into the balloon, attach sandbags to each "V" shroud of the balloon (fig. 21). Note in figure 21 that the bow of the balloon is correctly headed into the wind, the portion of gas already in the balloon driven toward the stern by this wind pressure.

***o.*** When the first hydrogen tank becomes empty, apparent when the rushing sound of gas ceases, remove the inflation hose and connect it to the second tank. It is not necessary to pinch or double back the hose when the adapter is removed from an exhausted to a fresh tank to avoid loss of gas by the balloon. The balloon is a low-pressure type, and this fact, coupled with the tendency of hydrogen to rise to the top of the bag away from the appendix, causes little or no gas to escape during the cylinder-changing process. After the second tank is exhausted, connect the hose to the third. When this is exhausted, connect it to the fourth.

***p.*** During the feeding of the fourth tank, remove the four fin stablizers stowed in Case CY-62/MRQ-2 and proceed as follows:

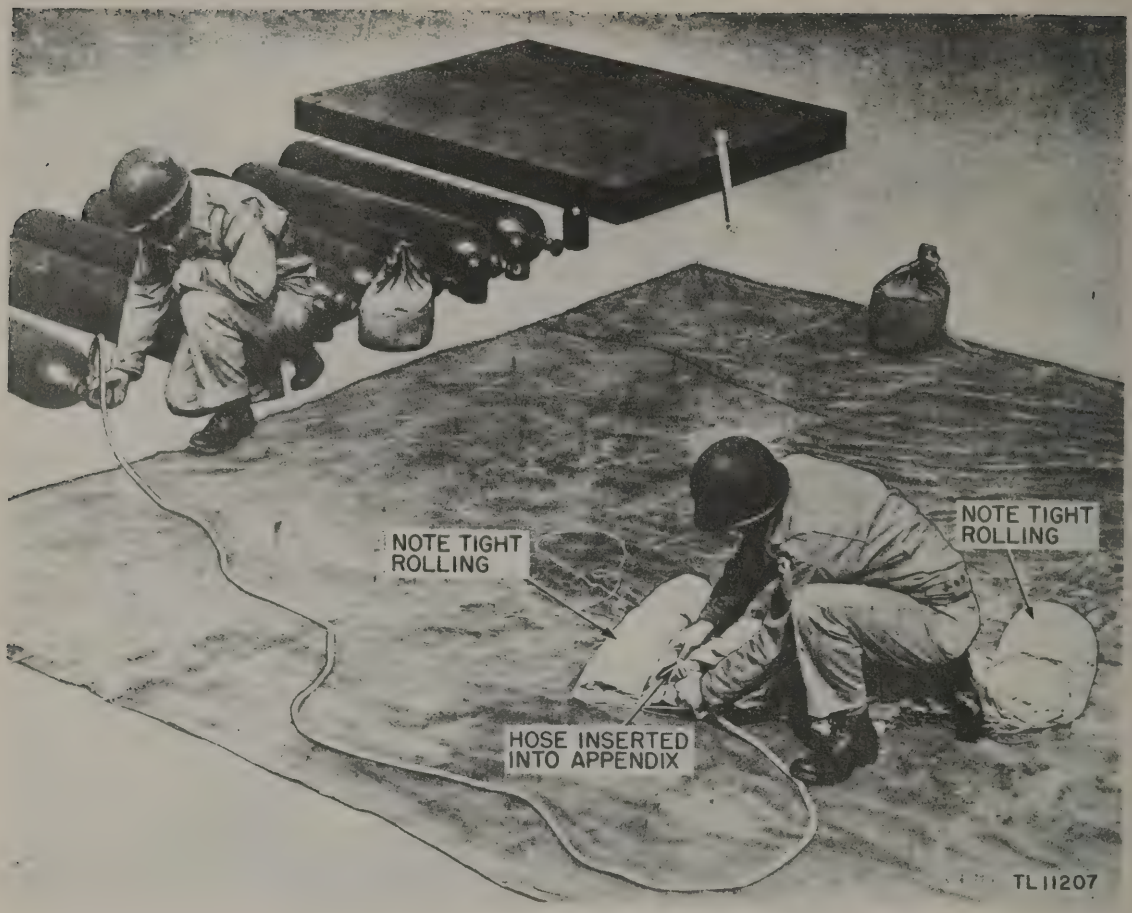



*Figure 18. Inserting inflation hose into the appendix.*

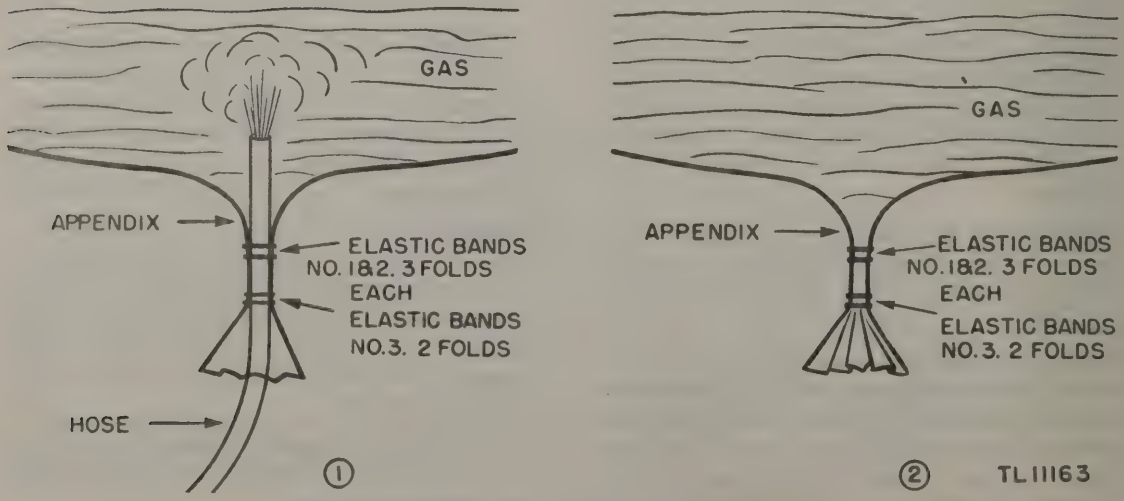



*Figure 19. Elastic band positions for securing appendix.*

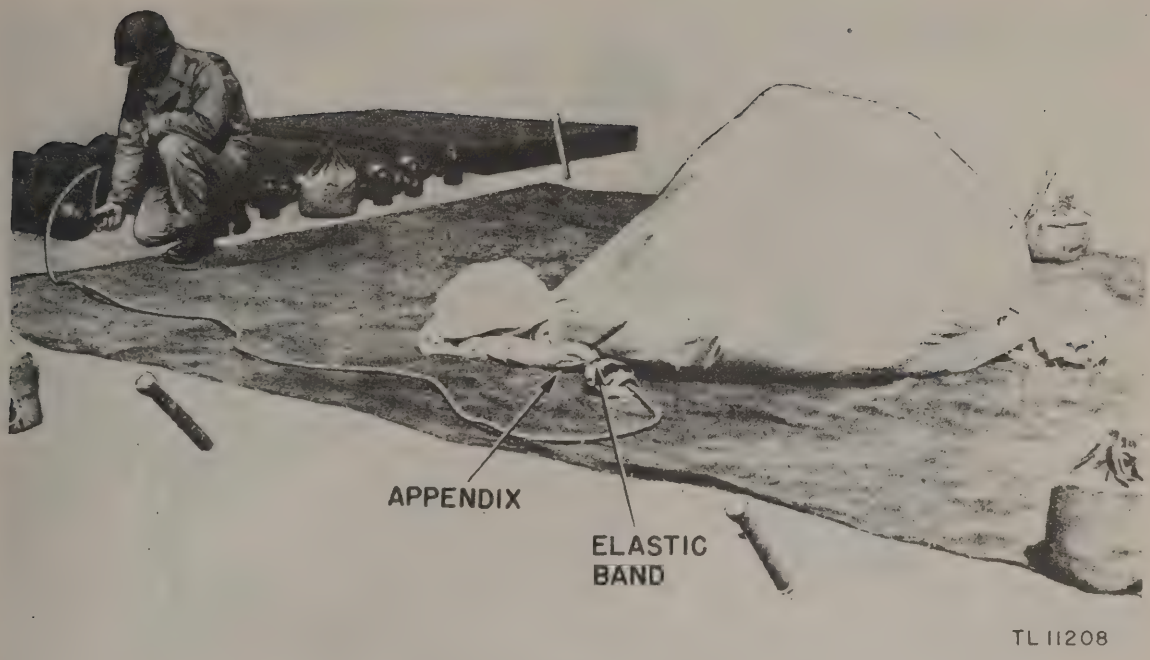



*Figure 20. Feeding gas to balloon.*




*Figure 21. Attaching sandbags to balloon during discharge of first tank.*




*Figure 22. Installing stabilizer fin top position.*




*Figure 23. Testing for correct inflation pressure.*

(1) Select the stabilizer fin marked TOP and place it in position (fig. 22), one man keeping the stabilizer in place while another secures the snap fasteners as shown in the insert in figure 22.

(2) When the snap fasteners are secured, attach the stabilizer bracing guys (string shown dropping loosely from the fin stabilizer in fig. 22) to the appropriate stabilizer patches (small reinforced circles, sewn to fabric). These guys are secured to the patches by small brass couplers attached permanently to the guys. When correctly attached the fin stabilizers center themselves as shown in figure 25.

(3) Likewise attach the port and starboard stabilizers.

q. After the top, port and starboard stabilizer fins have been secured, proceed to complete inflation of the balloon, using tanks five, and six, and as much of tank seven as necessary to give the balloon snug, thoroughly-rounded form. No pressure gauge is necessary. Correct inflation pressure is gauged by placing the hand firmly against the bag and pressing slightly inward. The balloon should give no more than shown in figure 23. In warm climates and higher altitudes the balloon will reach its snug, thoroughly-rounded form with less gas; in very cold climates with more. Likewise in a hot sun it will require less gas to fill than in heavy overcast. Its lifting power, however, will be slightly decreased.

*r.* After hand-testing the balloon for correct inflation, remove the hose and seal the appendix with a third elastic band. The two rubber bands on the upper portion of the appendix should each be folded three times; the rubber band securing the lower portion folded twice.

*s.* Attach the bottom stabilizer in the same manner as the top, port and starboard described above. Check carefully to see that all fin stabilizer guys are neither fouled nor crossed. This will be very important to stable flying of the balloon.

*t.* Remove the balloon bridle (made up of the individual shrouds as shown in figure 25) from Bag CW-19/MRQ-2 into which it was previously placed to protect the balloon fabric from being cut by the thimble. Attach the brass shackle provided in maintenance Case CY-72/MRQ-2 to the thimble.

*u.* The balloon is now ready for flying. Figure 25 shows its completed appearance with parts indicated.

*v.* If the balloon is not to be used at once, it may be left secured to its bed temporarily by the continued use of sandbag and stake moorings. If it is not to be used until the next day, or if a storm is approaching which may endanger the balloon, it should be moored by the mooring net specially provided (figs. 11 and 24). Proceed as follows:

(1) If not already on its bed, walk the balloon to the bed, bow always pointing into the wind.

(2) Attach sandbags to the bridle "V" shrouds (fig. 25).

Two or three sand bags should be secured to the forward "V" shrouds if a strong wind is present or anticipated.

(3) Tie the bow and stern handling lines to the stakes (fig. 24).

(4) Remove stabilizers from balloon and place in stabilizer Case CY-62/MRQ-2. Place bridle Bag CW-19/MRQ-2 on brass thimble before placing mooring net over balloon.

(5) Tie a length of rope on one side of the mooring net and pass it over the balloon. Pull the mooring net over the balloon with this.

(6) Fasten the mooring net to the stakes driven into the ground around the balloon bed.

(7) Check to see if all lines are secure and balloon able to weather approaching storm or winds which may occur during the night or period of standby.

**17. BALLOON FLYING TECHNIQUE.** As the actual process of flying the balloon is tied in with the erection and installation of the antenna, flying technique will be covered in Section IV.

**18. DISASSEMBLY AND DEFLATION OF THE BALLOON.** When antennas A and B are disassembled for the ceasing of operations or moving to another site, the balloon should be handled as follows:

*a.* After the winch has brought the balloon within reach of the ground, two men should grasp the "V" shrouds (fig. 25) securely and walk the balloon, bow always toward the wind, to its bed.

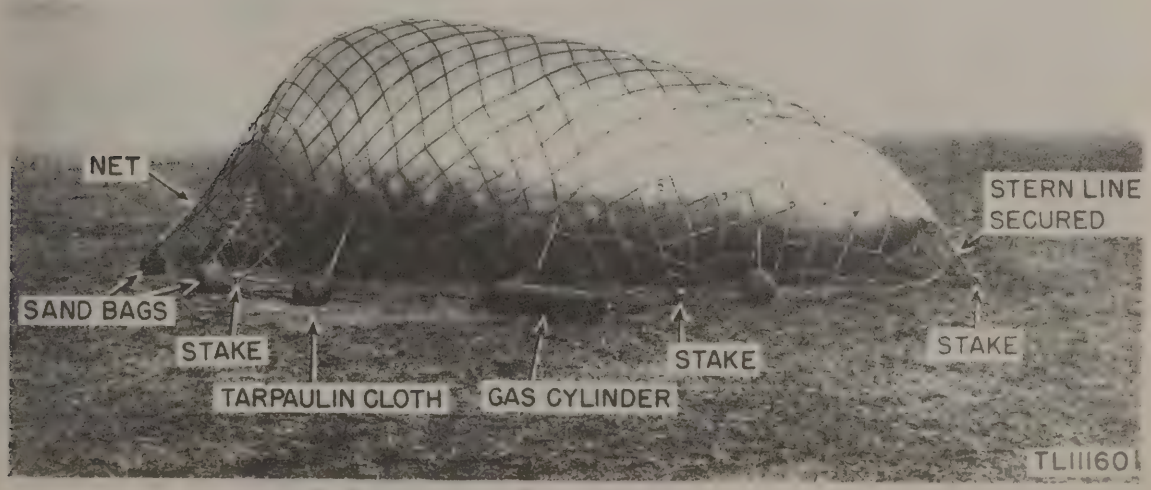



*Figure 24. Balloon secured by mooring net. Gas cylinders may be used as additional anchor if storm is imminent.*

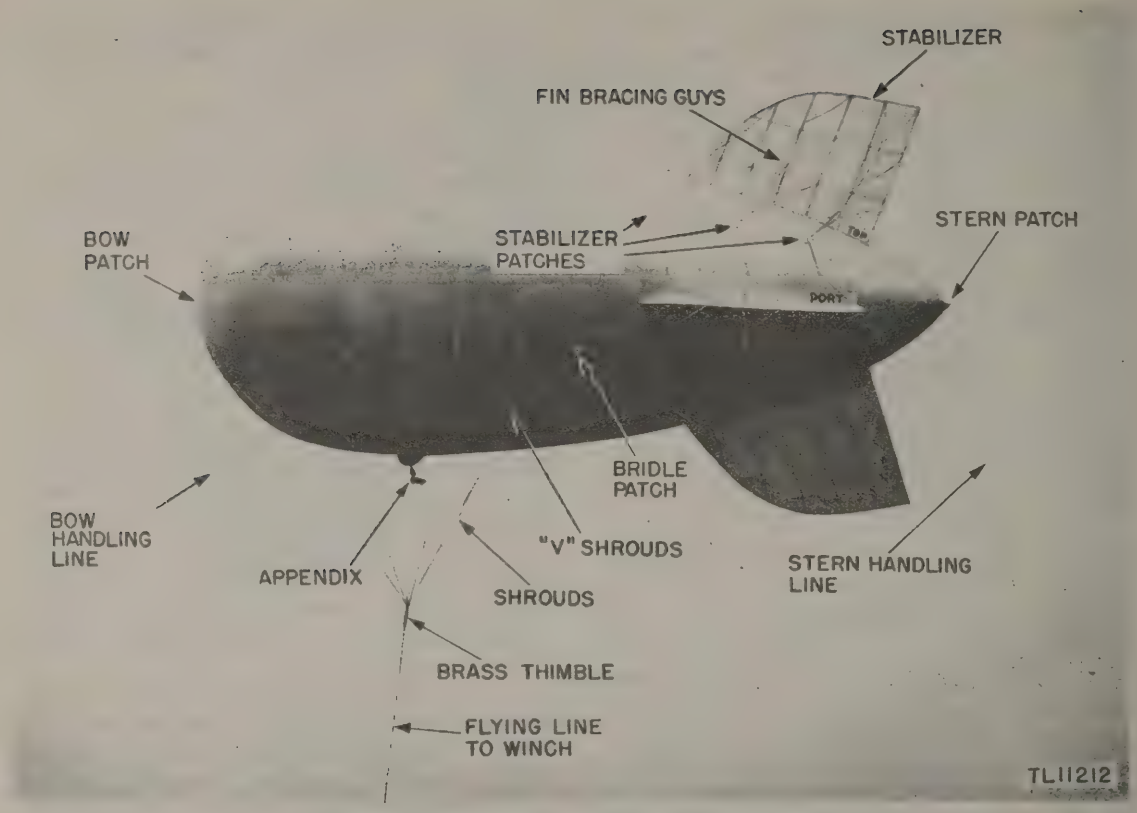



*Figure 25. Balloon MK-93/MRQ-2, fully rigged, flying.*

*b*. Attach sandbags to the "V" shrouds. If a strong wind is present, attach two or three sandbags to the forward "V" shrouds. The bow must be headed into the wind.

*c*. Tie the bow and stern handling lines securely to stakes.

*d*. Remove the fin stabilizers from the balloon reversing the process previously outlined.

*e*. Remove all rubber bands from the appendix sleeve.

*f*. Remove the sandbags attached to the "V" shrouds and walk the balloon shroud lines *under* the balloon. This will turn the balloon upside down, placing the appendix on top. The hydrogen gas, being lighter than air, will at once begin to escape.

**CAUTION: The danger of igniting hydrogen gas is greatest when balloon is deflated because gas mixes with air in explosive proportions. Keep fire, motor vehicles with running motors, and wool-clothed personnel away from the site.**

*g*. Again attach the sandbags to the "V" shrouds of the inverted balloon to maintain it in this position as well as to secure it.

*h*. When the balloon is nearly deflated, begin rolling the bow and stern ends in a manner similar to that shown in figure 14.

*i*. When the balloon is completely deflated, stretch it out as shown in figure 13; then place it, fully extended, on the tarpaulin ground cloth. Sprinkle the balloon fabric with talcum powder provided in Maintenance Box CY-72/MRQ-2. This will prevent the fabric from sticking and adhering to itself when rolled and stowed in Bag CW-20/MRQ-2. If the balloon is wet, allow it to dry completely before applying talcum powder. A balloon which has become glued to itself may be rendered useless for flight.

*j*. Place bridle Bag CW-19/MRQ-2 over the thimble of the balloon bridle to prevent cutting of the fabric by the thimble.

*k*. Fold the balloon fabric loosely and place it in stowing Bag CW-20/MRQ-2.

# SECTION III
# INSTALLATION OF KITE

**19. WHEN KITE SUPPORT IS USED.** In winds over 20 miles per hour, kite support of antennas A and B should be used. It is advisable, however, to assemble the kite as well as the balloon so, should the balloon suddenly fail as a support, the kite may be substituted with a minimum interruption to Radio Set AN/MRQ-2.

**20. LIFTING POWER OF KITE.** Kite VKS-1 will lift 200 pounds from the ground in a 30-mile wind. Never attempt to fly the kite without the aid of Reel Assembly RL-104 MRQ-2, the hand-operated winch. Personnel may be lifted off the ground and injured.

**21. KITE CASE.** Kite VKS-1 is stowed in Case CY-73/MRQ-2 and is packed in a folded condition needing assembly of struts and vertical stabilizer before assuming its box kite flying form. When assembled the length of the kite is 10 feet, wing section span 14 feet, tail section span 5 feet. Assembled it weighs 20 pounds.

**22. KITE ASSEMBLY.** Proceed as follows:

**a.** Choose a clear section of ground free from sharp tree stumps, thorns, or objects which may tear the fabric of the kite during the assembly process.

**b.** Unpack the kite and its assembly parts from Case CY-73/MRQ-2 (fig. 26).




*Figure 26. Unpacking Kite VKS-1, parts identified.*

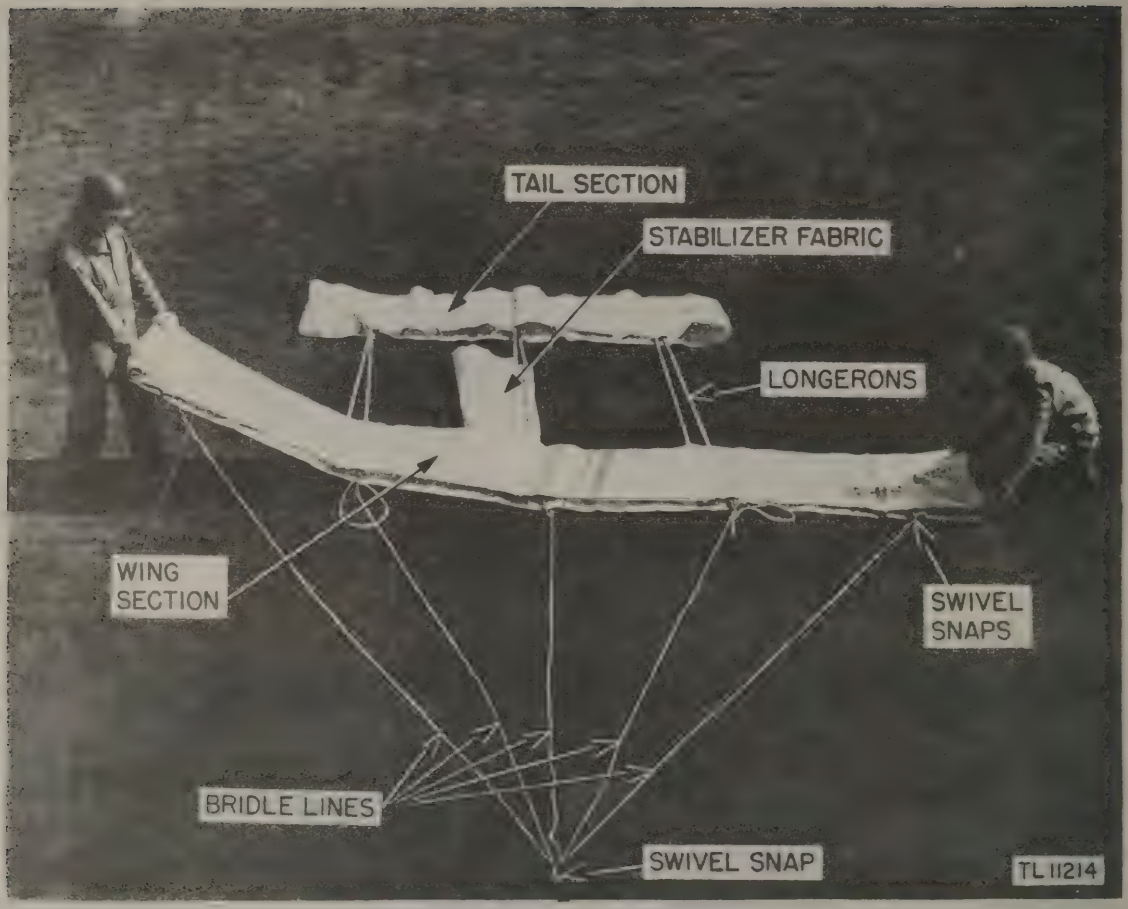



*Figure 27. Laying out kite in a flat clear area.*

*c.* Lay out the kite in the clear area chosen in paragraph 22*a* (fig. 27).

*d.* Assemble forward struts of the vertical stabilizer (fig. 28). Place the 5/8-inch round stabilizer strut in the forward sleeve of the stabilizer fabric and insert the rod in the metal strut keepers attached to the upper and center longerons (fig. 28).

*e.* Be sure that there are no kinks in vertical strut wires and that the thimbles (small metal eyelets) connecting the strut wires to the metal fittings are hanging loose and free in their fittings. If these thimbles are jammed sideways at an angle, they will effectively shorten the strut wire length, and the kite will not go together properly.

*f.* Assemble the diagonal cross struts (fig. 29) in the inboard section of the wing on either side of the vertical stabilizer.

The first diagonal strut in each section is easily placed in position since there is no tension on the fabric at that time. The insertion of the first strut, however, puts tension on the fabric, making it necessary that the second strut be bent slightly in order to go into position. The tension on the fabric can be reduced by bending the first strut with an elbow while at the same time bending the second strut and placing it into position. Metal fittings attached to the longerons are provided for the locating of struts. The screw head on each end of each strut must be properly seated in the hole on the corner of the fitting to prevent slippage of the struts after being placed in position. This is very important if the kite is not to collapse before or during flying. The diagonal cross struts should be placed with their smooth rounded surface facing forward and therefore into the wind. This offers less wind resistance and causes the kite to fly better.

*g.* Assemble cross struts in both sections of tail in the same manner.

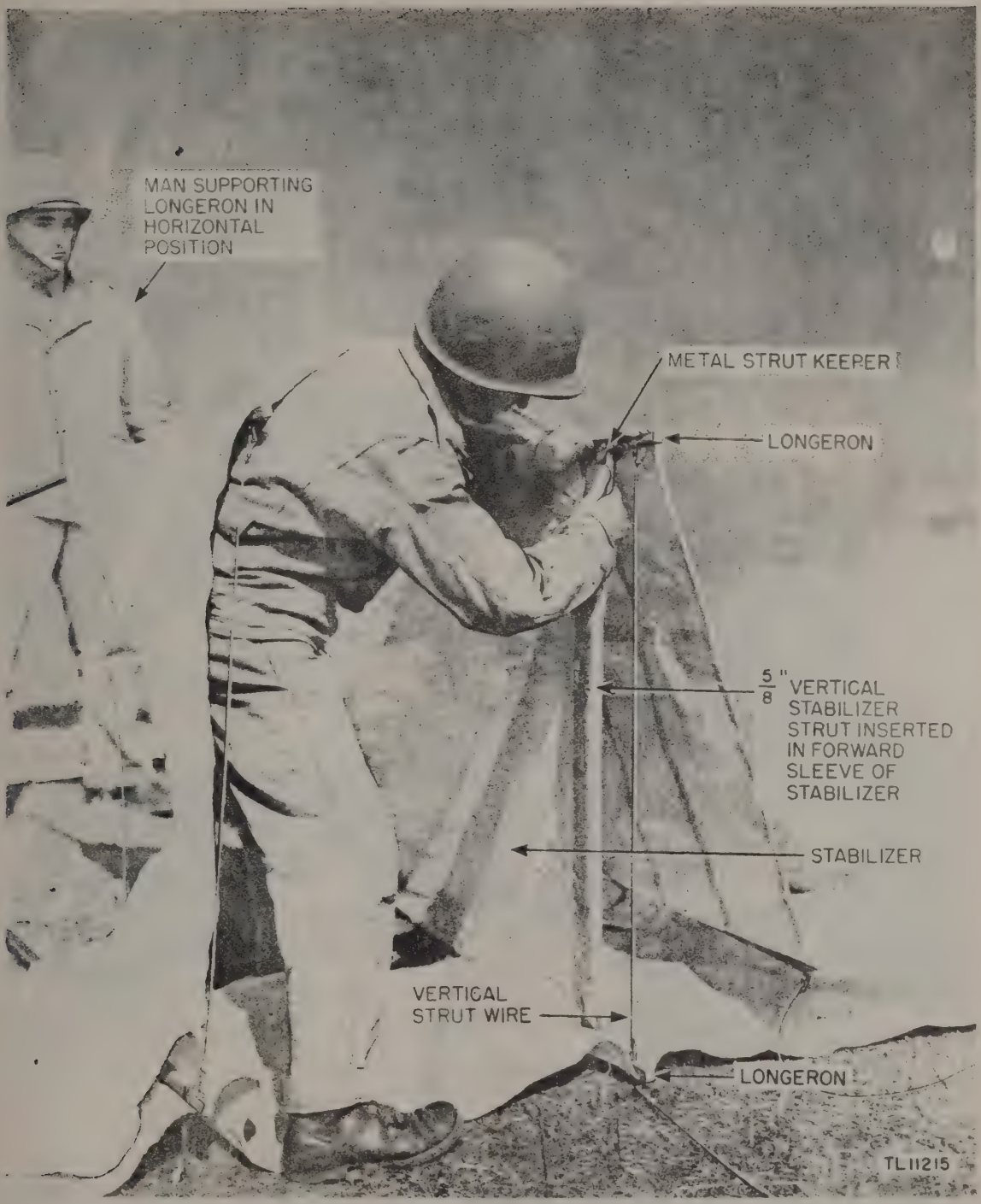



*Figure 28. Assembling forward strut of vertical stabilizer.*




*Figure 29. Placing a diagonal cross strut in position. Strut is bowed by hand pressure to allow placement.*

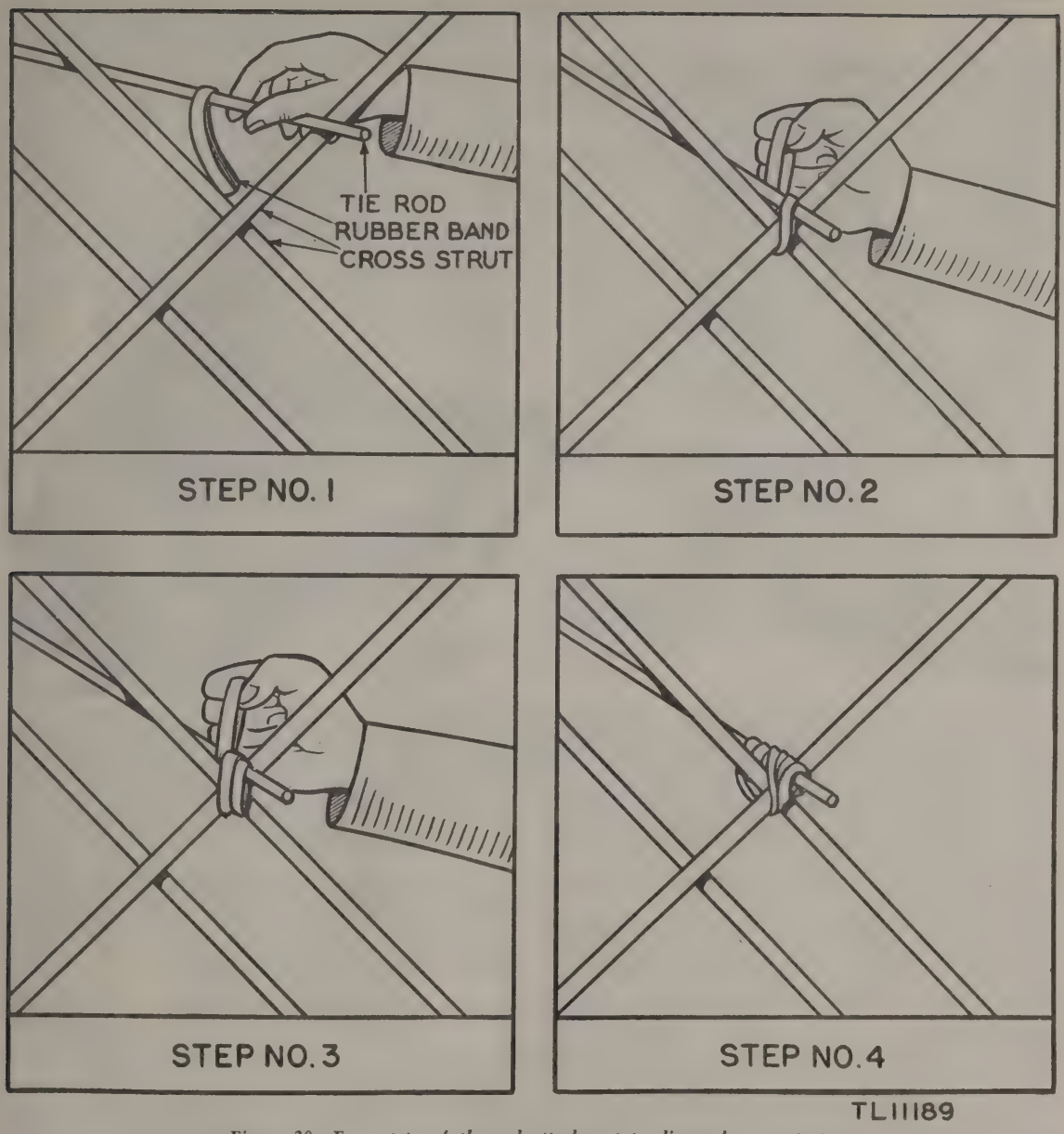



*Figure 30. Four steps of the rod attachment to diagonal cross struts.*

*h.* Assemble cross struts in remaining outboard sections of the wing.

*i.* Complete assembly of vertical stabilizer by insertion of 5/8-inch vertical strut through aft sleeve of stabilizer fabric and into position in metal keepers on upper and lower center longerons. This completes stabilizer assembly.

*j.* Place a tie rod with a rubber band over it at the intersection of the cross struts with the rubber band behind the struts (figs. 30 and 31).

*k.* Straighten the diagonal cross struts while in position until the point of intersection of the two struts is near to the center of the section.

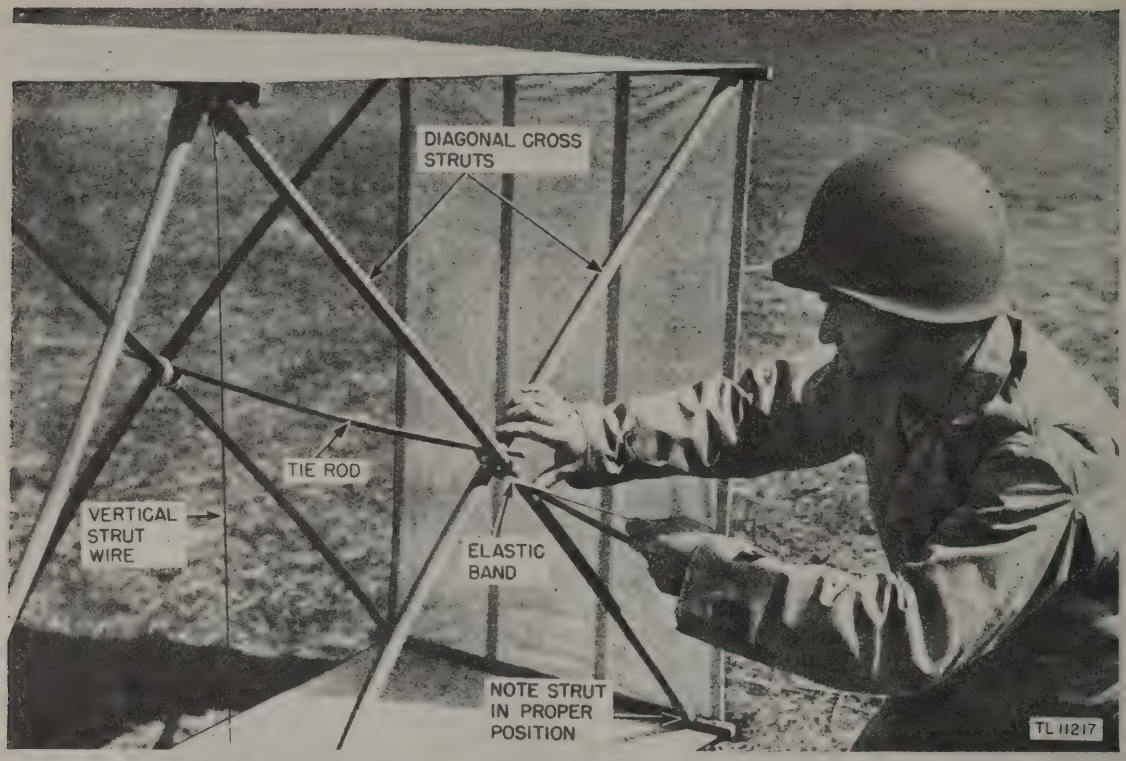



*Figure 31. Position of the tie rod resting on diagonal cross struts. Starting first loop of elastic band.*

*l.* Fasten the tie rod in place. Stretch the rubber band as far as possible at all times; draw under the intersection of struts; up and over the tie rod in front of the struts; and again back under the intersection.

*m.* Continue lapping until tie rod is firmly held in position, and complete the operation by lapping the free end of the rubber band over the tie rod in front of the struts.

*n.* Extend the bridle lines. Be sure the lines are not fouled and that the swivel snaps are hanging loose and free in the fittings. The kite is now ready for flying. See figure 32 on opposite page.

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# SECTION IV
# INSTALLATION OF ANTENNAS A AND B

**23. INSTALLATION OF ANTENNAS A AND B.** Since these two antennas are similar except for size and are both balloon or kite-supported, their physical installation will be treated together. As previously outlined, antenna A is used for frequencies between 0.95 and 8.0 megacycles; antenna B for frequencies between 3 and 18 megacycles. The special use of antenna A for the frequencies normally covered by antenna B will be discussed later in Part Three. For a rule-of-thumb, however, the antennas should be used for their respective ranges unless otherwise authorized by the officer in charge.

**24. DIMENSIONS.** A schematic layout showing antenna leg, height, and counterpoise dimensions appears in figure 33. Note that the angle $\phi$ is 55° for both antennas A and B, making the entire upper apex angle of both antennas 110°, a compromise angle to provide maximum performance at all frequencies.

**25. COUNTERPOISE INSTALLATION.** After a site has been surveyed and chosen as outlined in Part Two, Section I, proceed as follows:

*a.* Drive in the first ground stake at the spot chosen for the location of the near apex of the antenna triangle. Note that Radio Set AN/MRQ-2 must be located within three or four feet of this stake due to the limiting factor of the 12-foot transmission line which must connect the antenna to the radio set. In this choice, concealment features for Radio Set AN/MRQ-2 should be considered. If concealment is impossible using a single transmission line, the two Cables RG-61/MRQ-2 provided with the antenna assembly may be used, one connected as an extension to the other. This arrangement should be used, however, only when a single line will not suffice, as the extra line introduces undesirable losses.

*b.* Place the metal ring attached to a shock snubber (to which a triangular insulator in turn is secured) over this stake. See figure 34 for identification of the various antenna components.

*c.* From Bag BG-102-A remove hand Reels RL-103/MRQ-2 on which Counterpoise AT-55 MRQ-2 (1,612 ft. of No. 14 phosphor-bronze stranded wire) is wound, when antenna A is to be installed. From Bag BG-102-A remove hand Reels RL-103/MRQ-2 on which Counterpoise AT-56 MRQ-2 (625 ft. of No. 14 phosphor-bronze stranded wire) is wound, when antenna B is to be installed.

*d.* Hook the served thimble (near the end of the appropriate counterpoise) to the wire loop of the triangular insulator which is already secured to the ground stake. Connect the wire end to the insulator binding post as shown in figure 35.

*e.* Remove the transit compass previously used in surveying the site and determine the azimuth angle of the beam. Extend the counterpoise its full length in this direction.

NOTE: The counterpoise direction fixes the beam direction. Be sure that the counterpoise runs in a straight line. If the counterpoise is not tautly laid the antenna legs will not be far enough apart (fig. 36) and will reduce the interior angle "A" and disrupt the phasing of the entire beam. The corkscrewed arrow in figure 36 depicts the erratic action of the beam due to an incorrectly and loosely laid counterpoise.

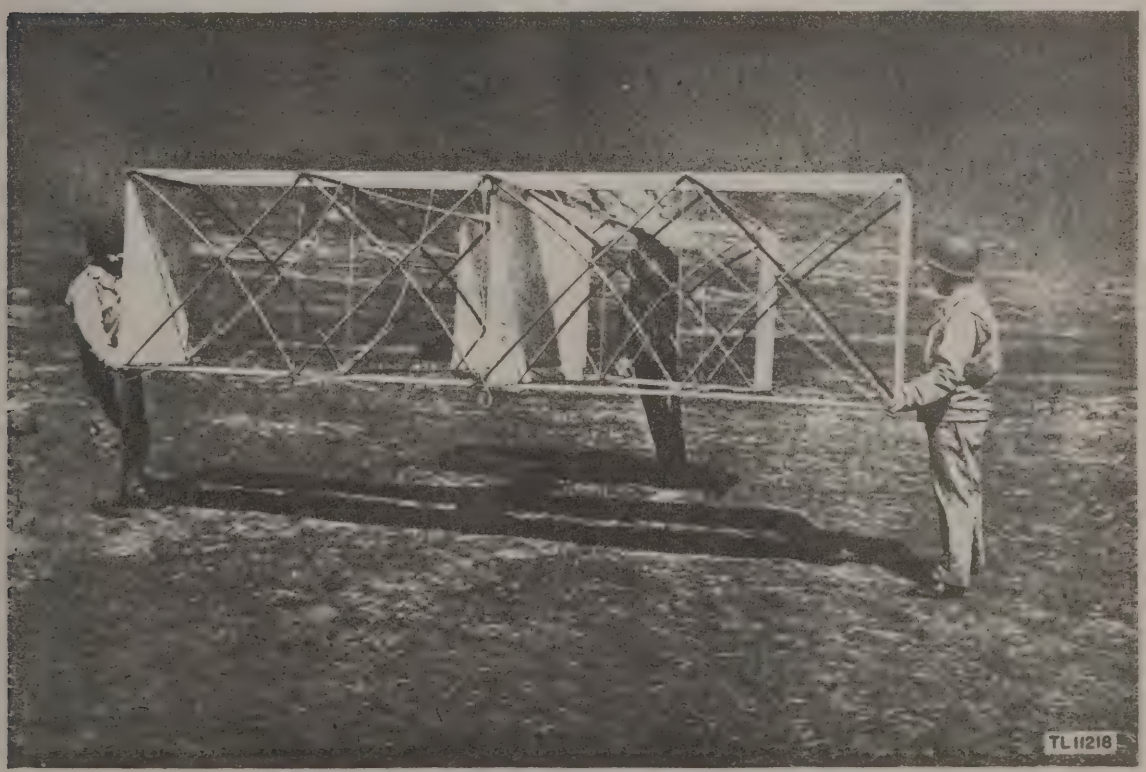



*Figure 32. Kite fully assembled, three men carrying it into position.*

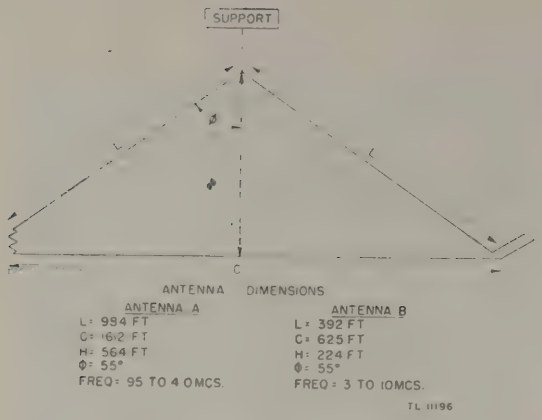



*Figure 33. Dimension of antennas A and B.*

f. Drive in a ground stake at the far end of the counterpoise, attaching an insulator and its snubber exactly as previously done at the near end.

g. Drive the ¼-ton, 4 x 4 truck containing the winch (or carry the winch if no truck is available) to the approximate center of the counterpoise, locating the winch some 200 to 400 feet (depending upon wind strength) to windward from the counterpoise center. Unwind a short length of flying line and lock the winch.

**26. ANTENNA INSTALLATION, FIRST STEPS.**

a. Remove the two hand reels RL-103/MRQ-2 from Bag BG-102 containing antenna wire and drop line for the appropriate antenna (fig. 37). Antenna Wire Assembly AS-92/MRQ-2 is used for antenna A; Antenna Wire Assembly AS-91/MRQ-2 for antenna B. Carry reels to winch position.

b. Walk the balloon or kite to the winch position. The balloon should be walked with nose into the wind, the kite also into the wind. The center bridle snap of the kite should be fastened to the upper edge of the wing section to insure against premature rising.

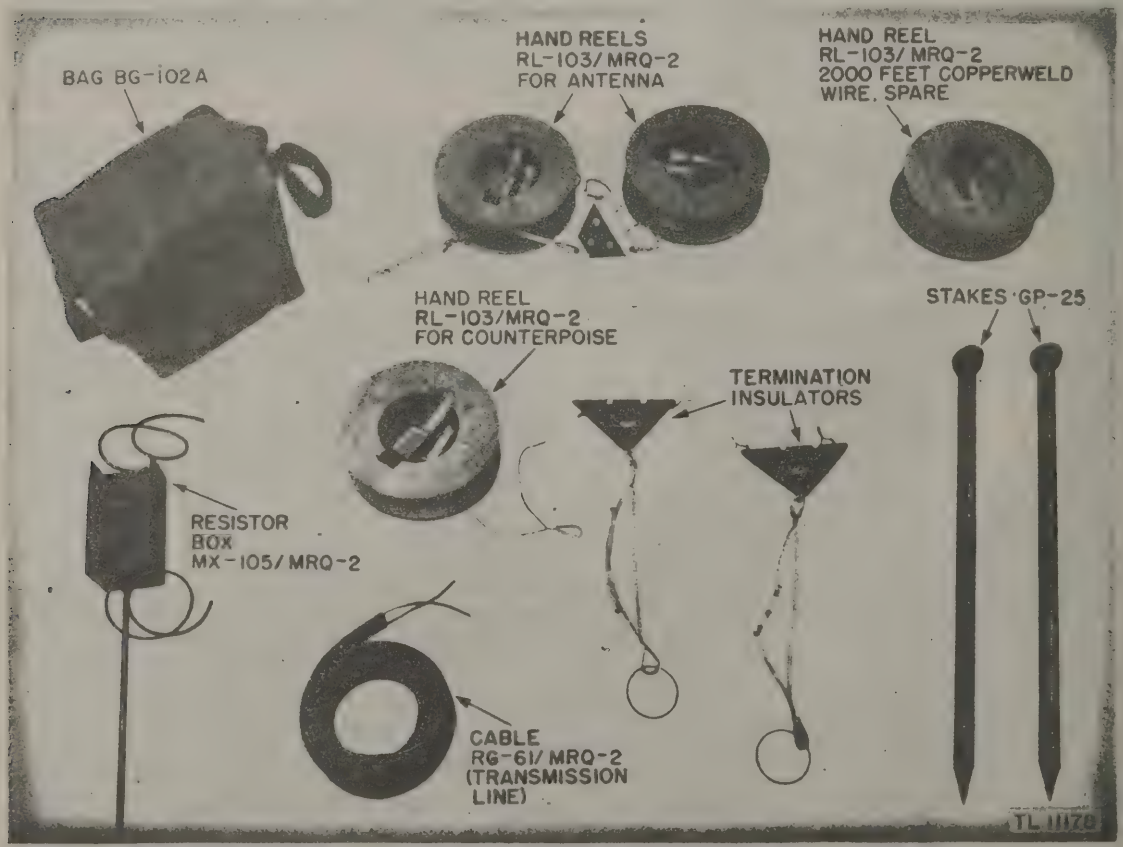



*Figure 34. Antenna components.*

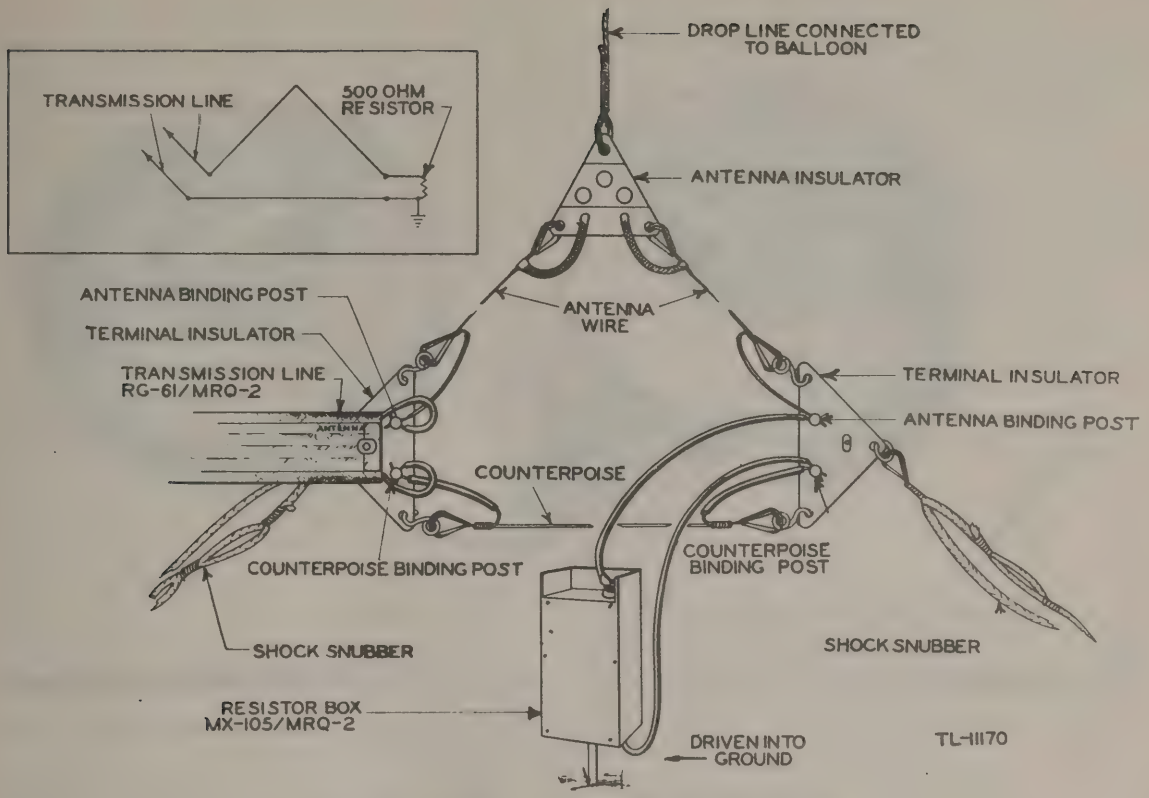



*Figure 35. Compressed schematic showing hardware and accessory conections for antennas A and B.*

**c.** With the balloon at the winch position, couple the thimble attached to the balloon shroud lines to the nylon flying line wound on the winch. Use the brass shackle with removable cross bolt and safety catch for this coupling. Shackle attachment is shown in figure 38.

**CAUTION: Be sure safety catch is secured tightly after drop and flying lines are attached so removable cross bolt will not fall out allowing the balloon to fly away or the kite to crash.**

***d.*** Unwind the nylon antenna drop line wound over the antenna wire on Reel RL-103/MRQ-2 (fig. 37) and attach thimble at its end to the brass shackle as shown in figure 38. The shroud lines, shackle, flying line, and drop line when completely rigged, are shown in figure 39.

**27. FLYING THE BALLOON.** With balloon and antenna rigged as shown in figure 39 proceed as follows:

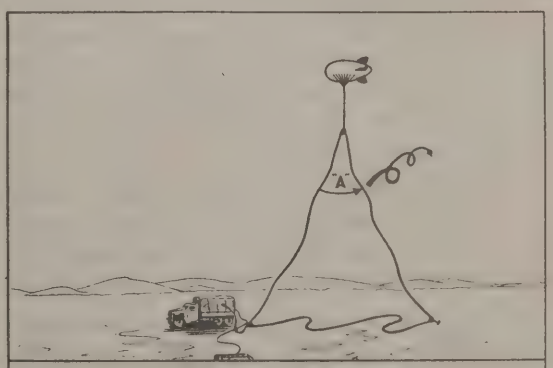



*Figure 36. Antenna legs and counterpoise lengths.*

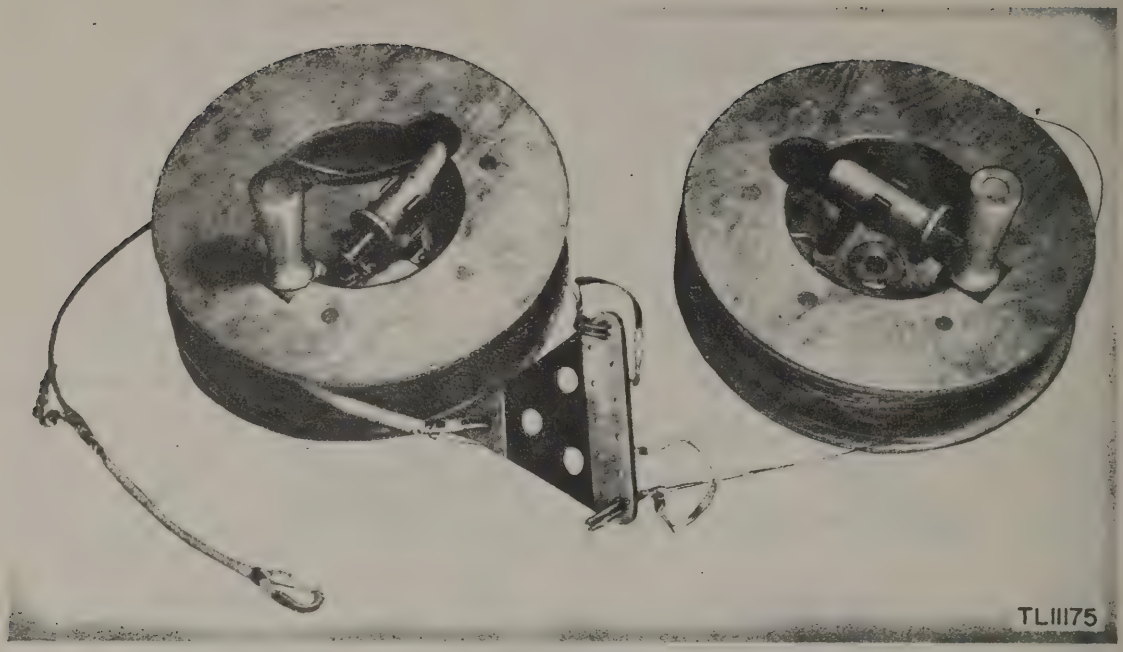



*Figure 37. Reels RL-103 MRQ-2 wound with antenna wire and joined by triangular insulator. Note nylon drop line also wound on reel, its ends served to thimbles.*

**a.** Allow the balloon to rise some 100 or 200 feet depending on the drop line length of the antenna used. (Drop line on antenna A is 100 feet; on antenna B, 200 feet.)

**b.** The two Reels RL-103/MRQ-2 are then held in each hand, arms extended, as the balloon rises further. This is to prevent a snarling of the two antenna wires which are forming the antenna triangle legs (fig. 40).

**c.** As the balloon rises further two men should each take one Reel RL-103/MRQ-2 and walk the antenna legs to the ends of the counterpoise (fig. 41). (Let the balloon rise smoothly, not in jerks.)

**d.** When the antenna wire has been completely unreeled from each hand reel, hook the ends of the wire to the triangular insulators as shown in figure 35.

**e.** Adjust the height of the balloon by means of the length of the controlling flying line so that the antenna becomes taut and takes most of the load. The flying line should be comparatively slack, taking only a fraction of the load, acting now only as a safety line should the antenna break.

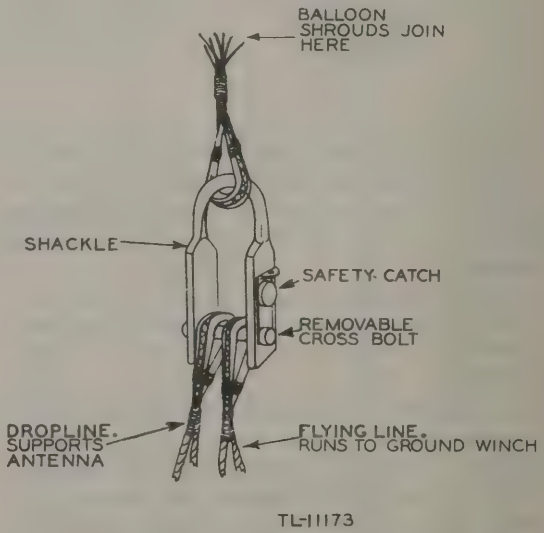



*Figure 38. Brass coupling removable cross bolt safety catch, and various attached lines.*

**f.** These balloon-flying techniques should be kept in mind:

(1) A rising balloon should be allowed to go up smoothly, never in jerks.

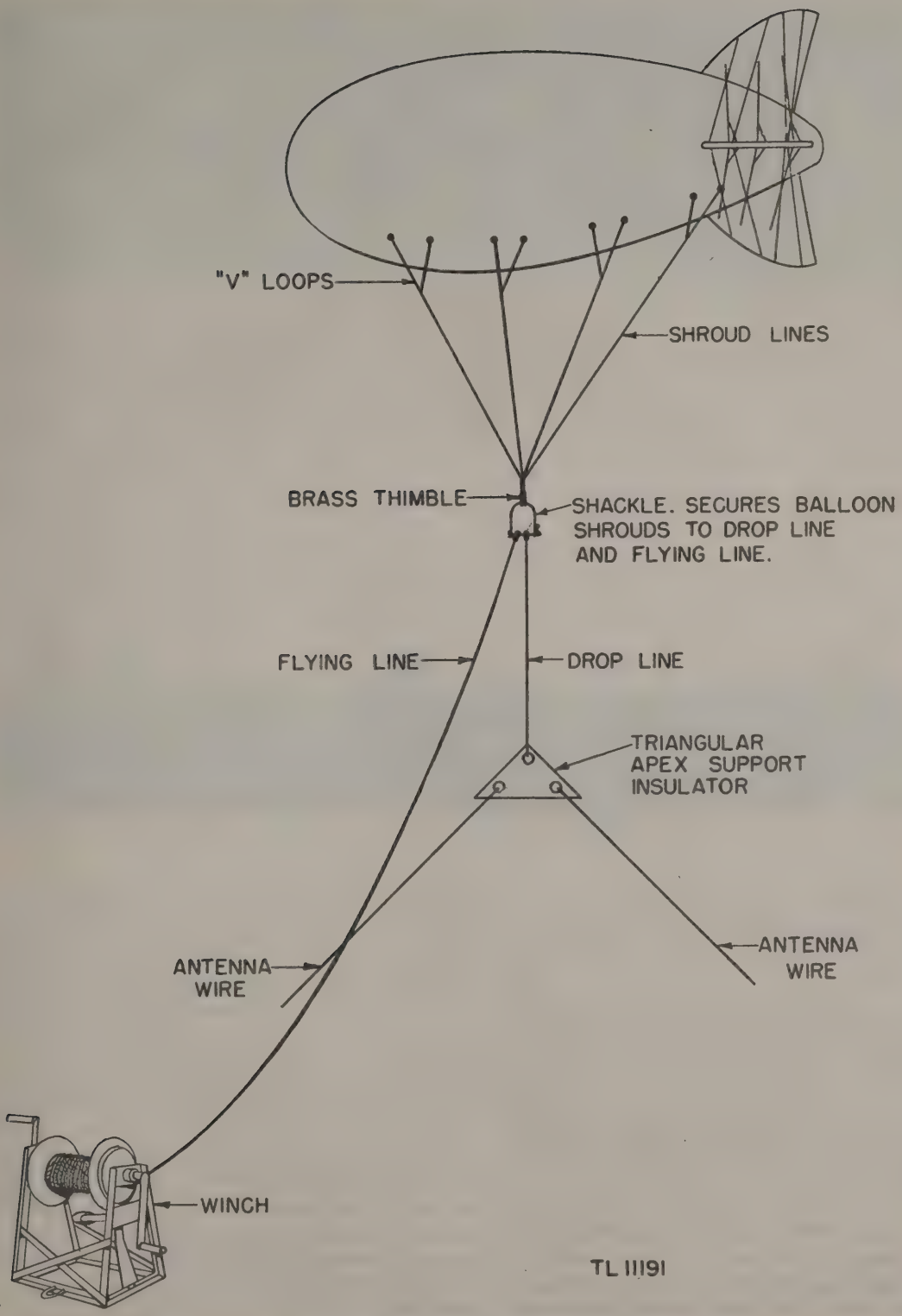



*Figure 39. Line and rigging connections using balloon as antenna support.*




*Figure 40. Reels extended as antenna legs start upward.*

(2) If a balloon dives, give it plenty of slack so it will right itself. Never pull on a diving balloon, or the dive will be increased, causing the balloon to crash.

(3) If a balloon flies in circles, the fin stabilizers may be incorrectly installed. Pull down the balloon and check them.

(4) If the balloon fails to lift the antenna load, the gas inside may be impure, the balloon may have been punctured, or the appendix loose. Pull down and examine.

(5) If a small dent appears in the nose when sunshine is obscured by overcast, it is not particularly important and is due to contraction of the balloon's gas due to cooling. Don't worry about it unless dent becomes deep. Then pull down and examine for punctures or loose appendix.

(6) The safest place for the balloon in a storm is upstairs. If it is near or on the ground it may destroy itself. It will outride most storms if kept high.

**28. ANTENNA INSTALLATION, FINAL STEPS.** With the balloon now in position and antenna legs secured to insulators at the two ends of the counterpoise, then:

*a.* Drive the antenna terminating resistance, Resistor Box MX-105/MRQ-2, into the ground at the far end of the counterpoise and connect it to the triangular insulator, to the antenna, and to the counterpoise as shown in figure 35. Figure 42 shows the resistance with cover removed and connecting wires identified.

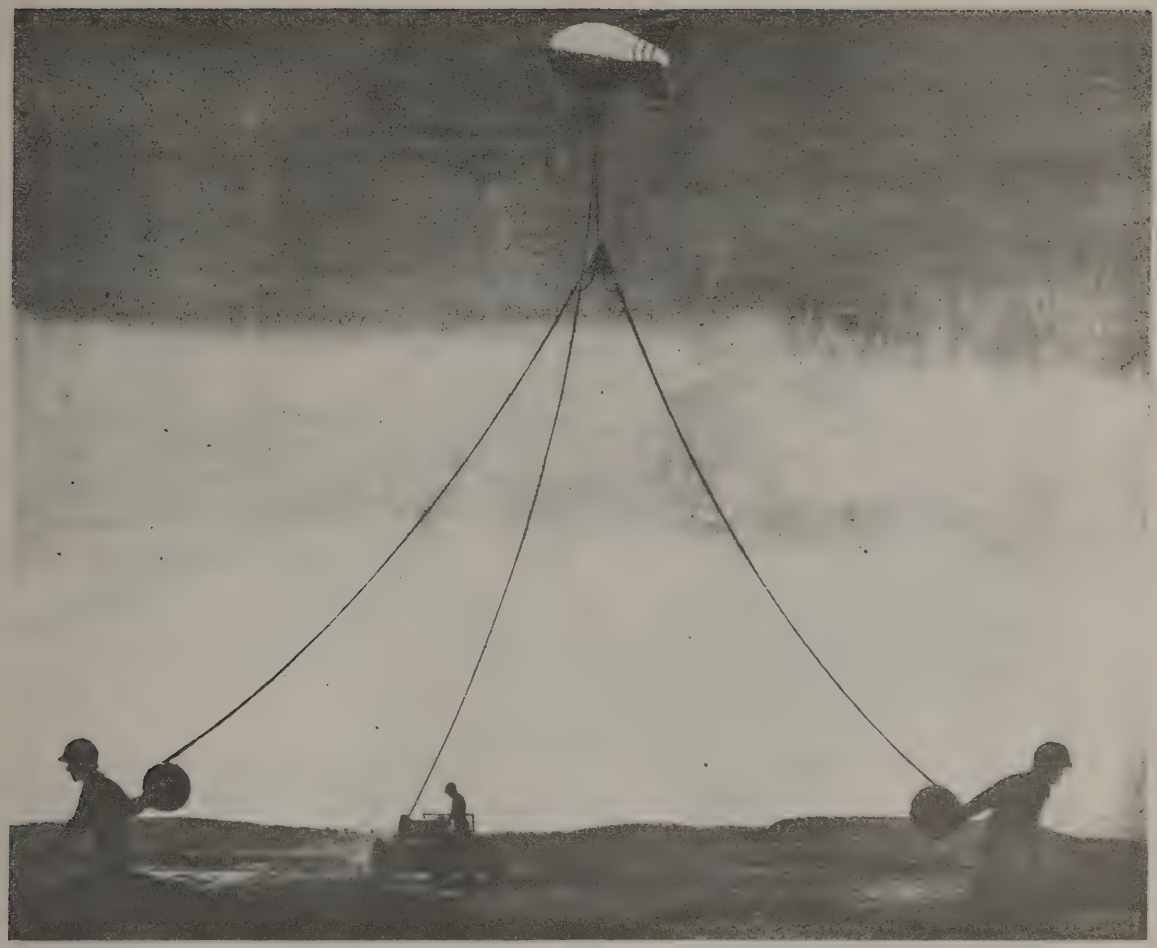


*Figure 41. Reels being walked to counterpoise ends.*

*b*. Connect the transmission line, Cable RG-61/MRQ-2, to the near end of the antenna triangle, securing the snap fastener on the cable to that on the insulator. The insulated cable wire marked ANTENNA connects to the antenna leg; the other wire to the counterpoise (fig. 35).

*c*. Connect the other end of the transmission line to the wall lead-in connections of Radio Set AN/MRQ-2, securing it by the wingnuts provided and attaching the snap fasteners in order to place the cable weight upon the fastener instead of on the wingnut connection. See figure 43.

NOTE: Trace the wire connected to the antenna leg and be sure it attaches to the white porcelain lead-in and not to the grounded binding post connected to the body of the shelter. If this connection is reversed the antenna will not work.

*d*. Visually check the complete installation to make certain all connections are clean and tight. If Radio Transmitter T-55 MRQ-2 fails to be properly loaded by either antenna A or B, remove the transmission line from the wall wingnut lead-ins and check for overall antenna continuity of the antenna system measured across the two transmission line wires. It should show between 400 and 700 ohms dc resistance. More than that may indicate an open circuit, poor connections, or blown termination resistance.

*e*. If all connections are tight and the antenna shows continuity, the antenna assembly is ready to operate, using the balloon as support.

**29. FLYING KITE VKS-1.** If the kite is to be used for antenna support instead of the balloon, it should

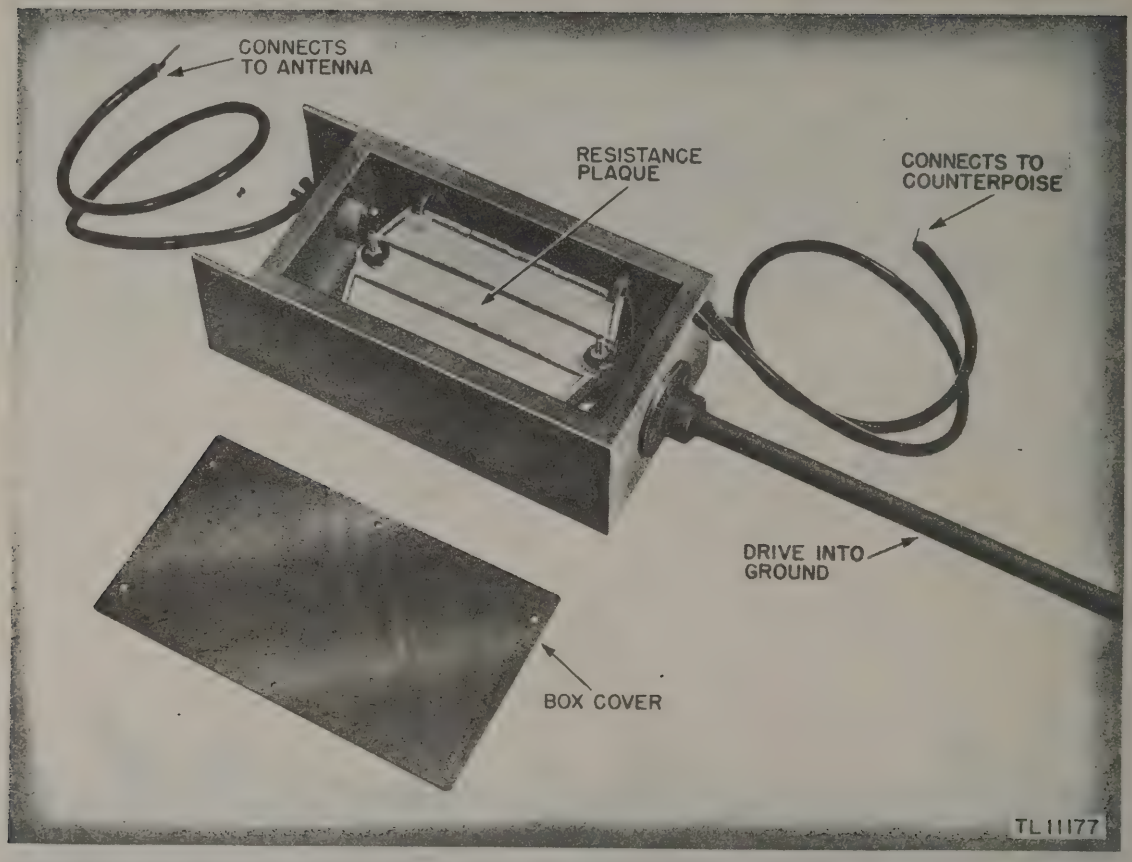



*Figure 42. Resistance Box MX-105/MRQ-2 with parts and connecting wires identified.*

be secured to the flying line in the same manner as the balloon. Proceed as follows:

**a.** Extend the bridle lines. Check to see they are not fouled and that swivel snaps are hanging loose and free in their fittings.

**b.** Attach the bridle ring and swivel to the flying line (fig. 44). Also attach shackle and antenna drop line as in balloon installations. Check all connections for secureness.

**c.** Pay out 150 to 200 feet of flying line from the winch and walk the kite (three men) to the end of this line. Place the center bridle line, which was attached to the upper edge of the wing section to prevent the kite from rising, to the lower edge of the wing section. With the flying line from the winch to kite fairly taut, face the kite into the wind. With a slight upward toss the kite becomes airborne.

**d.** In winds over 20 miles per hour the kite will take off easily and often by itself when turned into the wind. Rising very rapidly, the vibrating fabric will generate a loud roaring sound much like a rocket. This is a normal condition and not a sign that the kite is incorrectly rigged or otherwise misadjusted.

**e.** Pay out line until the kite rises high enough to support the antenna triangle in a vertical position. Then slack off the flying line exactly as done when using balloon support to place the load on the antenna instead of on the flying line.

**f.** To lower the kite:

(1) Reel in the kite flying line, making sure the line is *always kept taut.* If not, the kite may dive and crash.

(2) When the kite is up about 100 feet, walk the kite down, *always keeping the flying line taut.*

(3) When the kite bridle line is within reach, take hold of the *center* bridle line and bring the kite to the ground gently.

(4) Attach the center bridle line to the snap on the upper edge of the wing section. This will prevent the kite from rising again.

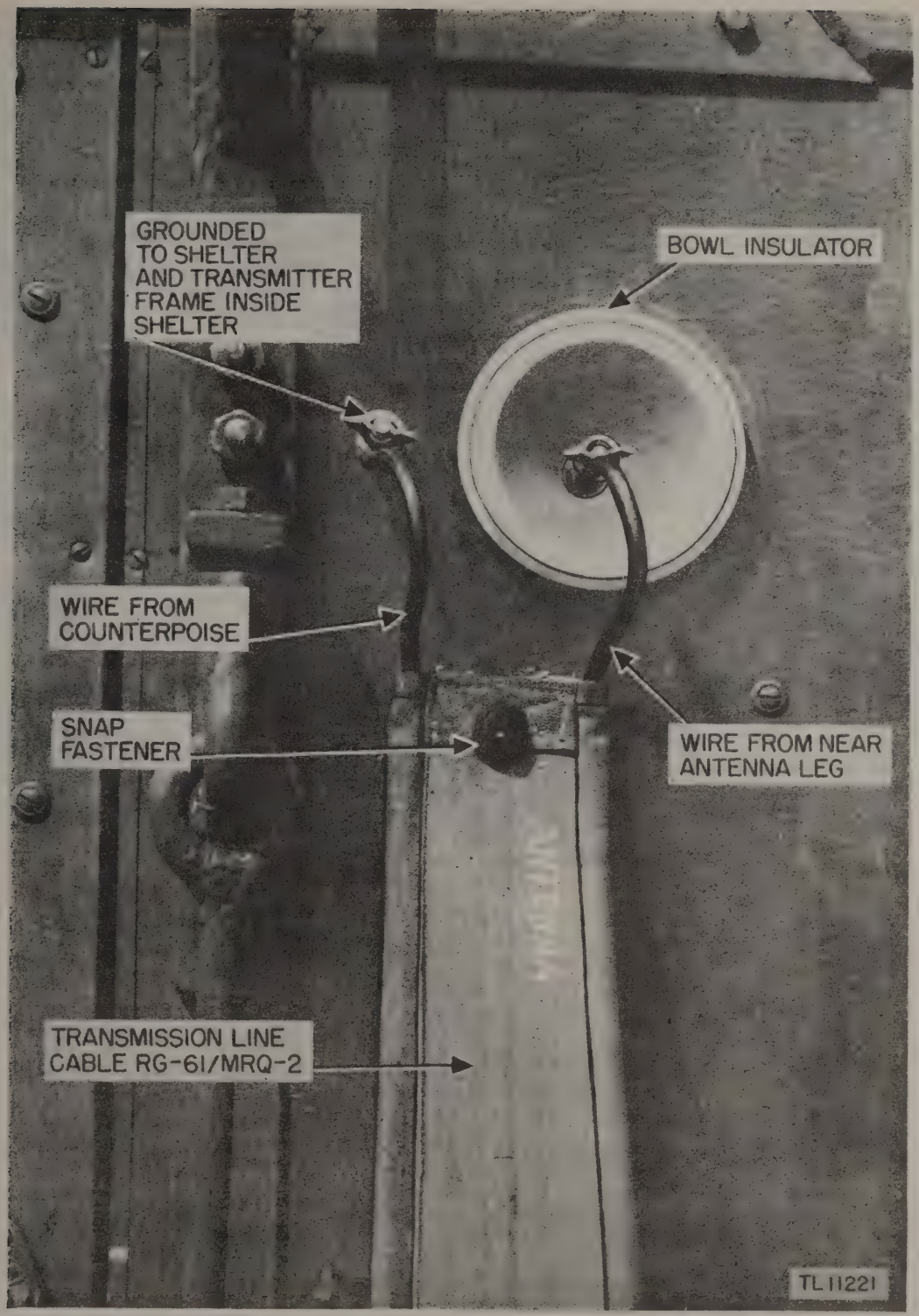



*Figure 43. Transmission line connection to wall of Shelter HO-17-( ). Note cable wire from antenna leg connects to porcelain bowl lead-in; wire from counterpoise connects to grounded binding post.*

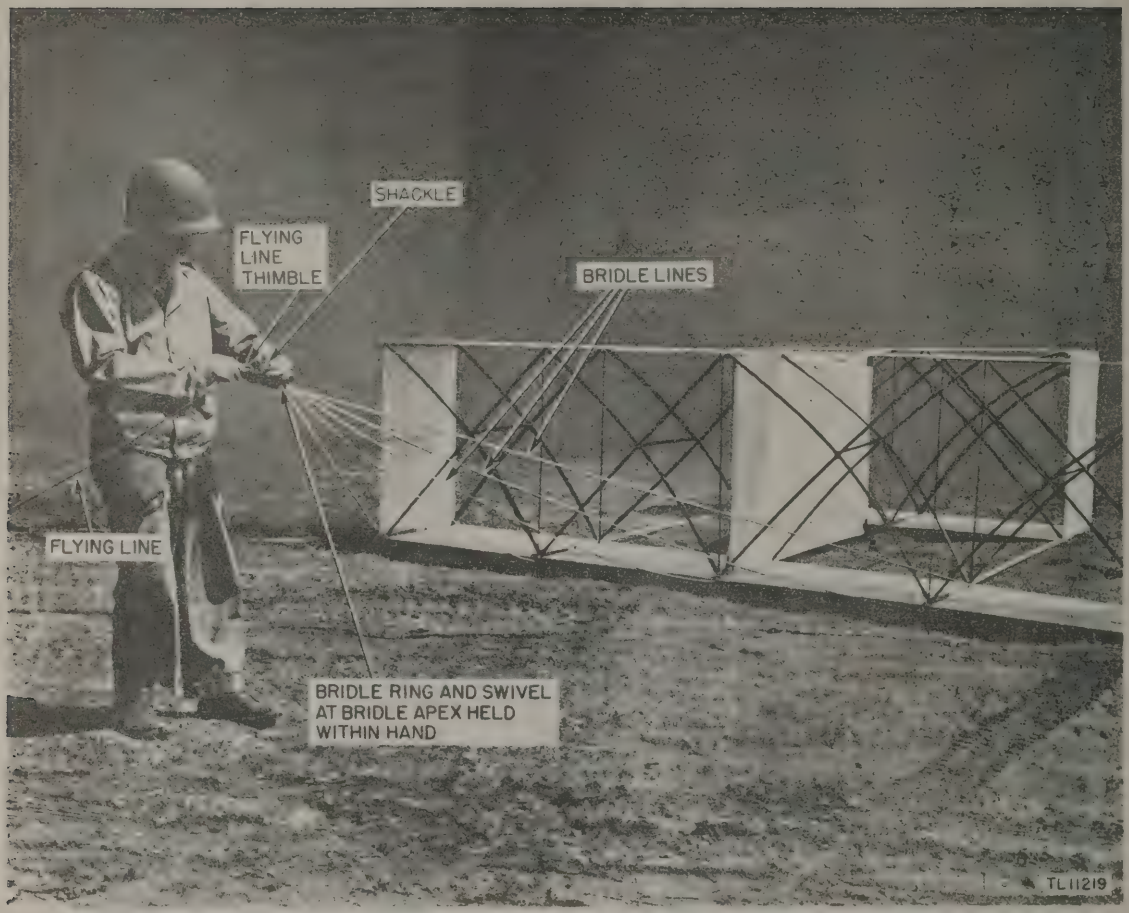



*Figure 44. Attached flying line from winch to completely rigged kite ready for flying.*

g. To moor the kite:

(1) Place two or three sandbags on the inboard and outboard sections of the tail and wing sections of the kite.

(2) Attach the bridle loop to two sand bags or tie it to Stake GP-25.

(3) No covering is required on the kite.

# SECTION V

# INSTALLATION OF AUXILIARY ANTENNA ASSEMBLY AS-93/MRQ-2, ANTENNA C

**30. LOCATION OF ANTENNA C.** The same general precautions outlined for choosing a site for antennas A and B hold for antenna C if maximum performance is to be obtained. However, the antenna will still perform creditably where favorable location is sacrificed for installation speed, ease of concealment, and tactical consideration, as may often be the case. It must be kept in mind, though, that the range and effectiveness of antenna C is far less than that of antennas A and B, at the same time superior to the five-section whip, antenna D.

**31. UNLOADING ANTENNA C.** Unload the following from the carrying vehicle:

*a.* Bag BG-102 containing:

Antenna Wire Assembly AT-57/MRQ-2, 134½ feet No. 16 copperweld, insulators attached.
Counterpoise AT-58/MRQ-2, 130 feet No. 16 copperweld, insulators attached.
Mast Cap MP-8
Six guy ropes, 35 feet.
Six guy ropes, 25 feet.
Two pulley ropes, Guy GY-24A.
Guide rope, 15 feet, for stake alignment.

*b.* Four lance Poles PO-2.

Two steel Mast Sections MS-25.
Six Stakes GP-25.

**32. INSTALLATION OF ANTENNA C.** Proceed as follows:

*a.* Mark out 125 feet in a cleared area in the direction that the antenna will extend.

*b.* Take two lance Poles PO-2 and join them together with Mast Section MS-25 (fig. 45).

*c.* Take the 15-foot section of measuring guide rope contained in Bag BG-102 and drive three metal Stakes GP-25 into the ground, 120° apart and each 15 feet from the pole as measured by the guide rope.

*d.* Place Mast Cap MP-8 (fig. 45) to which three guy ropes are attached, on top of the lance pole.

*e.* Hook the shorter guy ropes to the eyelets provided on Mast Section MS-25.

*f.* Snap the pulley rope Guy GY-24-A on the Mast Cap MP-8.

*g.* Hoist the lance pole to its vertical position. This can be most easily done by one man holding the base of the pole firmly on the ground while a second man elevates the free end.

*h.* Fasten the guy ropes to the stakes.

*i.* Set up a second pole 125 feet from the one just erected in the same manner.

*j.* Attach one end of Antenna Wire Assembly AT-57/MRQ-2 to the end of the pulley rope. The antenna wire can be told from the counterpoise because the antenna wire is made up of two sections connected by

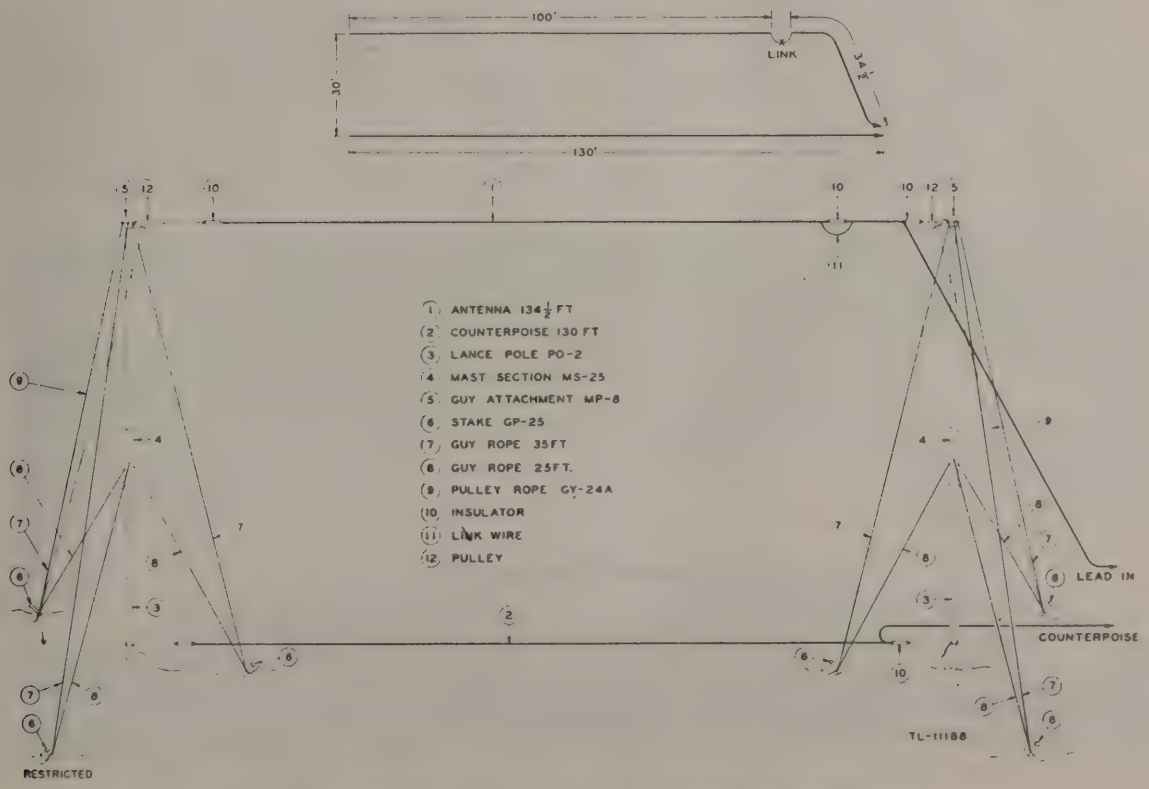



*Figure 45. Installation of antenna C showing lance poles and rigging.*

a link wire and is 134½ feet in length, whereas the counterpoise is 130 feet and in one length.

*k.* Unroll and walk out the antenna wire taking care not to tangle or kink it.

*l.* Attach the other end of the antenna to the pulley rope leaving enough wire extended for attachment to transmitter.

NOTE: The shorter section of the antenna (34½ feet) should be nearest the transmitter.

*m.* Remove the 5-section rod antenna from Mast Base MP-47 and attach the antenna wire lead-in to the base. Raise the antenna.

*n.* Remove Counterpoise AT-58 MRQ-2 from Bag BG-102 and tie the insulator at one end of the counterpoise to the lance pole approximately two feet above the ground.

*o.* Extend the counterpoise, taking care not to kink or tangle the wire. Then tie the far end of the counterpoise with the rope provided to the second lance pole, approximately 2 feet above the ground.

*p.* Attach the counterpoise wire to the grounded binding post used for attachment of the half-rhombic counterpoise.

*q.* For use between 0.95 and 1.8 megacycles the complete length of the antenna is employed and the link wire on the antenna joined. For use between 1.7 and 6.4 megacycles the 34.5-foot length of wire is used only. In this latter case, the wire link must be open.

# *PART THREE*

# *OPERATION*

## SECTION I
## OPERATION OF ANTENNAS A AND B

**33. TRANSMIT-RECEIVE OPERATION.** Half-rhombic antennas A and B work equally well on receiving or on transmitting: If either antenna will transmit a strong signal to a given point it will receive equally well from that point, the power gain of the antenna being applied to both incoming and outgoing signals. For instance, if Radio Transmitter T-55/MRQ-2 delivers 500 watts to antenna A, which has a power gain of 20 times at a certain frequency, the effective power of the transmitter will be increased in the direct line of the beam to 10,000 watts. Similarly, signals received from a 5-watt station directly in the beam will be increased as if the received signal came from a 200-watt station. This equal performance of an antenna on transmitting and receiving is known as antenna reciprocity and is more fully covered in Technical Manual TM 11-314, Antennas and Antenna Systems.

**34. GROUND WAVE AND SKY WAVE.** As is the case with most medium-frequency antenna systems, transmissions from antennas A and B depend for effect on either the ground wave or the sky wave sent out by the antenna. As shown in figure 46, the ground wave is sent out at a low vertical angle from the antenna and, skirting the ground, is effective in reaching receivers within an approximate 50- to 100-mile radius. The sky wave, power-radiated at a higher vertical angle, strikes the ionosphere and is reflected back to earth at distant points beyond the limit of the ground wave. The ground wave and reflected sky wave often overlap, providing continuous coverage for considerable distances. At other times, the sky wave returns to earth at a point hundreds of miles away, leaving a gap between ground and the sky wave known as skip distance. For the practical operation of antennas A and B,

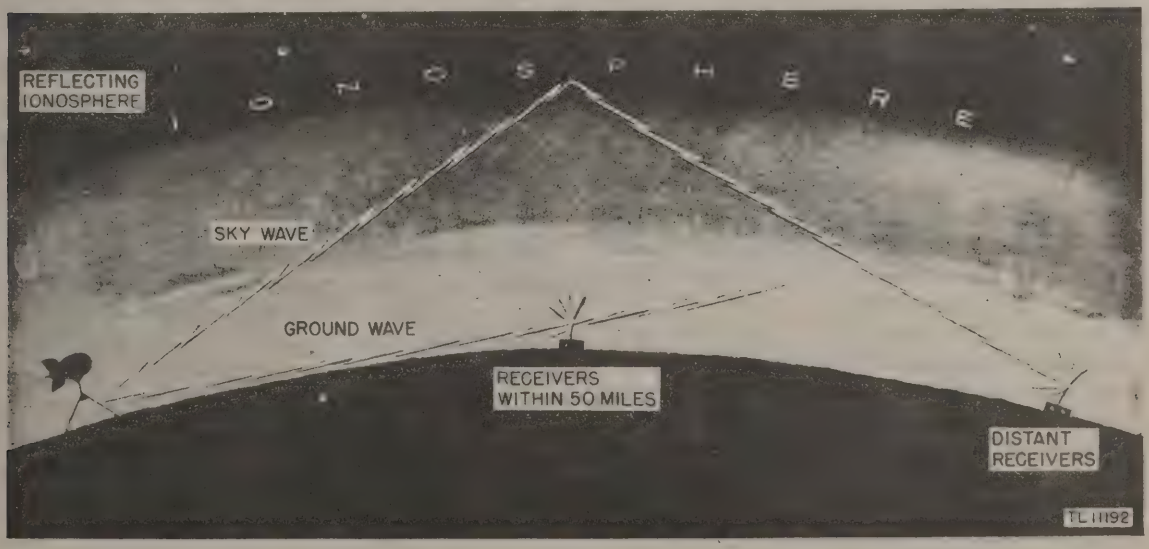



*Figure 46. Ground and sky waves produced by antennas A and B.*

however, little thought need be given to the sky wave, ground wave, and skip distance if a rule-of-thumb is followed: If signals received on antenna A or B from a given point at a given time are strong, antenna A or B will transmit just as strongly to that point at that time on the same frequency.

**35. ORIENTATION FOR MAXIMUM SIGNAL STRENGTH BY RECEIVING.** If it is desired to receive or transmit signals to one locality, antenna A or B is normally aimed at that locality with the aid of the transit compass as outlined in Part Two, Section IV. For the greatest possible transmitting signal strength, however, follow the procedure outlined below after compass sighting.

*a.* Tune in a signal coming from the desired locality on one of the receivers provided in Radio Set AN/MRQ-2. Once tuned in, leave the receiver controls fixed so an increase or decrease in volume with antenna changes will be noted.

*b.* Leaving the near end of the antenna triangle fixed, change the position of the far end of the triangle, thus swinging the antenna to the left or right until the loudest signal on the receiver is produced. Use hand signals from Radio Set AN/MRQ-2 to the far end of the antenna to indicate increased or decreased signals produced by the new direction. (Swing the counterpoise with the antenna to maintain the antenna's triangular shape.) Each change in direction will of course require movement of the terminating resistance and ground stake.

*c.* Thus, if it is desired to transmit to, or cover, a given area at a later prescribed time, the antenna may be oriented in advance if signals from that area can be intercepted, and the antenna swung for maximum received signal strength, using these received signals as a beacon. Then, when it is later desired to reach or cover the area, maximum possible transmitted power can be delivered at once without further orientation, transmissions, or delay.

*d.* After swinging the antenna for maximum possible signal strength, take care that all antenna connections are secure and tight before each new direction is tested. The winch should be so placed that the antenna wires fly approximately over the counterpoise. Be sure the terminating resistance is connected before any test is made. If it is not, signal strength may drop and the new direction may wrongly be considered inferior, due solely to an open terminating resistance connection.

**36. ORIENTATION FOR TRANSMITTING, DIRECT AIM.** If it is desired to reach a given point or cover a small area, antenna A or B should be aimed preferably by the prior interception of signals from that area and by aiming the antenna on these incoming signals; or by careful transit compass alinement if no signals can be intercepted in advance.

**37. ORIENTATION FOR TRANSMITTING, SPREAD AIM.** It may often be desirable to transmit the strongest possible signals covering more than one point or one area, sometimes spreading over a wide sector. The beaming action of antennas A and B will therefore be analyzed in detail so that the exact coverage of either antenna at a given frequency can be considered before operational plans are formed.

**38. BEAM ACTION OF ANTENNAS A AND B.** Both antennas concentrate radio energy fed to them into a beam, precisely as a searchlight concentrates the light it casts in the direction it is pointed. Unlike a searchlight, however, the width of the radio beam sent out by antennas A and B varies with the frequency at which the antennas are used: The higher the frequency used, the sharper and more powerful the beam. Using antenna A, for instance, the beam produced at 4 megacycles is far sharper and more powerful than that produced at 0.98 megacycles, and so on.

**39. POLAR COORDINATE PATTERNS.** To analyze the width and power of beam transmitted by antennas A and B at the various frequencies used by Radio Set AN/MRQ-2, polar coordinate patterns based on actual field strength measurements are shown in this manual. These patterns are essentially graphs indicating field strength of a beam measured at various angles from the zero azimuth, or direction in which the beam is aimed. Figure 47 will illustrate how these patterns are used.

*a.* Figure 47 ① presents a plan view looking directly down upon the counterpoise wire of antenna A or B. The terminating resistor, or resistance box, is shown at the far end of the counterpoise; the transmission line feeder at the near end. A dotted arrow

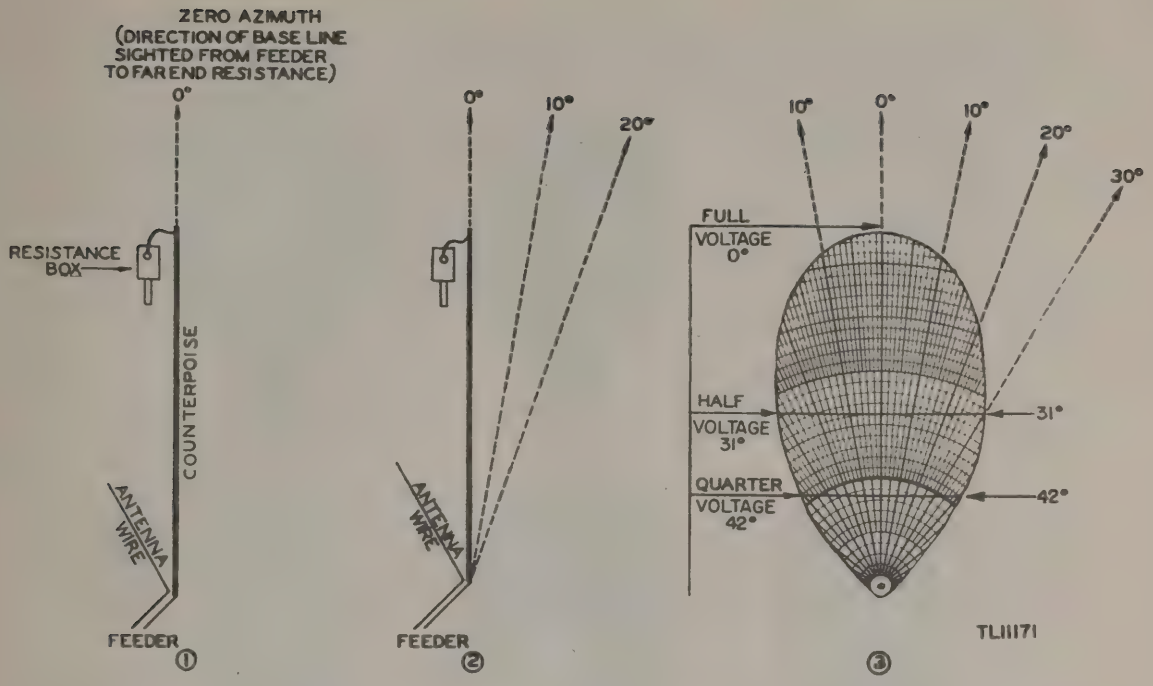



*Figure 47. Relation of azimuth angle to strength of a radio beam.*

points to the zero azimuth angle, or a site made from the near to the far end of the counterpoise, the direction in which the beam is aimed.

**b.** The dotted lines in figure 47 ② show azimuth angles of 10° and 20° off the zero.

**c.** These various azimuth angles are again shown in figure 47 ③ but superimposed is a typical beam pattern chosen at random (antenna A operating at 3 megacycles).

**d.** Note that the beam pattern is fan- or lobe-shaped and divided by lines 10° apart, extended in some cases by dots to show various azimuth angles. The pattern is also divided by circle arcs at different distances from the small circle at the base of the lobe. These circle arc divisions represent relative signal voltages produced by the radio beam. The points where these arcs intersect azimuth divisions at the edge of the pattern show at a glance how much relative signal will be radiated at each angle off the zero of the antenna.

**e.** Use figure 47 ③ as an example. Note the arrow pointing to the top of the fan or lobe. The vertical zero azimuth line cuts the edge of the pattern at the topmost arc, indicating that the beam radiates maximum signal voltage at 0°, the reason for carefully aiming a beam on target for point-to-point communication.

**f.** Now note the middle arrow and line marked HALF VOLTAGE drawn exactly half way between the top of the lobe and small lower dotted circle. It intersects the edge of the lobe at 31°. Therefore at 31° the maximum signal voltage delivered by the beam has been reduced to half. The line marked QUARTER VOLTAGE drawn a quarter way between the top of the lobe and small lower dotted circle indicates that at 41° one-quarter maximum signal voltage is transmitted by the beam. In this way the relative signal transmitted at any azimuth angle may be quickly estimated.

**g.** In figures 48 and 49 are shown polar coordinate patterns for antennas A and B at various frequencies. Keep in mind, however, that these patterns are not mutually comparable as to signal output. True, the sharper beams indicate greater power than the broader beams at zero azimuth, a correct assumption, but the various patterns are not drawn to mutually proportionate scale. Therefore, each must be considered and analyzed separately.

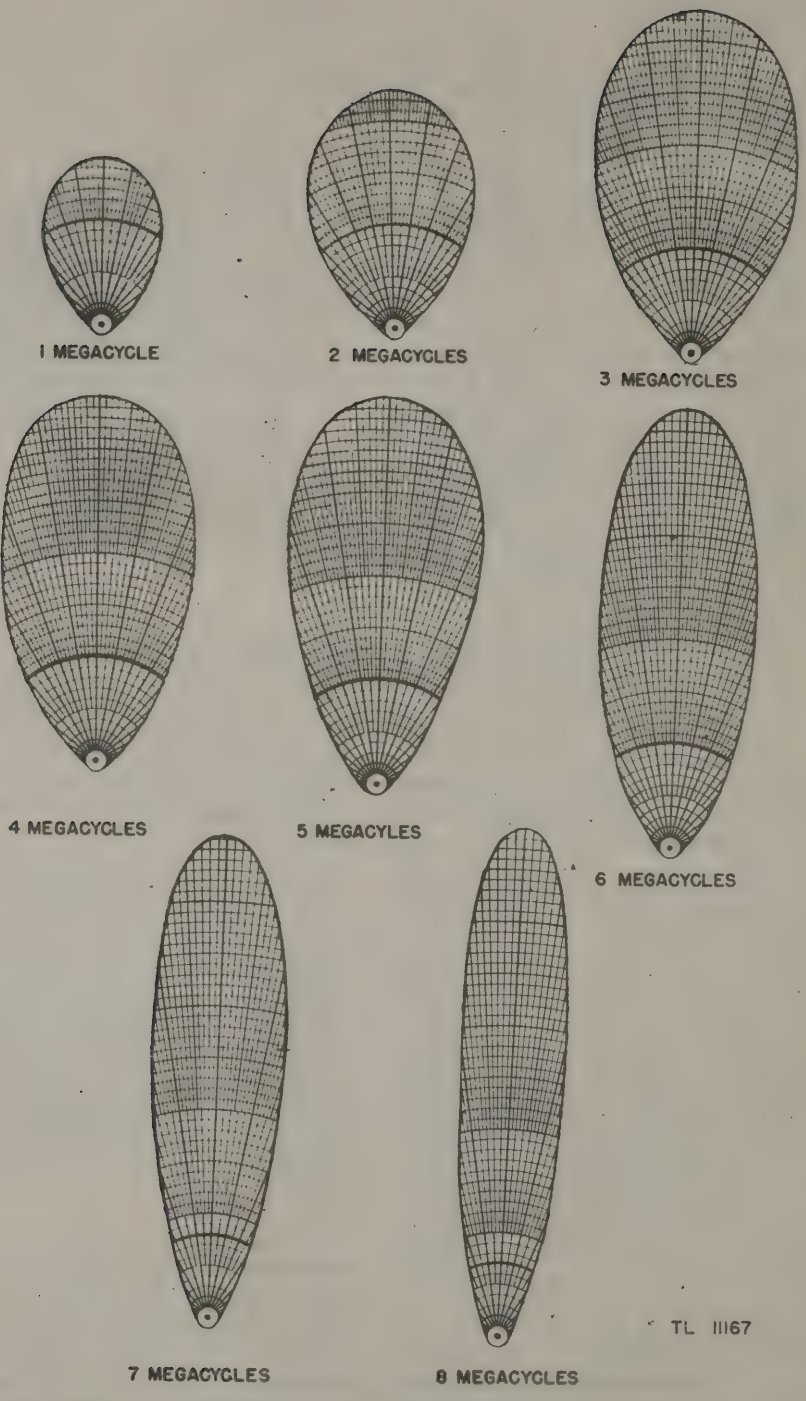



*Figure 48. Beam patterns of antenna A, 1 to 8 megacycles.*

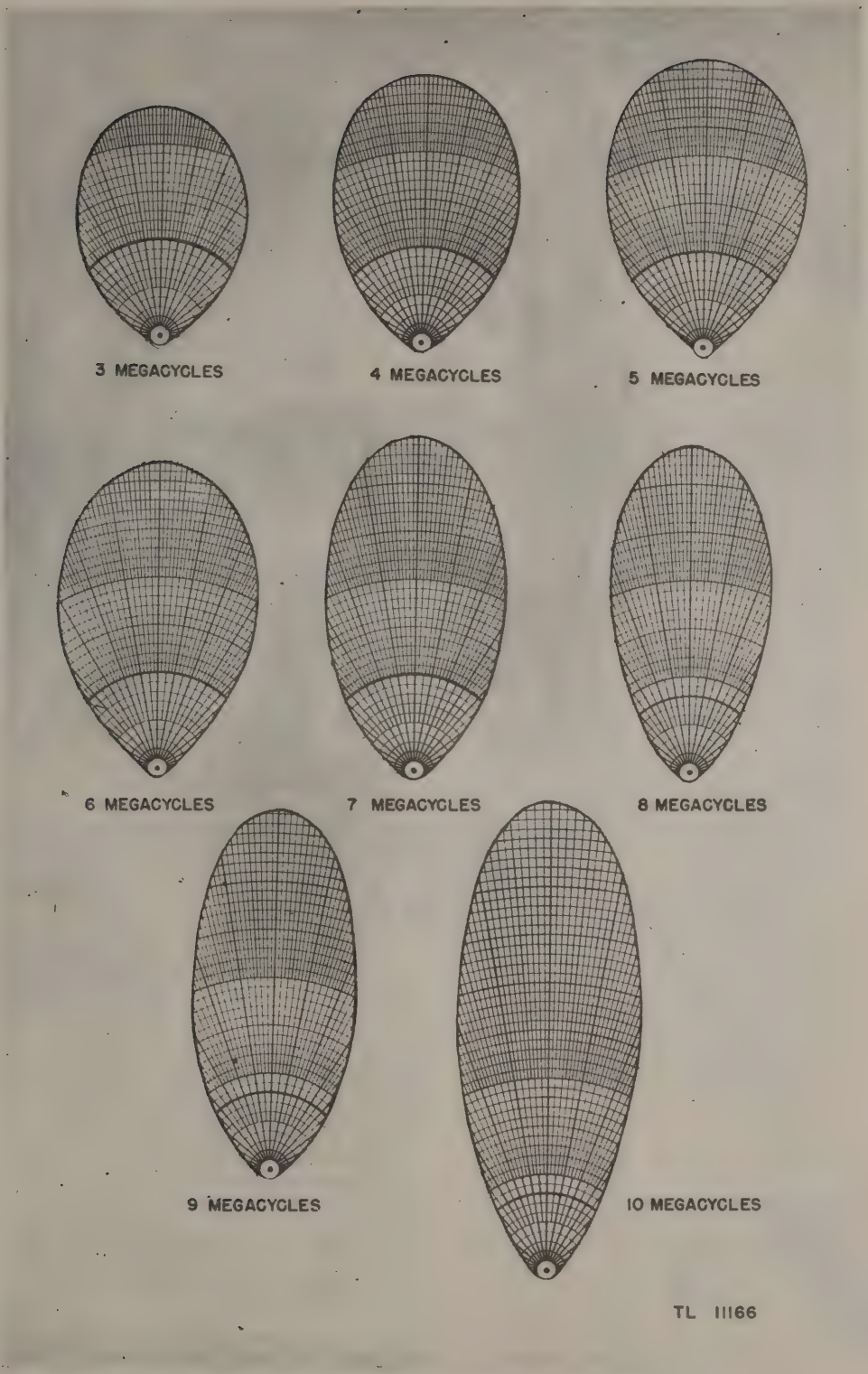



*Figure 49. Beam patterns of antenna B, 3 to 10 megacycles.*

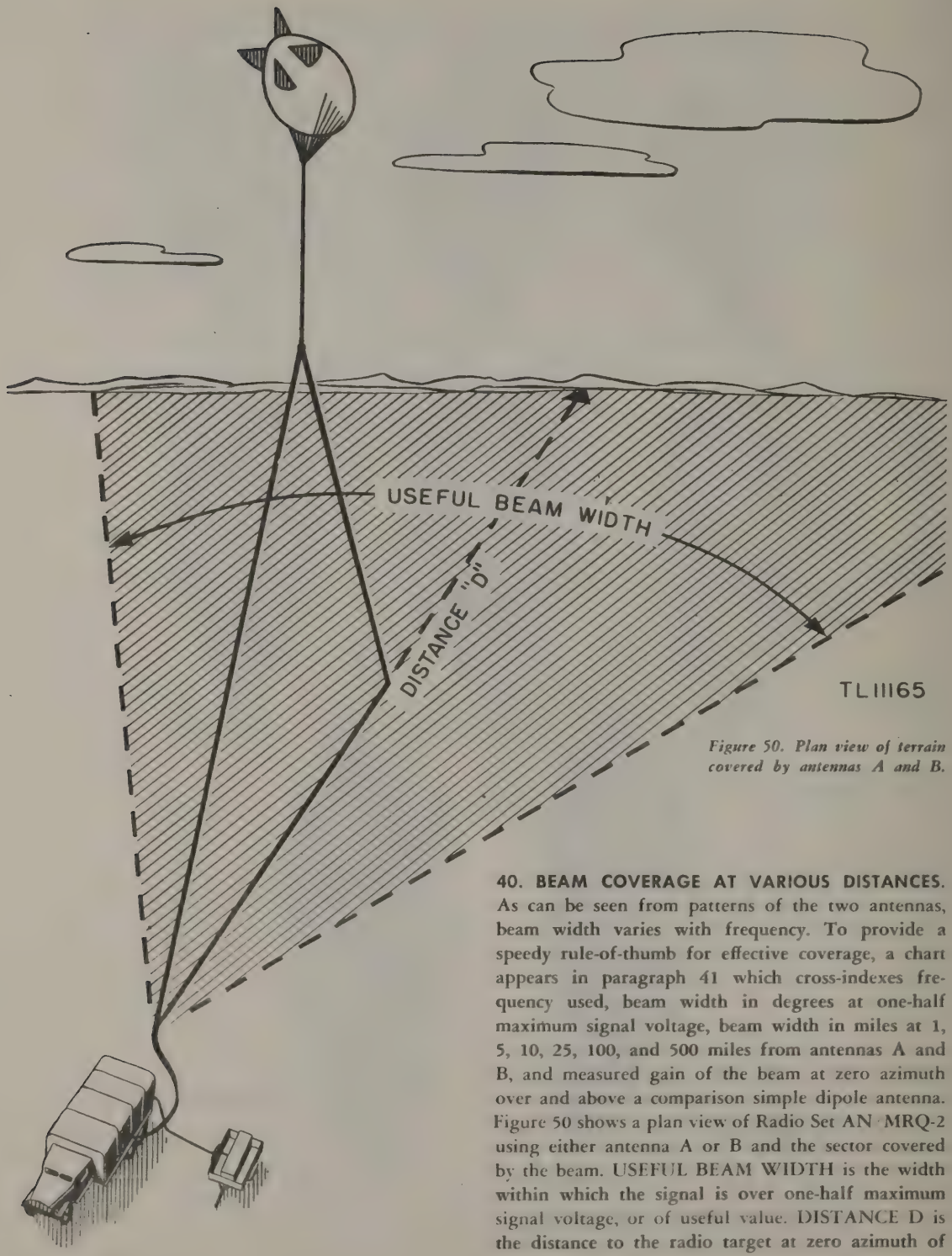



*Figure 50. Plan view of terrain covered by antennas A and B.*

**40. BEAM COVERAGE AT VARIOUS DISTANCES.** As can be seen from patterns of the two antennas, beam width varies with frequency. To provide a speedy rule-of-thumb for effective coverage, a chart appears in paragraph 41 which cross-indexes frequency used, beam width in degrees at one-half maximum signal voltage, beam width in miles at 1, 5, 10, 25, 100, and 500 miles from antennas A and B, and measured gain of the beam at zero azimuth over and above a comparison simple dipole antenna. Figure 50 shows a plan view of Radio Set AN/MRQ-2 using either antenna A or B and the sector covered by the beam. USEFUL BEAM WIDTH is the width within which the signal is over one-half maximum signal voltage, or of useful value. DISTANCE D is the distance to the radio target at zero azimuth of the beam.

## 41. TABLE OF FREQUENCY, COVERAGE, AND SIGNAL GAIN, ANTENNAS A AND B.

| | *Frequency in mega-cycles* | *Useful beam-width (½ signal voltage)* | *Beam width in miles at 1 mile* | *Beam width in miles at 5 miles* | *Beam width in miles at 10 miles* | *Beam width in miles at 25 miles* | *Beam width in miles at 100 miles* | *Beam width in miles at 500 miles* | *Measured gain over dipole at zero azimuth of beam* |
|---|---|---|---|---|---|---|---|---|---|
| ANTENNA A | 1 | 76° | 1.5 | 7.8 | 15.6 | 39 | 156 | 780 | 4 DB (2.5 times) |
| | 2 | 72° | 1.4 | 7.2 | 14.4 | 36 | 144 | 720 | 7 DB (5.0 times) |
| | 3 | 66° | 1.3 | 7.0 | 14 | 35 | 140 | 700 | 10 DB (10 times) |
| | 4 | 58° | 1.1 | 5.5 | 11 | 27.5 | 110 | 550 | 11 DB (12.5 times) |
| | 5 | 52° | 0.96 | 4.8 | 9.6 | 24 | 96 | 480 | 12 DB (16 times) |
| | 6 | 40° | 0.7 | 3.6 | 7.2 | 18 | 72 | 360 | 13 DB (20 times) |
| | 7 | 30° | 0.5 | 2.5 | 50 | 12.5 | 50 | 250 | 15 DB (32 times) |
| | 8 | 22° | 0.4 | 2 | 4 | 10 | 40 | 200 | 17 DB (50 times) |
| ANTENNA B | 3 | 90° | 2 | 10 | 20 | 50 | 200 | 1000 | 5 DB (3.1 times) |
| | 4 | 82° | 1.7 | 8.5 | 17 | 42 | 168 | 840 | 9 DB (8.0 times) |
| | 5 | 76° | 1.5 | 7.5 | 15 | 37.5 | 150 | 750 | 10 DB (10.0 times) |
| | 6 | 66° | 1.3 | 6.5 | 13 | 32.5 | 130 | 650 | 10 DB (10 times) |
| | 7 | 62° | 1.2 | 6 | 12 | 30 | 120 | 600 | 11 DB (12.5 times) |
| | 8 | 56° | 1.06 | 5.30 | 10.6 | 26.5 | 106 | 530 | 13 DB (20 times) |
| | 9 | 52° | 0.9 | 4.5 | 9 | 27.5 | 90 | 450 | 14 DB (25 times) |
| | 10 | 46° | 0.8 | 4 | 8 | 20 | 80 | 400 | 16 DB (40 times) |




*Figure 51. Beam angles at various frequencies. They may be transferred to any map.*

**42. TRANSFER OF BEAM COVERAGE TO A MAP.** To quickly lay out a beam on any map, regardless of scale, to find what towns, villages, or areas will be covered at any frequency the various beam widths are exactly drawn in figure 51. To transfer angles from this figure to the map, merely trace the beam width indicated on thin paper placed over the figure; then transfer to the desired map. This method will be of great importance in decisions as to whether one, two, or three Radio Sets AN/MRQ-2 will be necessary to cover a given sector, or whether a single radio set will satisfactorily cover required areas at the same time.

**43. OPERATION OF ANTENNA A AT FREQUENCIES NORMALLY ASSIGNED TO ANTENNA B.** It is possible, when properly authorized by the officer in charge, to use Antenna A on frequencies up to 18 megacycles, the high frequency limit of Radio Transmitter T-55/MRQ-2. This use of the large antenna will considerably sharpen the radio beam produced and very materially add to its power. Keep in mind, however, that sharpness and greater strength are excellent for point-to-point work, but where a wide area must be covered a broad beam is necessary at the sacrifice of power. At all times when antenna A is used on frequencies assigned to antenna B (with the possible exception of 3, 4, and 5 megacycles) it should be very carefully oriented so that the beam will not miss its target.

**44. SIMULTANEOUS OPERATION OF TWO OR MORE HALF-RHOMBIC ANTENNAS FOR THE COVERAGE OF SEVERAL SECTORS.**

*a.* It may be desirable to operate two or more installations of Radio Sets AN/MRQ-2 simultaneously with the half-rhombic antenna of the first covering one sector, the half-rhombic of the second covering another. When such operations are planned, the half-rhombic antennas should be placed sufficiently far apart so supporting kites, balloons, and lines do not tangle.

*b.* As a relatively small amount of power is radiated at right angles from antennas A and B, thus minimizing interaction, two half-rhombics may be placed side-by-side, provided that several hundred feet of clearance are allowed to prevent the tangling of rigging. While this side-by-side operation is technically satisfactory at this distance, the placement of one half-rhombic antenna directly in front of, or in the field of the beam of, another half-rhombic is to be strictly avoided, as phase differences existing between the two antennas (now interacting) may radically alter the beam patterns which may then assume wholly unpredicted shapes in the horizontal and vertical planes. These unpredicted shapes may nullify previous careful orientation. Therefore, when one half-rhombic antenna is placed within the beam of a second half-rhombic, separate them by at least 2,000 feet.

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# SECTION II

# OPERATION OF ANTENNA C

**45. OPERATION AT VARIOUS FREQUENCIES, WIRE LENGTH.** For the operation of antenna C between 0.95 and 1.8 megacycles the full length of the antenna is used. For operation between 1.7 and 6.4 megacycles the 34.5-foot length of wire is used, with the antenna's link wire left open.

**46. DIRECTION OF TRANSMISSION.** The field pattern transmitted by antenna C is, to all intents and purposes, circular, transmitting equally in all directions.

**47. EFFECTIVE POWER OF ANTENNA C.** If it is desired to cover all directions with Radio Set AN/MRQ-2, antenna C provides more signal strength than antenna D, the 5-section whip. With the radio transmitter correctly loaded, antenna C is superior to antenna D by the following ratios:

| *Frequency* | *Gain over antenna D* |
|---|---|
| 0.95 | 13.0 decibels (20 times) |
| 2.0 | 11.0 decibels (12.5 times) |
| 3.0 | 6.0 decibels (4.0 times) |
| 4.0 | 6.0 decibels (4.0 times) |
| 5.0 | 5.0 decibels (3.17 times) |
| 6.0 | 4.0 decibels (2.5 times) |

**48. SEND-RECEIVE OPERATION.** When using antenna C, the switching change from send to receive is automatically accomplished by antenna change-over relay RY1A in Radio Transmitter T-55/MRQ-2.

# SECTION III

# OPERATION OF ANTENNA D

**49. OPERATION OF ANTENNA D.** As the effective power and range of antenna D is greatly inferior to antenna A, B, or C, it will usually be operated as an emergency or stop-gap antenna until other more suitable antennas are erected. Or it may be used where the utmost concealment is desired, or when in motion. Keep the following points in mind when using antenna D:

*a*. If possible, keep the antenna vertical when transmitting or receiving. It sends and receives stronger signals when vertical.

*b*. See that the antenna does not rest on, or touch, trees, branches, or shrubbery when sending or receiving. These leak off radio-frequency power, decreasing transmitting range and reducing the strength of received signals.

*c*. Take care not to touch antenna D when transmitting. Very high radio-frequency voltages are present and may cause serious burns.

*d*. When using antenna D, be extremely careful not to add gas to Power Unit PE-95-( ) while the transmitter is in operation. The truck and trailer assume high radio-frequency potentials due to the short length of the antenna and insufficient grounding which may cause a spark to jump from gas can to filler pipe during the refueling process, causing a fatal explosion. Turn off the radio transmitter before adding gas and leave it off until the operation is finished.

# *PART FOUR*

# *PREVENTIVE MAINTENANCE*

## SECTION I

## SCOPE

**50. PURPOSE OF PREVENTIVE MAINTENANCE.** The purpose of preventive maintenance is to maintain the equipment in a state of good repair by a regularly-scheduled series of checking procedures so equipment will be ready for instant use at any time, and so the period required for corrective maintenance will be reduced.

**51. SCHEDULES.** Three check lists are schedules to accomplish this purpose:

*a.* *Schedule I.* Before operation.

*b.* *Schedule II.* During operation.

*c.* *Schedule III.* After operation.

**52. PROCEDURE.** Each of these schedules will be followed by such personnel and maintenance equipment as are available for the operation of Antenna Assembly AS-51/MRQ-2.

## SECTION II

## PREVENTIVE MAINTENANCE FOR BALLOON MX-93/MRQ-2

**53. SCHEDULE I. BEFORE OPERATION.**

*a.* Check to see that balloon bridle lines are correctly secured to patches, and that none are loose or disconnected.

*b.* Check to see that thimble has not cut into balloon fabric, and that it is protected by Bag CW-19/MRQ-2.

*c.* Check to see that appendix is open and clear. If sticking of internal fabric is starting or suspected, shake talcum into the appendix opening. Stretch out and shake bag to disperse the talcum well within the bag.

*d.* Check bag for tears, punctures or visible leaks. Accomplish repair as outlined in Part Six. This repair may either take the form of a temporary outside patch or, if time permits a permanent internal patch.

*e.* Check outside fabric to be sure that no oil or grease has been spilled upon the rubber fabric. If it has, carefully rub it off with a dry cloth. Do not attempt to use gasoline to remove oil spot. Gasoline will attach rubber balloon fabric, rendering it spongy, soft, and useless.

*f.* Check stabilizer fins to see that snap fasteners are secure with no unraveling threads. Check the fin-bracing guys for loose thread connections, loose strings, missing brass eyelets.

*g.* Check elastic band supply.

*h.* Check stern and bow handling lines and see if their respective patches are well secured to bow and stern with no unraveling threads. Also check security of shroud lines and brass thimble.

*i.* Check hydrogen cylinders. Be sure that:

(1) Sufficient fully-charged cylinders are available and marked to allow speedy inflation.

(2) Discharged cylinders are so marked and their re-use not attempted, since their re-use would delay inflation.

(3) Valves are not stuck, requiring straining and delay between cylinder change during inflation.

(4) Threads are clean and free from dirt to permit speedy and certain hose attachment.

*j.* Check tarpaulin ground cloth to make sure that no briars, spurs, or sharp metal slivers adhere to or are protruding through it. These may puncture or tear balloon fabric.

*k.* Check following spare parts for completeness and serviceability. Replace unserviceable items:

2 Balloon MX-93/MRQ-2, 1,150 cubic feet capacity.
2 Bag CW-20/MRQ-2, for stowing Balloon MX-93/MRQ-2.
2 Bag CW-19/MRQ-2, for stowing Balloon bridle.
16 Stabilizer for Balloon MX-93/MRQ-2.
2 Case CY-62/MRQ-2, wood, for stowing stabilizers.

## 54. SCHEDULE II. DURING OPERATION.

*a.* If, after the balloon has been inflated and flown to its normal height in the rays of the hot sun, the sun is obscured by heavy overcast or clouds, the gas within the balloon will contract due to cooling action. This contraction will make the balloon appear underinflated, a dent appearing in the nose, visible from the ground. This is a normal physical occurrence, frequently observed, and does little but decrease the lifting power slightly and increase balloon drag, causing the balloon to fly slightly back with the wind. If, however, the dent in the balloon nose becomes deep and the drag becomes so great that the legs of the antenna triangle are no longer equilateral, haul the balloon down and inflate it further. Be sure the elastic bands sealing the appendix are sufficiently tight and folded as required. If the nose dent becomes very deep, or stabilizer sag or flap, the balloon may have sustained a puncture and should be hauled down at once for examination, repair, and re-inflation if total loss of the balloon is to be prevented. This precaution has been covered in Part Three, but is again emphasized as a feature of preventive maintenance.

*b.* To prevent major interruption to the operation of Radio Set AN/MRQ-2 due to balloon failure, Kite VKS-1 should have previously been assembled as a preventive maintenance step and at once substituted for the balloon, wind velocity permitting.

*c.* If the balloon behaves badly during flight, and wind velocity is insufficient to support the kite, it is recommended that the installation of antenna C be begun at once so a minimum of operating time is lost while the balloon is hauled down, repaired, and re-flown.

## 55. SCHEDULE III. AFTER OPERATION.

*a.* Before stowing the balloon in Bag CW-20/MRQ-2 make sure that:

(1) All hydrogen gas has been expelled from the balloon. Any remaining gas may deteriorate fabric.

(2) Shroud lines, "V" loops, and all patches are intact with no evident signs of tearing.

(3) Talcum has been sprinkled over fabric folds.

(4) No rips, tears, or punctures exist.

(5) Temporary outside patches have been reinforced by permanent inside patches.

(6) Male portions of snap fasteners securing fins are securely fastened to stern of balloon envelope.

(7) Bow and stern handling lines are well secured to their respective patches and have not become frayed.

(8) Brass thimble is covered by Bag CW-19/MRQ-2 to protect balloon fabric from being cut by the thimble. Bag CW-19/MRQ-2 stows in the large balloon stowing Bag CW-20/MRQ-2, along with the balloon.

*b.* After stowing the balloon in Bag CW-20/MRQ-2 make sure that:

(1) The bag is stowed, stored, or carried in a place where too much heat will not be present. Do not stow near a combustion engine, over an exhaust pipe, or where hot air from an air-cooled engine may overheat it. Heat will cause the fabric to adhere to itself and render the balloon useless.

(2) The bag is not stowed *under* other equipment. The weight of other apparatus upon the balloon fabric will crush and permanently crease the rubber bag after a short time, causing the balloon to tear when flying; and will cause the development of seams and tears, rendering the balloon useless without extensive corrective maintenance. Also, equipment stowed on top of Bag CW-20/MRQ-2 containing the folded balloon will, when the carrying vehicle is driven a few miles, begin to chafe and rub the balloon fabric, soon rendering it useless without ex-

tensive corrective maintenance. *Stow the balloon ON TOP of all other equipment.*

*c.* Before stowing the four balloon stabilizers in Case CY-62/MRQ-2, check them to see that no tears are present. Check fin bracing guy strings for loose connections, loose strings, or missing metal couplers.

*d.* Be sure that discharged hydrogen cylinders are properly marked to prevent loss of time due to attempts to inflate a balloon from exhausted tanks, and to prevent useless unloading of empty tanks from the carrying vehicle preparatory to inflation.

*e.* Check tarpaulin ground cloth to see that no briars or sharp objects are rolled into it before repacking and stowing. Due to vibration, these may cut the cloth when equipment is transported in the carrying vehicle.

*f.* Check following spare parts for completeness and serviceability. Replacing unserviceable items:

2 Balloon MX-93/MRQ-2, 1,150 cubic feet capacity.
2 Bag CW-20/MRQ-2, for stowing balloon.
2 Bag CW-19/MRQ-2, for stowing balloon bridle.
16 Stabilizer for Balloon MX-93/MRQ-2.
2 Case CY-62/MRQ-2, wood, for stowing stabilizers.

# SECTION III

# PREVENTIVE MAINTENANCE FOR KITE VKS-1

### 56. SCHEDULE I. BEFORE OPERATION.

*a.* Check for small tears or rips in kite fabric which due to wind pressure and fabric vibration, may later develop into large tears when the kite is flown. The loud rocket-like sound heard when the kite leaves the ground in a high wind is caused by this vibration. Repair all rips or tears at once as outlined in Part Six.

*b.* Check that no kinks exist in vertical strut wires connecting the upper and lower longerons. See that the strut wire thimbles (small metal eyelets) connecting the street wires to the metal fittings are hanging loose and not set at an angle, thereby shortening the strut wires.

*c.* Check that the screw heads on each end of the diagonal cross struts are properly seated in their longeron fittings. If they are not, the kite may collapse in flight.

*d.* Check that the diagonal cross struts are assembled with the round surface facing forward and therefore into the wind direction, giving less wind drag to the kite.

*e.* See that tie rods are firmly in place and elastic bands are correctly attached.

*f.* See that bridle lines are in good condition, are not frayed, and are firmly attached to kite fabric. Check sewing of the bridle thimble for tightness. See that sewing is not frayed.

*g.* Check the following spare parts provided in Case CY-73/MRQ-2 for completeness and serviceability, replacing unserviceable items:

2 extra longerons.
6 extra diagonal cross struts.
2 extra tie rods, 3/8-inch.
1 extra corner stiffeners.
12 extra elastic bands.
1 extra vertical stabilizer, 5/8-inch.

### 57. SCHEDULE II. DURING OPERATION.

*a.* Check kite visually when it is in flight to see that it is riding well and that no parts appear to be collapsed, broken, or dangling. If they are, bring the kite down carefully and repair. If Balloon MX-93/MRQ-2 has been previously prepared for flying, substitute it at once to allow minimum interruption of Radio Set AN/MRQ-2 operation; or switch to antenna C, if erected, if the balloon has not been prepared.

*b.* If kite is flying normally and riding well, see that the greater part of the load on the kite is taken by the antenna and not by the flying line. In this way the antenna will be kept in its ideal triangular shape, with both triangle legs taut.

### 58. SCHEDULE III. AFTER OPERATION.

*a.* Perform checks as outlined in paragraphs 56*a* to *f*.

*b.* Check the spare parts outlined in paragraph 56*g* for completeness and serviceability. Replace unserviceable items.

# SECTION IV

# PREVENTIVE MAINTENANCE FOR ANTENNAS A, B, AND C

**59. SCHEDULE I. BEFORE OPERATION.** Since the three antennas are commonly composed of wire lengths, insulators, accessory guy ropes, and fixtures, their preventive maintenance will be treated as a unit in all schedules.

*a.* Check the two Reels RL-103/MRQ-2 joined by a triangular insulator and each wound with 984 feet of No. 16 AWG copperweld wire, comprising Antenna Wire Assembly AS-92/MRQ-2 for antenna A. See that no kinks, "Q" loops, or sharp right-angle bends have been accidentally made in the wire. If kinks are severe enough to make breakage possible during flying, cut out the kink with pliers and repair at once by a Western Union splice, as outlined in paragraph 186 of Field Manual FM 24-5, Signal Communication.

*b.* Follow the same check and repair procedure for:

(1) Antenna Wire Assembly AS-91/MRQ-2, for use with antenna B.

(2) Counterpoise AT-56/MRQ, for use with antenna A.

(3) Counterpoise AT-55/MRQ-2, for use with antenna B.

(4) Antenna Wire Assembly AT-57/MRQ-2, for use with antenna C.

(5) Counterpoise AT-58/MRQ-2, for use with antenna C.

*c.* Test Resistance Box MX-105/MRQ-2 for defective wiring or open circuits in the resistance plaques. If this resistor is open, antennas A and B will not function properly, becoming bi-directional, more noisy on reception, and reflecting strong reactance back to Radio Transmitter T-55/MRQ-2 during transmitting (on some frequencies). Proceed as follows:

(1) Use Analyzer BC-1052-( ) provided with Radio Set AN/MRQ-2 and read resistance across the two external connections of the resistance box. Be sure prods make good connection with the metal of each binding post. This resistance should be between 400 and 600 ohms. The exact value is of no great importance due to variations in resistance plaques supplied with the equipment. A continuity resistance between these values, however, MUST be present. High resistance readings may mean poor prod connections, unsoldered internal leads, or burnt-out resistance plaque. If necessary, use spare resistance box supplied with the antenna assembly.

(2) As a maintenance expedient to permit operation of Radio Set AN/MRQ-2 with antenna A or B, should both resistance boxes supplied with the assembly have open circuits, two separated Stakes GP-25 may be driven into the ground and used as a substitute for the resistance box. Proceed as follows:

(*a*) Drive one stake into the ground at the far end of the counterpoise. Attach counterpoise to it, making a good electrical connection.

(*b*) Drive another stake into the ground some 5 feet away from the first stake. With test prod leads from Analyzer BC-1052-( ) (extended if necessary by additional wire), measure the stake-to-stake resistance. Relocate the stake until resistance reads between 400 and 600 ohms.

(*c*) Connect the leg of the antenna wire to the second stake, thus providing the antenna with a usable stopgap terminating resistance.

*d.* Test overall continuity of antennas A and B before operation by using Analyzer BC-1052-( ) as supplied with Radio Set AN/MRQ-2. Proceed as follows:

(1) Connect test prods of Test Set 1-56-( ) to the transmitter end of transmission line Cable RG-61/MRQ-2 (correctly attached to the antenna proper which is in turn properly terminated at its far end). The cable should not be connected to Radio Transmitter T-55/MRQ-2.

(2) Read resistance across the transmitter end of the cable. It should be between 400 and 700 ohms.

(3) If an open circuit is shown, some fault in the antenna system exists. Recheck the whole system for broken wires, broken connections, or open joints.

(4) These expedients are outlined in preventive maintenance to prevent erratic, poor and sometimes unidentifiable performance by the antenna assembly which might well be cured before operation is begun.

*e.* Check the winch, Reel Assembly RL-104/MRQ-2, for free reeling operation, ratchet pawl operation, and brake operation. Be sure the thimble is well-served to the flying line and will not come off under load, allowing the balloon to fly away or the kite to crash. If the winch is mounted on a ¼-ton,

4 x 4 truck, see that the through bolts securely hold the wooden cross members and winch.

*f.* Check the following spare parts for completeness and serviceability. Replace unserviceable items.

1 Antenna Wire Assembly AS-92/MRQ-2 for antenna A.

1 Antenna Wire Assembly AS-91/MRQ-2 for antenna B.

1 Counterpoise AT-56/MRQ-2 for use with Antenna Wire Assembly AS-91/MRQ-2.

1 Counterpoise AT-55/MRQ-2 for use with Antenna Wire Assembly AS-92/MRQ-2.

2 Cable RG-61/MRQ-2, 500 ohms.

4 Snubber, anchor, with termination insulators.

4 Reel RL-103/MRQ-2, wood, hand, for Antenna Wire Assembly AS-91/MRQ-2 and AS-92/MRQ-2.

2 Reel RL-103/MRQ-2, wood, hand, for Counterpoise Wires AT-55/MRQ-2 and AT-56/MRQ-2.

2 Bag BG-102, canvas for stowing antenna assembly.

2 Reel RL-103/MRQ-2, each containing, 2,000 feet bulk No. 16 copperweld wire.

1 Resistance Box MX-105/MRQ-2, for antenna termination.

**60. SCHEDULE II. AFTER OPERATION.** The following schedule should be performed after operation of antenna A, B, or C has been finished:

*a.* When disassembling Antenna Wire Assembly AS-91/MRQ-2, AS-92/MRQ-2, and AT-57/MRQ-2, and Counterpoise AT-55/MRQ-2, AT-56/MRQ-2, and AT-58/MRQ-2, take care that no kinks, sharp bends, or "Q" loops exist in the wire. If severe kinks exist, repair at once by cutting out the section containing the kink and repairing break by a Western Union splice, soldered, as outlined in paragraph 186 of Field Manual FM 24-5, Signal Communication.

*b.* Test Resistance Box MX-105/MRQ-2 for continuity as outlined in paragraph 59*c*. If open circuit exists and is due to faulty wiring, repair at once. If it is due to faulty resistance plaque, replace with spare Resistance Box MX-105/MRQ-2. Mark the faulty box. By no means use it again until repaired.

*c.* Check the winch, Reel Assembly RL-104/MRQ-2, as outlined in paragraph 59*e*.

*d.* Check spare parts as outlined in paragraph 59*f*.

# *PART FIVE*

# *FUNCTIONING OF PARTS*

## SECTION I
## ANTENNAS A AND B

**61. BEAM ACTION OF ANTENNAS A AND B.**

*a.* When properly erected and adjusted, half-rhombic antennas A and B radiate a major portion of the radio-frequency power fed to them in the direction of the triangle base line as sighted from the near end at the transmitter to the far end at the terminating resistance. Antennas A and B act to concentrate this radio power much like a searchlight concentrates a light beam as shown in figure 52.

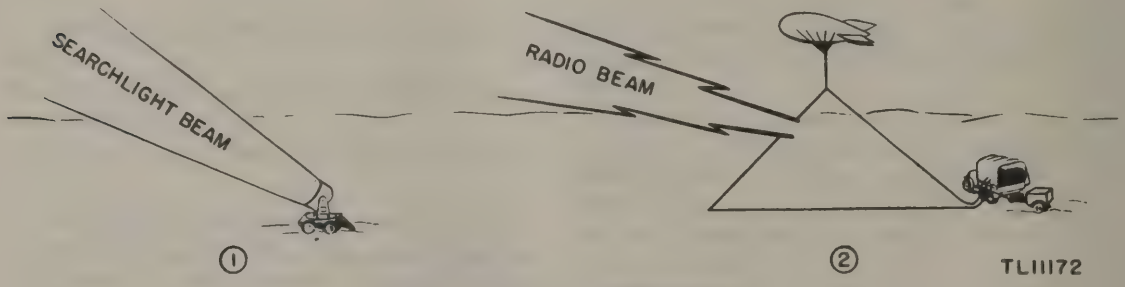



*Figure 52. Radio and searchlight beams.*

*b.* Conversely, on reception, antennas A and B receive and amplify signals within their beam area, rejecting or discriminating against signals arriving from localities outside the beam. The action on receiving is much like looking at a target through a telescope: the target itself is magnified; the surrounding area not seen.

**62. FUNCTION OF THE TRANSMISSION LINE.**

*a.* The transmission line, Cable RG-61/MRQ-2, is used to carry power from the transmitter to the antenna on transmitting, and from the antenna to the receiver on receiving. Whether the line connects to the transmitter or receiver depends upon the position of the antenna change-over Relay RY1A in Radio Transmitter T-55/MRQ-2. The impedance of the cable is 500 ohms, which matches the average characteristic impedance of both antenna A and antenna B. Due to this impedance match, little or no radiation occurs from the line which, in effect, acts like a watertight hose carrying water from a hydrant without leaks. This analogy is shown in figure 53.

*b.* Conversely, on receiving, this cable conducts signals picked up by the antenna to the receiver without itself abstracting signals from the air. If two wires were used, widely separated and attached at random in place of the line, impedances would not be matched, the line would radiate in unwanted directions when transmitting, and would pick up undesirable signals outside the beam when receiving. The line is necessary, therefore, and acts like a pipe for radio signals.

**63. BEAM-FORMING FUNCTION OF WIRES.** Radio frequency power from the transmitter is piped

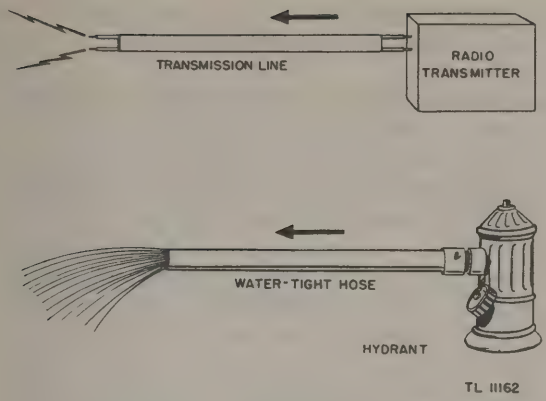



*Figure 53. Similarity of transmission lines and watertight hose.*

through the transmission line to leg No. 1 of the antenna and to the counterpoise (fig. 54). As this power flows through leg No. 1 and leg No. 2, each leg acts as if it were an individual long wire antenna, producing four major lobes of power radiation at a very definite angular relation to the wire itself. This angular relation depends on the length in wavelengths of each leg. (See the angles shown by arrows in figure 54 and marked △.) As longer leg lengths are used at a fixed operating frequency, the closer these lobes lie to the wire, and the smaller the angle △ becomes.

*a.* When these antenna legs are tilted at a correct angle in respect to the ground, a combination of these lobes take place: Lobes C and C1, and D and D1 combine adding their power together, while lobes A and B, and A1 and B1 act to cancel. Thus radiation from combined legs 1 and 2 is then concentrated in two directions: directly forward, and directly to the rear. The terminating resistance, however, eliminates the rear transmission.

*b.* This action of the terminating resistance in eliminating rear transmission can easily be understood

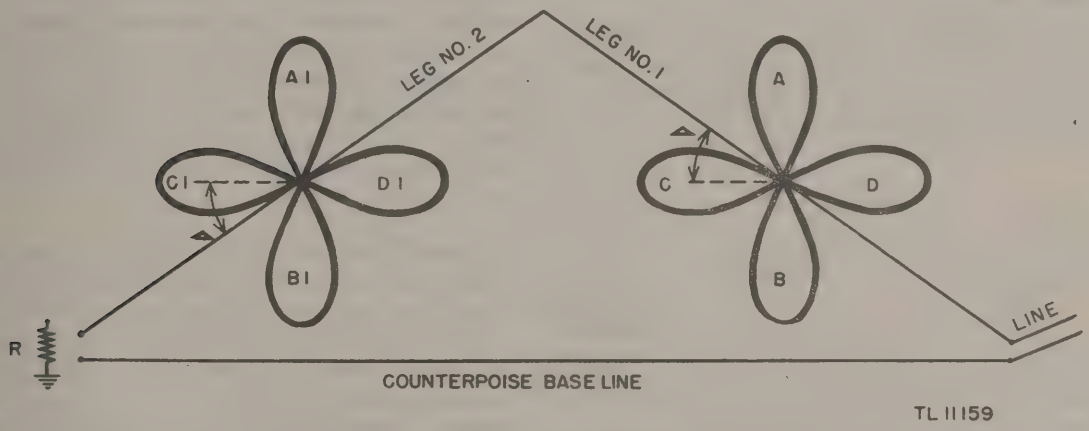



*Figure 54. Radiation lobes produced by the individual legs of antennas A and B.*

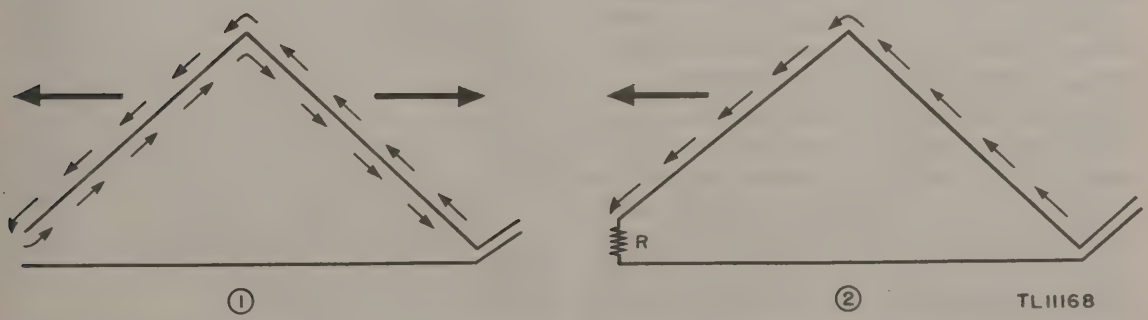



*Figure 55. Current flow without and with the terminating resistance. Note that the unterminated antenna is bidirectional, the terminated antenna unidirectional. Direction of transmission is indicated by large arrows.*

by examining current flow (fig. 55 ①). Small arrows lying close to the antenna wires indicate current flowing from the transmission line to the far end of the antenna wire, and in so doing radiating power in the forward direction of the antenna. Arriving at the far end of the antenna (note that the terminating resistance is omitted), the current would normally be reflected back and travel in the opposite direction as indicated by small arrows pointing from left to right. While traveling in this opposite direction the current would radiate power toward the rear of the antenna. The terminating resistance, however, prevents this round trip by the current. Figure 55 ② shows current flowing from the rear to the far end of the antenna while radiating forward. Arriving at the terminating resistance, the current not already radiated in the forward direction is at once dissipated by the terminating resistance in the form of heat. The result is forward transmission only by the antenna. It should be noted that the terminating resistance in no way decreases the power radiated forward, merely absorbing the power which, without it, would be radiated to the rear.

*c.* The antenna's function on receiving is similar. Incoming signals, within the antenna's forward beam, strike the antenna and set up currents moving from left to right as shown in figure 56.

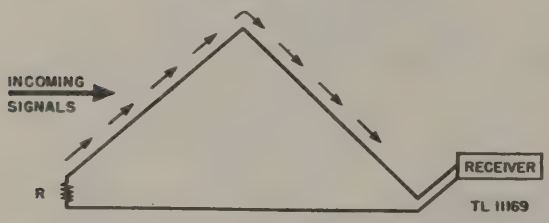



*Figure 56. Currents set up in the antenna wire by incoming signals in the antenna's beam.*

These currents proceed directly to the receiver. Signals arriving from the rear of the antenna, however, set up currents moving in the opposite direction, and arriving at the terminating resistance, are dissipated. Hence, reception from the rear is eliminated.

*d.* Signals which arrive from angles other than those at the front and rear of the antenna, for instance from the side, set up opposing currents in the antenna wires, canceling each other to an extent depending on azimuth angle of arrival and operating frequency. This degree of cancellation is directly keyed to the polar beam patterns shown in figures 48 and 49, greatest cancellation taking place at angles at which minimum signal is indicated.

**64. APEX ANGLES OF THE ANTENNA TRIANGLE.** As can be readily seen from figure 54, it is essential for the production of greatest beam power that antenna triangle legs No. 1 and 2 be set at an angle which will produce maximum addition of lobes C and C1 and maximum cancellation of lobes A and B, and A1 and B1. This upper apex angle for antennas A and B is 110°, the optimum angle for the average lobe (at frequencies employed by Radio Set AN/MRQ-2) and therefore for maximum output. A further interesting and important characteristic of half-rhombic antennas A and B is that the optimum apex angle varies in opposite direction to the optimum length of the triangle legs for a change in frequency. Beam production by the two antennas is therefore self-stabilized as frequency is shifted.

**65. COUNTERPOISE FUNCTIONING.** The counterpoise wire forming the base of the antenna triangle serves as a low resistance return for the terminating resistance and completes the antenna's electrical circuit. It also serves, in part, as an artificial ground underneath the antenna which, because of its low resistance as compared to earth, acts to materially increase transmitted and received signal strengths, likewise stabilizing the antenna's operation over differing soil conditions.

**66. VERTICAL POLARIZATION.** Signals transmitted by antennas A and B are *vertically polarized* and therefore produce maximum signal in all vertical whip antennas employed by field radio stations or vehicular installations within the beam of the antenna. This identical polarization is of enormous advantage in missions assigned to Radio Set AN/MRQ-2. These two antennas are likewise vertically polarized on reception, providing increased signal strengths from whip antennas used by installations within the beam. It should be kept in mind, however, that identical polarization is no longer an important factor when signals are reflected by the heavyside layer as occurs when transmitting or receiving beyond the approximate ground wave range of antennas A and B, around 50 to 75 miles. When signals are returned to earth by the reflecting heavyside layer, they assume random polarization, much like a ricocheting bullet may turn end-over-end after striking a deflecting surface.

# SECTION II

# ANTENNA C

**67. CURRENT FLOW IN ANTENNA AND COUNTERPOISE.** When transmitting with Antenna Assembly AS-93/MRQ-2, power fed from Mast Base MP-47 proceeds along the lead-in wire and to the antenna proper, radiating energy as it does. Reaching the end of the antenna, no terminating resistance is used as with antennas A and B. Therefore, the remaining energy is reflected back along the wire to the mast base, radiating power on this return trip. This round trip by the current also takes place in Counterpoise AT-55/MRQ-2 which, together with the antenna wire proper, forms a Marconi-type antenna system.

*a.* The counterpoise is purposely elevated from the ground by two or three feet to avoid losses which would occur due to the counterpoise trying to act as a leaky dielectric capacitor if it were laid directly on the ground. This action is in no way connected with the counterpoise functioning of antennas A and B.

*b.* Standing radio-frequency waves present on the counterpoise, vary with the frequency employed, the entire vehicle body of Radio Set AN/MRQ-2 including the power unit at times assuming a relatively high radio-frequency potential above ground. For this reason the power unit should never be filled with gasoline when the transmitter is operating and is using antenna C. Radio-frequency arcs jumping from the gas can to the power unit filler pipe may explode the gas.

**68. DIRECTIONAL CHARACTERISTICS OF ANTENNA C.** Due to the resonant and round-trip flow of current in the antenna and its comparative shortness as measured in wavelengths of the operating frequency, its pattern is omnidirectional for all useful purposes.

**69. POLARIZATION OF ANTENNA C.** As the vertical lead-in, the counterpoise, and the flattop of the antenna are radiating (or receiving), polarization will be both vertical and horizontal, plus a complex wave front of varying polarizations. Due to this, antenna C will receive vertical, horizontal, elliptical, diagonal, or spherical polarized signals with nearly equal efficiency. It is well termed an all-purpose antenna due to this and its circular horizontal field pattern.

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# SECTION III

# ANTENNA D

**70. CURRENT FLOW.** Current flow in the five-section whip antenna proceeds from the bottom to the top of the antenna and downward again, producing standing waves by the round trip circuit. Maximum current in the antenna is produced near the mast base (a large percentage of it inside Shelter HO-17-( ) and within the antenna-loading inductance). The fact that this maximum antenna current, which accounts for radiation, is either inside the shelter or close to the bottom of the mast base causes the whip to be a very poor and inefficient transmitting and receiving antenna compared to antennas A, B, and C. Should the whip be used at frequencies in the neighborhood of 30 megacycles, it would then become a vertical half-wave dipole antenna with maximum current at its center, thereby greatly improving its efficiency. At frequencies used by Radio Transmitter T-55/MRQ-2, however, efficiency is sacrificed in favor of physical expediencies of size, mobility, and speed of installation.

**71. POLARIZATION OF ANTENNA D.** Due to the fact the antenna is operated in the vertical position for maximum output, its polarization is vertical. Because of this, it receives signals well from other vehicular or field installations using whip antennas, likewise vertically polarized.

**72. DIRECTIONAL CHARACTERISTICS OF ANTENNA D.** The five-section whip antenna sends and receives equally well in all directions.

# *PART SIX*

# *CORRECTIVE MAINTENANCE*

**NOTE: FAILURE OR UNSATISFACTORY PERFORMANCE OF EQUIPMENT WILL BE REPORTED ON W.D. A.G.O. FORM NO. 468. IF THIS FORM IS NOT AVAILABLE, SEE TM 38-250.**

## SECTION I

## TROUBLE CHART FOR ANTENNA ASSEMBLY AS-51/MRQ-2

**73. TROUBLE CHART.** When antenna assembly trouble occurs, first check this chart for identification of fault.

| *Trouble* | *Probable causes* | *Remedy* |
|---|---|---|
| Balloon will not lift antenna. | Gas impure due to large quantity of air in the bag. | Deflate and reinflate with pure gas. |
| | Leak in the fabric. | Repair leak with temporary outside or permanent inside patch. |
| | Substitute wire too heavy for balloon. | Use No. 16 AWG copperweld wire as recommended. |
| | Flying line too tight, preventing balloon from lifting antenna. | Loosen flying line. |
| Balloon nose dented inward slightly when flying. | Balloon was inflated and flown in bright sun. The sun was obscured by clouds, thus contracting gas in the bag. | None necessary. |
| Balloon nose dented deeply; balloon drag too great. | Balloon has lost gas due to puncture or incorrect appendix sealing. | Haul down, examine and repair puncture, or tighten elastic bands securing appendix. |
| Balloon flies in circles. | Stabilizers incorrectly attached, or stabilizer guy lines fouled. | Haul down, and check stabilizers for correct placement as outlined in paragraph 16 *P*. |
| Balloon dives. | Tail is high due to short bridle lines to bow end from thimble; bridle lines may be fouled. | Haul in and examine bridle lengths to see if a bow line has not been shortened during repair. Lengthen line and repair again. |
| Balloon dives, then returns to normal height. | Downdraft air currents. | None. Don't worry unless it becomes too severe. Then replace with kite. Wind too strong for balloon. |
| Balloon "hunts" or moves about irregularly. | Balloon is working to stabilize itself in changing air currents. | None. Don't worry unless it becomes severe. Then replace with kite. Wind too strong for balloon. |
| Kite dives. | Bridle tangled or has one line broken. | Haul kite down and repair. |
| | Bridle thimble on kite fouled. | Haul kite down and repair. |
| | Swivel omitted on bridle line. | Haul kite down and repair. |
| | Displaced strut. | Haul kite down and repair. |

| *Trouble* | *Probable causes* | *Remedy* |
|---|---|---|
| Kite "hunts" or describes circle when at flying height. | Kite working to stabilize itself. | None. Self-compensating action. Don't worry. |
| Receivers in Radio Set AN/MRQ-2 noisy when receiving on Antenna A or B. | Loose, broken, or intermittent connections in antenna or counterpoise wires. | Check continuity with Analyzer BC-1052-( ). Repair. |
| | Intermittent open circuit in terminating resistor. | None. |
| | Static charges. | Replace terminating resistance. |
| | Terminating resistance open, causing antenna to receive from rear direction, thus picking up ignition noise of Power Unit PE-95-( ) used for power supply. | |
| | Bad site chosen. Beam path crosses high voltage lines, nearby village, or electrical equipment, and is picking up interference from it. | Move to a more favorable and noise-free site. |
| Receivers in Radio Set AN/MRQ-2 noisy when receiving on antenna C. | Loose broken or intermittent connections in antenna or counterpoise wire. | Check visually and repair. |
| | Antenna C erected too close to Power Unit PE-95-( ) and is picking up its ignition noises. | Relocate antenna C. |
| Plate current of final amplifier of Radio Transmitter T-55/MRQ-2 unstable when using antennas A, B or C. | Loose, broken, or intermittent connections in antenna or counterpoise wire. | Check continuity or check visually and repair. |
| | Intermittent open circuit in the terminating resistance used with antenna A or B. | Check continuity and replace if indicates open circuit. |
| | Grounded metal object or vehicle touching bare antenna wire. | Check visually and remove object. |
| Kite dives sideways into ground when first flown. | Kite improperly rigged or cross air currents may be present at low altitudes. | Replace broken parts and rerig correctly as outlined in paragraph 16. |
| Antennas A or B will not load final amplifier of Radio Transmitter T-55/MRQ-2 sufficiently. | Antenna wires broken, loose connections, or corroded binding posts somewhere in system. Termination resistor blown out. | Use Analyzer BC-1052-( ) supplied with Radio Set AN/MRQ-2 to check continuity of system. Disconnect transmission line from shelter HO-17-( ) wall binding posts and measure across the two transmission line wires. Over-all antenna system should not read over 700 ohms. If it does, visually check for poor connections, broken wires. Check continuity with Analyzer BC-1052-( ) and, if open, replace. |
| Rhombic antenna tuning dial on left upper front panel of Radio Transmitter T-55/MRQ-2 tunes broadly and sluggishly. No sharp peak obtainable in plate current of transmitter final amplifier. | Transmission Line RG-61/MRQ-2 saturated with moisture causing losses. | Dry out transmission line. Meantime replace with spare. |

# SECTION II

# MAINTENANCE PROCEDURES

**74. WIRE MAINTENANCE, TYPES OF WIRES USED.** Four distinct types of wire are used with Antenna Assembly AS-51/MRQ-2:

***a. No. 16 AWG Copperweld Steel Wire.*** This wire is used for the triangular legs of antennas A and B, and for both antenna and counterpoise of antenna C.

***b. No. 14 AWG Six-strand Phospher Bronze Wire.*** This wire is used for the counterpoise of antennas A and B.

***c. Seven-Millimeter Ignition Cable.*** This cable is sewed into the flat, double piece, water-repellent, canvas duck belt, forming transmission line Cable RG-61/MRQ-2.

***d. Copper Braid Wire.*** This wire connects both legs of the half-rhombic antenna to metal strip of drop-line insulator.

**75. MAINTENANCE AND REPAIR OF NO. 16 AWG COPPERWELD STEEL WIRE.** This wire, having a hard-steel, thinly copper-coated core, is tenacious and will not readily break or bend sharply unless struck by a sharp object or run over by a heavy vehicle in soft dirt. Copperweld steel wire, however, has characteristics which differ from conventional solid copper wire and should be kept in mind. Unless care is taken to prevent the wire from being nicked by pliers, sharp-edged rocks, metal, or climbing spurs, these nicks will penetrate through the outer shelf of copper and expose the steel to corrosion, weakening the wire's strength, and eventually leading to breakage. If corrosion is evident, cut out the affected section and repair. No. 16 AWG copperweld wire should be repaired by a Western Union splice as outlined in Field Manual FM 24-5, Signal Communication, paragraph 186.

**76. MAINTENANCE AND REPAIR OF NO. 14 AWG 6-STRAND PHOSPHOR-BRONZE WIRE.** Nicks will not start corrosion in this wire as they will with copperweld steel wire, but weakened sections should be repaired. Due to reluctance of phospher-bronze wire to stay in position sufficiently long after bending to allow soldering, a square knot splice (avoiding the fast-slipping granny knot) should be used, correctly seized and soldered as outlined in Field Manual FM 24-5, Signal Communication, paragraph 185,*b*(5).

**77. MAINTENANCE AND REPAIR OF 7-MM IGNITION CABLE.** Breaks in this wire are hard to detect due to tenacity of insulating material. If one is suspected (after a vehicle has run over cable) check continuity of the wire and with Analyzer BC-1052-( ) supplied with Radio Set AN/MRQ-2. Bare wire with pliers and make Western Union splice as outlined above. Solder and protect with rubber and fabric tape.

**78. MAINTENANCE AND REPAIR OF COPPER-BRAID WIRE.** This wire is tenacious and does not readily break. It may easily be soldered when breaks occur. No taping of the joint is necessary.

**79. MAINTENANCE AND REPAIR OF BALLOON MX-93/MRQ-2.** This is divided into three major categories: patching fabric, repair of stabilizers, repair of lines.

*a.* If a large leak or tear in the balloon fabric occurs, proceed as follows:

(1) Invert the balloon placing the appendix upwards as outlined in paragraph 18 *f*. Then deflate the balloon.

(2) Lay out the deflated balloon on the tarpaulin ground cloth, with the torn portion exposed.

(3) Lay the area to be patched on a flat smooth surface. A board wrapped with paper or cloth provides a good patching surface.

(4) Feed the torn area through the open appendix opening which, in effect, turns the torn area inside out, allowing the inside of the fabric to be worked on.

(5) Clean the area to be patched thoroughly with naptha provided in Repair Kit MK-15/MRQ-2.

**WARNING: Naptha is highly inflammable. Observe same strict fire regulations as during balloon inflation and deflation.**

(6) Take patching fabric provided in Repair Kit MK-15/MRQ-2 and cut a patch of suitable size, using Knife TL-29 supplied with Radio Set AN/MRQ-2. Make the patch large enough to provide good reinforcement and a secure grip when completed.

(7) Apply five or six coats of rubber cement provided in Repair Kit MK-15/MRQ-2 on the patch and on the balloon area (inside) containing the

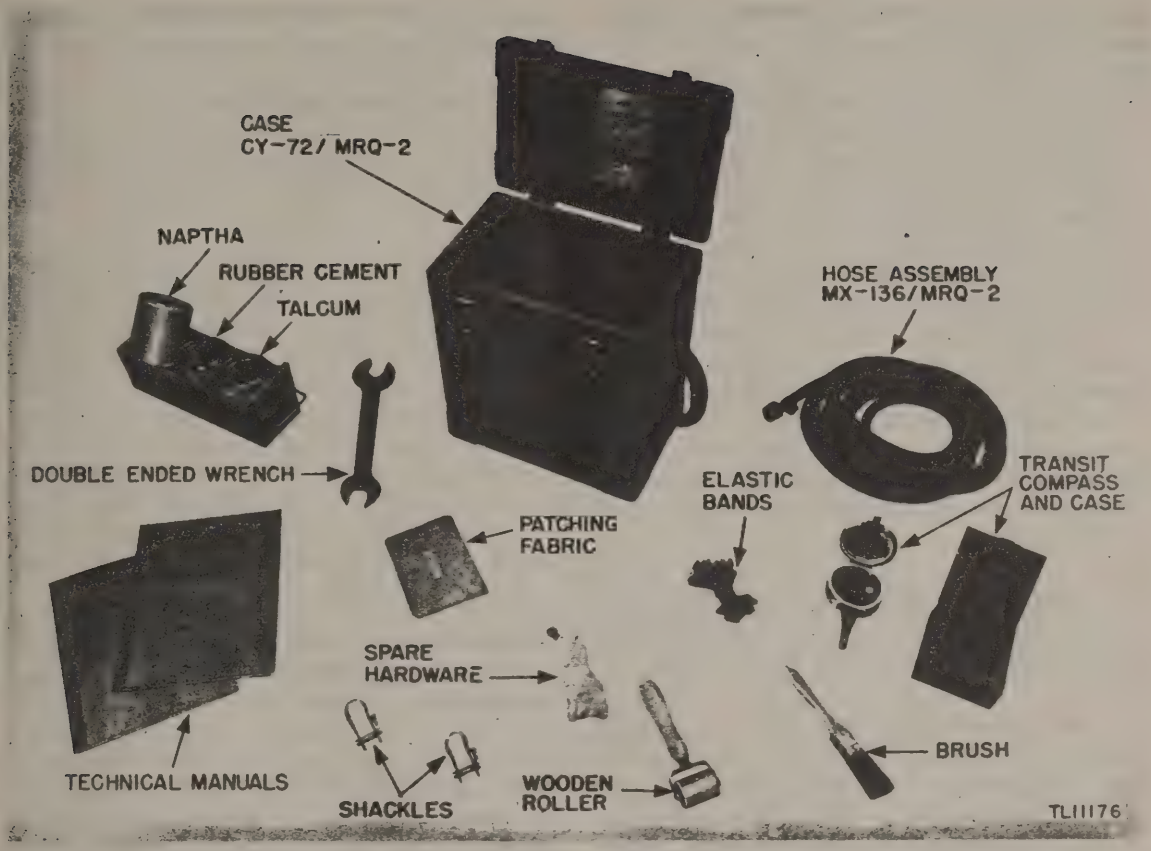



*Figure 57. Repair and miscellaneous equipment.*

tear. Each coat of rubber cement should be applied with the horsehair brush contained in Repair Kit MK-15 MRQ-2 at intervals a few minutes apart so that each coat of rubber cement is nearly dry before another is applied. If the rubber cement "blushes" (name for absorption of water and dampness by cement, turning it a diluted, milky white) try to apply cement in sunshine or in dry warm spot. In carrying balloon fabric, however, be careful not to tear or rip it, or to allow fabric to catch and cut on sharp protruding objects.

(8) Apply the patch to the torn area, taking care not to wrinkle the fabric or patch.

(9) With the board previously prepared serving as a flat reinforcing surface roll the patch, now applied to the tear, with the wooden roller provided in Repair Kit MK-15 MRQ-2.

(10) Sprinkle the repaired area with the talcum powder provided in Repair Kit MK-15 MRQ-2 to prevent its adhering or sticking to other parts of the balloon fabric when bag is stowed, rolled, or packed.

(11) Follow the same procedure when making an emergency or outside patch. An emergency patch is inferior, however, to permanent internal repair where the patch is not readily rubbed off by outside objects and where the balloon gas pressure acts to cement the patch more tightly instead of blowing it outward and off.

(12) Temporary outside patches should be reinforced with internal patches.

*b.* Stabilizer failures stem largely from twisted or tangled bracing guy strings which cause the stabilizer to sit at an angle, making the balloon circle or fly erratically. When strings break, repair them by tying with a square knot, sewing the loose ends. Take care, however, that additional string is added to provide length for the knot, or the broken guy string will be shortened, warping the stabilizer position and causing the balloon to fly erratically. Broken wooden struts may be repaired by string splicing; ripped fabric by secure sewing with needle and thread.

c. Repair of broken or frayed shroud lines should be accomplished by square knot (avoid the fast-slipping granny knot), with loose ends served. Where shroud lines have broken and are repaired take extreme care that the repaired line is not shortened during the process, causing the shortened line to take more than its share of the antenna and flying line load, possibly ripping out the bridle patch and puncturing the balloon and, if not causing an immediate puncture, causing the balloon to behave badly when flying. No exact data on shroud line lengths can be given in this manual due to differences in various balloon procurements, therefore it is an excellent idea to measure the balloon shrouds and record them before trouble starts. Then, when repair is necessary, exact information on the correct shroud lengths is available. For ideal flying balance the shrouds should be so adjusted that the balloon will fly 3° bow high.

**80. MAINTENANCE AND REPAIR OF KITE VKS-1.** This is divided into three major categories: patching fabric, repair of wooden cross members, repair of line.

a. The fabric forming the stabilizer and lifting surfaces of the kite is composed of waterproofed cotton. When rents or tears in the fabric occur they may be repaired precisely as a rent or tear in the balloon, using the naptha, patches, roller, rubber cement, and talcum supplied in Repair Kit MK-15/MRQ-2, following maintenance directions for the balloon.

b. Broken or cracked wooden diagonal struts, longerons, and tie rods may be repaired by tightly joining the broken members by hand, then securely binding with string or twine. Stopgap repair of the low-tension members such as tie rods may be affected by tire tape supplied with Radio Set AN/MRQ-2.

c. Kite bridle lines may be repaired either by replacement of the entire line or by the addition of sufficient line to the broken bridle line so that when knots are made, the line is not shortened, thus throwing a majority of the kite load on one place, causing the kite to crash. The repaired line should be lengthened to correct length needed to form the square knot. Exact bridle lengths cannot be given in this manual due to procurement differences of kite models. Kite bridle lines should be measured prior to use and a record of lengths kept so equal loading will take place on the kite following bridle line repair.

**81. MAINTENANCE AND REPAIR OF RESISTANCE BOX MX-105/MRQ-2.** The terminating resistance contained in Resistance Box MX-105/MRQ-2 may consist of two 250-ohm non-inductive plaque resistors, wired in series to provide a 500-ohm terminating resistance, or a single 500-ohm plaque may be supplied depending upon procurement differences. Ground stakes may be driven into the ground as previously described as a stopgap termination. There is no practicable way to repair an open resistor plaque and it should be replaced when an open or intermittent circuit develops.

**82. MAINTENANCE AND REPAIR OF WINCH, REEL ASSEMBLY RL-104/MRQ-2.** This winch is rugged in construction and requires little maintenance. The drum and moving parts are secured by a welded frame which cannot be disassembled, thus making major repair impossible. Repair will seldom, if ever, be required during the life of the winch. The winch requires no lubrication due to the employment of oilite bearings which are self-lubricating and composed of graphite and bronze. The drum is aluminum and therefore nonrusting. If aluminum drum has been marred or sharply dented due to accident, the damaged portion should be filed smooth so as to prevent the flying line from being chafed. Should sand or dirt accumulate between the brake band and brake drum, press the brake handle upward as far as it will go releasing the band tension on the drum, and blow out the dust or dirt. To prevent rusting of the square shaft ends over which the removable handles are slid, apply engine oil used for Power Unit PE-95-( ) supplied with Radio Set AN/MRQ-2. This may be either SAE 30 or SAE 10 oil depending upon climate.

## 83. MAINTENANCE PARTS LIST FOR ANTENNA ASSEMBLY AS-51/MRQ-2 (ANTENNAS A AND B).

**NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts listed can be requisitioned.**

| *Ref symbol* | *Signal Corps stock No.* | *Name of part and description* | *Quan per unit* | *Running spares* | *Orgn stock* | *3d ech.* | *4th ech* | *5th ech* | *Depot stock* |
|---|---|---|---|---|---|---|---|---|---|
| | 2A264-91 | ANTENNA WIRE ASSEMBLY AS-91/MRQ-2. | 1 | 1 | | * | * | * | * |
| | 2A264-92 | ANTENNA WIRE ASSEMBLY AS-92/MRQ-2. | 1 | 1 | | * | * | * | * |
| | 2Z556-93 | BALLOON MX-93/MRQ-2: with two sets of stabilizers. | 1 | 2 | | * | * | * | * |
| | 1F425-61 | CABLE RG-61/MRQ-2: transmission; 12 ft long; 2-wire. | 2 | 2 | | * | * | * | * |
| | 2A700-55 | COUNTERPOISE AT-55/MRQ-2. | 1 | 1 | | * | * | * | * |
| | 2A700-56 | COUNTERPOISE AT-56/MRQ-2. | 1 | 1 | | * | * | * | * |
| | 2A264-51/K1 | KITE: Navy Type VKS-1, Navy Spec. 4411 | 1 | 1 | | * | * | * | * |
| | 6H6302-4 | REEL ASSEMBLY RL-104/MRQ-2: includes 1 bag of hardware for mounting. | 1 | | | | | | * |
| | 1A816.4 | WIRE: bare; copperclad steel No. 16 AWG; solid; 2,000 ft long. | 2 | | | * | * | * | * |

* Indicates stock available.

## 83. MAINTENANCE PARTS LIST FOR ANTENNA ASSEMBLY AS-51/MRQ-2 (ANTENNAS A AND B). (Cont'd)

**NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts listed can be requisitioned.**

| *Ref symbol* | *Signal Corps stock No.* | *Name of part and description* | *Quan per unit* | *Running spares* | *Orgn stock* | *3d ech* | *4th ech* | *5th ech* | *Depot stock* |
|---|---|---|---|---|---|---|---|---|---|
| | 2Z5731-15 | REPAIR KIT MK-15/MRQ-2: includes:<br>1 brush, 1" wide<br>1 pint naphtha<br>1 roller, wood, 2"<br>1 pint rubber cement, Goodyear Airship Type 371-C<br>1 sq. yd. rubber patching fabric<br>1 pint talcum powder. | 1 | | | * | * | * | * |
| | 3Z6965-105 | RESISTANCE BOX MX-105/MRQ-2: consisting of 2 resistors each 250-ohm, 100-watt, non-inductive plaque type. | 1 | 1 | | * | * | * | * |
| | 6Z7920 | ROPE: nylon; 1150 ft long, 3/16" diameter; Columbian Rope Co., Auburn, N. Y. | 1 | 1 | | * | * | * | * |
| | 2A264-51 | TECHNICAL MANUAL TM 11-2610; Antenna Assembly AS-51/MRQ-2 and AS-93/MRQ-2. | 2 | | | | | | * |

* Indicates stock available.

## 84. MAINTENANCE PARTS LIST FOR ANTENNA ASSEMBLY AS-93/MRQ-2 (ANTENNA C).

**NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts listed can be requisitioned.**

| *Ref symbol* | *Signal Corps stock No.* | *Name of part and description* | *Quan per unit* | *Running spares* | *Orgn stock* | *3d ech* | *4th ech* | *5th ech* | *Depot stock* |
|---|---|---|---|---|---|---|---|---|---|
| | 2A264B-57 | ANTENNA WIRE ASSEMBLY AT-57/MRQ-2. | 1 | | | * | * | * | * |
| | 2A700-58 | COUNTERPOISE AT-58/MRQ-2. | 1 | | | * | * | * | * |
| | 2A1324 | GUY GY-24A. | 2 | | | * | * | * | * |
| | 2A2108 | MAST CAP AND GUY ASSEMBLY. | 2 | | | * | * | * | * |

* Indicates stock available.

# PART SEVEN

# SUPPLEMENTARY DATA

## SECTION I

## FIELD EXPEDIENTS, HALF-RHOMBIC ANTENNAS

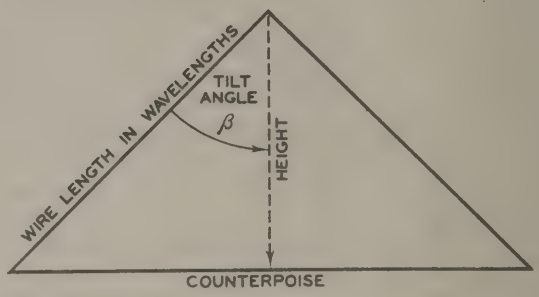
**85. HALF-RHOMBIC ANTENNAS OTHER THAN A AND B.** For communication or other radio measures, it is possible to use a half-rhombic antenna, correctly designed, at virtually any frequency at which the proper physical support is available, thus putting to use the large power gain and other advantages of this type of radio-beam antenna. This use of half-rhombic antennas other than antenna A and B is treated in this manual to provide information for field expedients. These antennas should be designed and used only with permission, and under the guidance of the officer in charge.

**86. PHYSICAL LIMITATIONS.** Since the triangular dimensions of the antenna are related mathematically to the operating frequency used, physical support at the correct height and sufficient wire for the triangle legs must be available to permit the installation of a given half-rhombic antenna. The height of this required support varies inversely with frequency: the lower the frequency used, the higher the support required for maximum gain, while at higher frequencies this support becomes of such practical size that lance poles, small masts, or trees may be used.

**87. WIRE LENGTH AND APEX ANGLES.** As previously stated, the required length of each side of the antenna triangle, the height of the upper apex angle above ground, and the counterpoise length are interrelated. To visualize this, see figure 58.

*a.* In figure 58 the *height* of the triangle is shown by the dotted line so marked.

*b.* *Wire length in wavelengths* indicated on the left leg in figure 58 is a measure which will be used for the design of any given half-rhombic. How to convert it to feet will be shown shortly.




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*Figure 58. Antenna triangle showing height of the upper apex, wire length on a leg and the antenna tilt angle.*

*c.* The *tilt angle B* is of great importance to the design and must be correct for maximum antenna gain.

*d.* The *counterpoise* length is determined by the leg length and the angle B.

**88. CHOOSING THE SIZE OF THE HALF-RHOMBIC ANTENNA TO BE USED; POWER GAIN AND WIDTH OF BEAM.** At any given frequency there are a number of half-rhombic sizes which may be used, varying from a minimum size at which the beam will work at a given frequency, to a large size limited only by the height of the support (balloon, kite, or pole), the weight of wire the support will carry, and the length of wire available. The larger the size at a given frequency, the sharper the beam produced and the more gain realized within that beam.

*a.* Various half-rhombic sizes are identified in engineering practice by referring to the number of electrical full wavelengths which lie on one of the vertically-supported triangle legs. For instance, the half-rhombic antenna shown in figure 58 would be

identified by the number of full wavelengths which lie on the leg marked *wire length in wavelengths* at a given frequency. If there were two full wavelengths lying on this leg at 2 megacycles it would be referred to as a half-rhombic antenna with two full wavelengths on a leg at 2 megacycles. This, in fact, is antenna A. Antenna B has two wavelengths on a leg at 5 megacycles.

*b.* Converting full wavelengths to feet is quickly done by the formula:

$$\text{Length of a full wavelength measured in feet} = \frac{984}{\text{Frequency in megacycles}}$$

*c. The minimum size* at which a half-rhombic will perform satisfactorily is one having a single full wavelength on a leg, or side, at the average frequency at which it is to be operated.

**89. HALF-RHOMBIC ANTENNA DESIGN CHART** (fig. 59). From the chart the triangular dimensions of any half-rhombic antenna may be quickly derived.

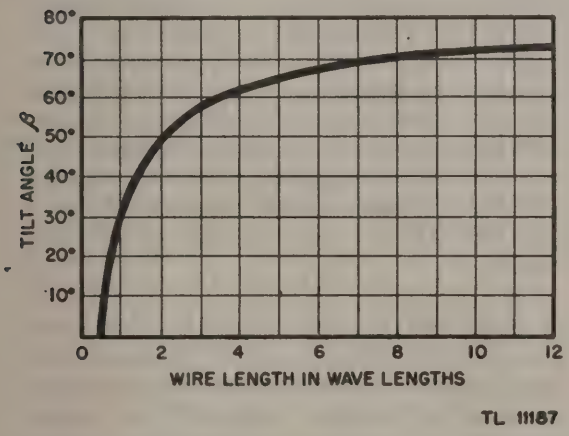



*Figure 59. Half-rhombic antenna design chart. Tilt angle plotted against wire length of each triangle leg.*

The tilt angle B (fig. 58) is plotted against the wire length measured in full wavelengths lying on an antenna triangle leg. For example, strong point-to-point ground wave communication is desired on 30 megacycles. As an expedient it has been decided to erect a half-rhombic antenna with two wavelengths on a leg at that frequency. Then:

$$\text{Length of a full wavelength measured in feet} = \frac{984}{30} = 32.8 \text{ feet}$$

Each vertically-supported leg of the antenna would then measure 32.8 x 2 (for two wavelengths) or 65.6 feet. From figure 59, the tilt angle B for an antenna with two wavelengths on a leg is shown as approximately 50°. As the tilt angle is exactly half the apex angle, the entire apex angle will be 100°. The correct counterpoise length will be that required to complete the triangle, simply determined by a method shown in the next paragraph.

**90. TRIANGLE DIMENSIONS WITHOUT TRIGONOMETRY.** In the above paragraph, the two leg lengths and the apex angle were quickly derived. However the height of the required supporting pole or mast, and the exact counterpoise length were not obtained. To avoid trigonometric functions, the following table keys all dimensions of the antenna triangle to the length of a side. Note that each dimension is expressed in wavelengths at the desired frequency. This is readily converted to linear feet by the formula in paragraph 88*b*. Using this method, any size half-rhombic antenna may be designed for any frequency by no more than multiplication.

| *Number of wavelengths on a triangle leg.* | *Tilt angle* β. | *Height of the upper triangle apex from the counterpoise (pole height), measured in wavelengths at the operating frequency.* | *Entire counterpoise length measured in wavelengths at the operating frequency.* |
|---|---|---|---|
| 1 | 30° | 0.87 | 1 |
| 2 | 50° | 1.3 | 3 |
| 3 | 57° | 1.6 | 5 |
| 4 | 62° | 1.9 | 7 |
| 5 | 65° | 2.1 | 9 |
| 6 | 67° | 2.3 | 11 |
| 7 | 68° | 2.6 | 13 |
| 8 | 70° | 2.7 | 15 |
| 9 | 70.5° | 3.0 | 17 |
| 10 | 71° | 3.3 | 19 |
| 11 | 72° | 3.4 | 21 |
| 12 | 73° | 3.5 | 23 |

*a.* For example, the half-rhombic antenna using 2 wavelengths on a side at 30 megacycles was quickly found in paragraph 89 to have 65.6 feet on a leg. Glancing at the table, it can be seen that an antenna with two wavelengths on a leg has a tilt angle of 50°, the pole height required 1.3 wavelengths, and the overall counterpoise length 3 wavelengths. Since the length of a wavelength at 30 megacycles was found to be 32.8 feet (by dividing the frequency in

megacycles into 984), the height of the pole required will be 42.6 feet and the counterpoise length 98.4 feet.

*b.* Take another example. As a field expedient, a very powerful beam is required to operate at 20 megacycles. The sector to be covered will be narrow, therefore the beam may be sharp and provide high gain. Balloon or kite support is available, therefore the height of the antenna supporting structure presents little or no problem. It has therefore been decided to erect an antenna with 12 wavelengths on a leg. The table shows that an antenna with 12 wavelengths on each leg must have its apex 3.5 wavelengths above ground, and a counterpoise 23 wavelengths long. Dividing 984 by the frequency in megacycles, or 20, we quickly find that the length of a full wavelength at 20 megacycles is 49.2 feet. Each leg of the triangle will then be 590 feet, the apex supported at 172.2 feet from the ground, and the over-all counterpoise length 1,131.6 feet. The gain of this antenna will approximate 18 decibels or a signal voltage gain of 64 times over and above a vertical dipole whip.

*c.* Where the size of the antenna will be wholly governed by the height of the supporting pole, tree, or mast, quick calculations can be made using the tabular column showing required pole height so the maximum size antenna (hence the greatest gain) may be designed for the available mast height. For example, a 60-foot palm tree may be available which appears to offer excellent half-rhombic antenna support. If the mean operating frequency to be used is 40 megacycles, dividing 984 by 40 shows a full wavelength to be 24.6 feet at that frequency. The table indicates that an antenna having two wavelengths on a leg requires a mast height of 1.3 wavelengths, or 31.9 feet. As the tree is far taller than 31.9 feet, a larger antenna is possible, therefore the table is reexamined for an antenna having six wavelengths on a leg which, the table indicates, requires a pole height of 2.3 wavelengths or 56.5 feet, easily possible with a 60 foot tree. Simple multiplication then shows the antenna will have 147.6 feet on each leg and 270.6 feet for its counterpoise. The beam produced by this antenna may be pointed in any direction simply by rotating the antenna around the tree.

***d. Steel masts, or wooden masts using metal guy wires must never be used.*** The presence of metal support at the center of the antenna will disrupt its functioning.

**91. TRANSMISSION LINE AND TERMINATING RESISTANCE.** Cable RG-61/MRQ-2, the transmission line supplied with Antenna Assembly AS-51/MRQ-2, may be used with any half-rhombic antenna employing frequencies up to 50 megacycles. The Resistance Box MX-105/MRQ-2, the terminating resistance used with this antenna assembly, may be used for any other half-rhombic antenna of which the dimensions fall within the scale shown in figure 59.

**92. SITES FOR HIGH-FREQUENCY OPERATION.** Where half-rhombic antennas are to be used for quasi-optical (line of sight) point-to-point work using frequencies upward of 20 megacycles, the antenna should be located on the highest possible ground for maximum effective range and signal strength. When so installed, the half-rhombic is one of the most effective types of beam antennas for the propogation and reception of high frequency, vertically-polarized signals. The use of this antenna will increase the distance obtained many times over and above that provided by a simple vertical dipole (half-wave antenna) at the same average height above ground.

**93. BEAM WIDTH.** The width of the beams produced by half-rhombic antennas of various sizes are shown in figure 60. The widths are indicated within each angle and represent an average over varying terrain and soil conditions. They are drawn to half power, in other words signals sent at any angle within the spread indicated will be more than half the beam's maximum power.

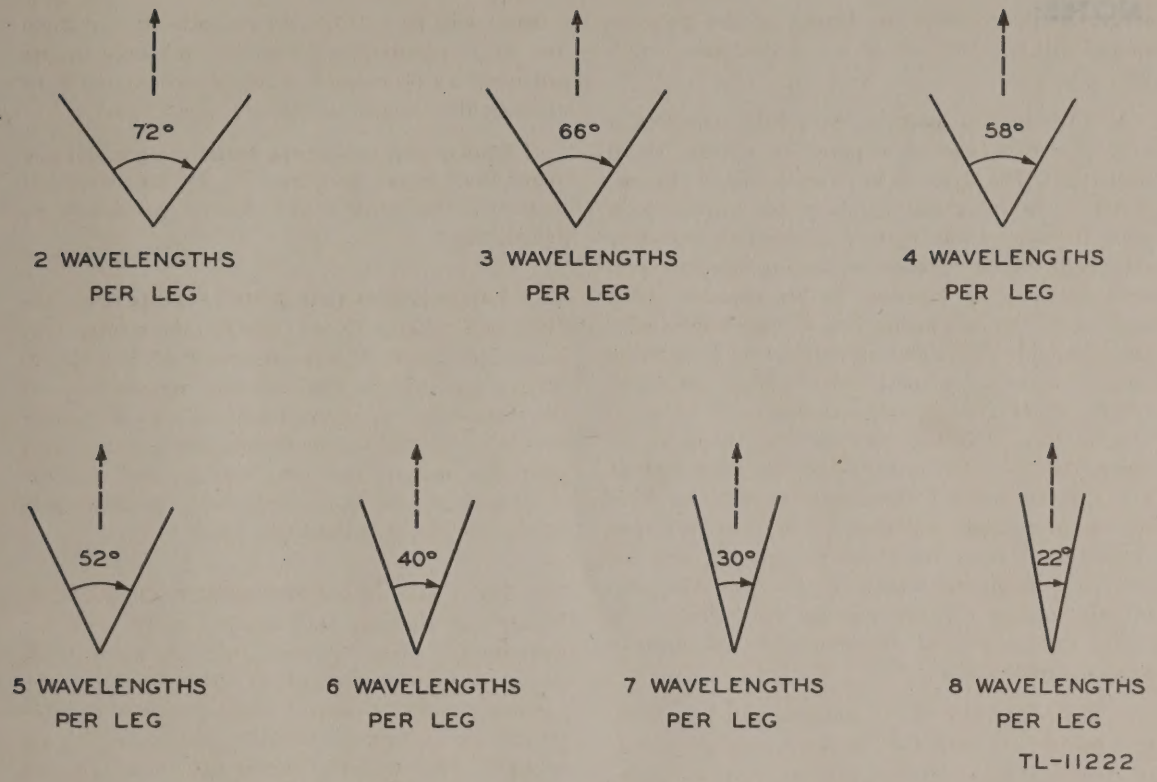



*Figure 60. Approximate beam width of various half-rhombic antenna sizes.*

**NOTES:**

1496—MPD—44; 1200; 31 July 44