CHAPTER 2

SIGHTING AND FIRE CONTROL EQUIPMENT

Proper employment of sighting and fire control equipment ensures effective fire against the enemy. This chapter describes this equipment and its applications.

Section I. COMPASS, M2

The compass (Figures 2-1 through 2-3) is used to measure azimuths or angles of site. It measures magnetic azimuths or grid azimuths, when the instrument has been declinated for the locality.

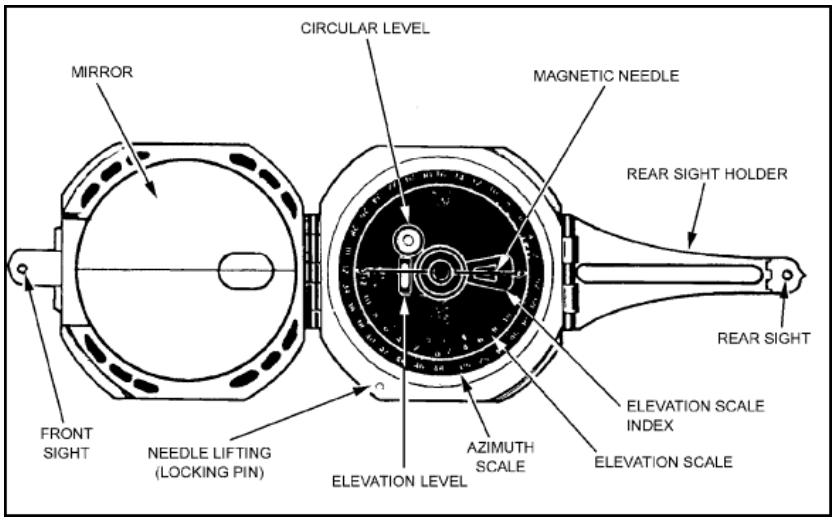

Figure 2-1. Compass, M2, (top view).

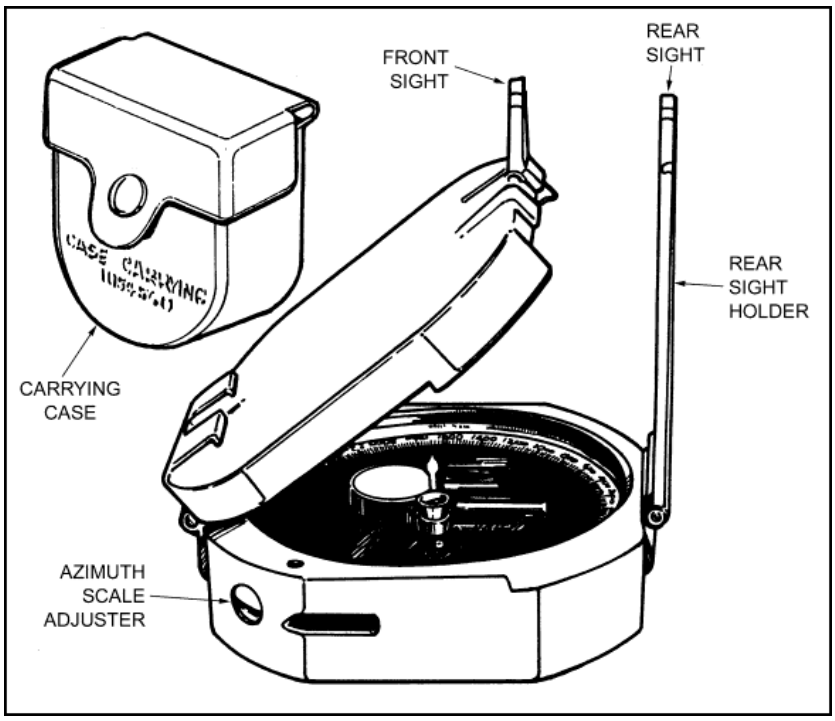

Figure 2-2. Compass, M2 (side view).

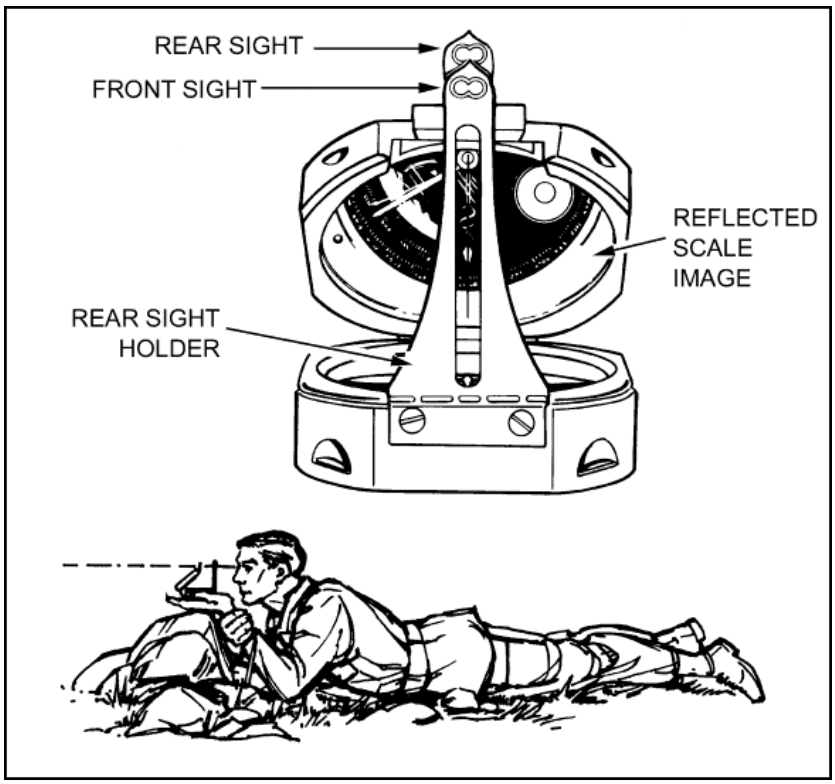

Figure 2-3. Compass, M2 (user's view).

Note: For detailed information, see TM 9-1290-333-15.

2-1. CHARACTERISTICS

The main characteristics of the M2 compass are:

Angle-of-site scale	1200-0-1200 mils
Azimuth Scale	0 to 6400 mils
Dimensions Closed	2 3/4 inches by 1 1/8 inches
Weight	8 ounces

2-2. DESCRIPTION

The principal parts of the compass are described herein.

a. **Compass Body Assembly**. This assembly consists of a circular glass window that covers the instrument, and keeps dust and moisture from its interior, protecting the compass needle and angle-of-site mechanism. A hinge assembly holds the compass cover in the position in which it is placed. A hole in the cover coincides with a small oval window in the mirror on the inside of the cover. A sighting line is etched across the face of the mirror.

b. **Angle-of-Site Mechanism**. The angle-of-site mechanism is attached to the bottom of the compass body. It consists of an actuating (leveling) lever located on the back of the compass, a leveling assembly with a tubular elevation level, and a circular level. The instrument is leveled with the circular level to read azimuths and with the elevation level to read angle of site. The elevation (angle-of-site) scale and the four points of the compass, represented by three letters and a star, are engraved on the inside bottom of the compass body. The elevation scale is graduated in two directions; in each direction it is graduated from 0 to 1200 mils in 20-mil increments and numbered every 200 mils.

c. **Magnetic Needle and Lifting Mechanism**. The magnetic needle assembly consists of a magnetized needle and a jewel housing that serves as a pivot. The north-seeking end of the needle is white. (The newer compasses have the north and south ends of the needle marked "N" and "S" in raised, white lettering.) On some compasses a thin piece of copper wire is wrapped around the needle for counterbalance. A lifting pin projects above the top rim of the compass body. The lower end of the pin engages the needle-lifting lever. When the cover is closed, the magnetic needle is automatically lifted from its pivot and held firmly against the window of the compass.

d. **Azimuth Scale and Adjuster**. The azimuth scale is a circular dial geared to the azimuth scale adjuster. This permits rotation of the azimuth scale about 900 mils in either direction. The azimuth index provides a means of orienting the azimuth scale at 0 or the declination constant of the locality. The azimuth scale is graduated from 0 to 6400 in 20-mil increments and numbered at 200-mil intervals.

e. **Front and Rear Sight**. The front sight is hinged to the compass cover. It can be folded across the compass body, and the cover is closed. The rear sight is made in two parts--a rear sight and holder. When the compass is not being used, the rear sight and holder are folded across the compass body and the cover is closed.

2-3. USE

The compass should be held as steadily as possible to obtain accurate readings. The use of a sitting or prone position, a rest for the hand or elbows, or a solid nonmetallic support

helps eliminate unintentional movement of the instrument. When being used to measure azimuths, the compass must not be near metallic objects.

a. To measure a magnetic azimuth--

(1) Zero the azimuth scale by turning the scale adjuster.

(2) Place the cover at an angle of about 45 degrees to the face of the compass so that the scale reflection is viewed in the mirror.

(3) Adjust the front and rear sights to the desired position. Sight the compass by any of these methods:

(a) Fold the rear sight holder out parallel with the rear sight of the compass face perpendicular to its holder. Sight through the window in the cover. If the object sighted is at a lower elevation than the compass, raise the rear sight holder as needed. The compass is correctly sighted when it is level and the black centerline of the window, rear sight, and object are aligned.

(b) Raise the front and rear sights perpendicular to the face of the compass (Figure 2-2 and Figure 2-3). Sight over the tips of the rear and front sights. The compass is correctly sighted when it is level and the tips of the sights and object are aligned.

(4) Hold the compass in both hands, at eye level, with the arms braced against the body and the rear sight near the eyes. For precise measurements, rest the compass on a nonmetallic stake or object.

(5) Level the instrument by viewing the circular level in the mirror and moving the compass until the bubble is centered. Sight on the object, look in the mirror, and read the azimuth indicated by the black (south) end of the magnetic needle.

b. To measure a grid azimuth--

(1) Index the known declination constant on the azimuth scale by turning the azimuth scale adjuster. Be sure to loosen the locking screw on the bottom of the compass. (The new lightweight [plastic] M2 compass has no locking screw.)

(2) Measure the azimuth as described above. The azimuth measured is a grid azimuth.

c. To measure an angle of site or vertical angle from the horizontal--

(1) Hold the compass with the left side down (cover to the left) and fold the rear sight holder out parallel to the face of the compass, with the rear sight perpendicular to the holder. Position the cover so that, when looking through the rear sight and the aperture in the cover, the elevation vial is reflected in the mirror.

(2) Sight on the point to be measured.

(3) Center the bubble in the elevation level vial (reflected in the mirror) with the level lever.

(4) Read the angle on the elevation scale opposite the index mark. The section of the scale graduated counterclockwise from 0 to 1200 mils measures plus angles of site. The section of the scale graduated clockwise from 0 to 1200 mils measures minus angles of site.

Section II. AIMING CIRCLES, M2 AND M2A2

The aiming circle is used to obtain angular values. It is a low-power telescope that is mounted on a composite body and contains a magnetic compass, adjusting mechanisms, and leveling screws for establishing a horizontal plane. The instrument is supported by a baseplate for mounting on a tripod. Angular measurements in azimuth are indicated on graduated scales and associated micrometers.

2-4. CHARACTERISTICS

The main characteristics of the aiming circles are described herein.

	M2	M2A2
Weight (w/o equipment)	9 pounds	9 pounds
Weight (w/equipment less batteries)	21 pounds	21 pounds
Azimuth rotation	6400 mils	6400 mils
Elevation (maximum)	800 mils	1100 mils
Depression (maximum)	400 mils	400 mils
Magnification	4 power	4 power
Field of view	10 degrees	10 degrees

2-5. DESCRIPTION

The M2 and M2A2 aiming circles consist of an elbow telescope mounted on orienting and elevating mechanisms, which are contained within a main housing. The main housing, in turn, is supported by adjusting screws through the baseplate.

2-6. USE

The M2 or M2A2 aiming circle (Figure 2-4) is used for the precise measurement of the azimuth and elevation angles of a ground or aerial target with the respect to a preselected baseline as required for the orientation of indirect fire weapons. It can also be used for general topographical surveying.

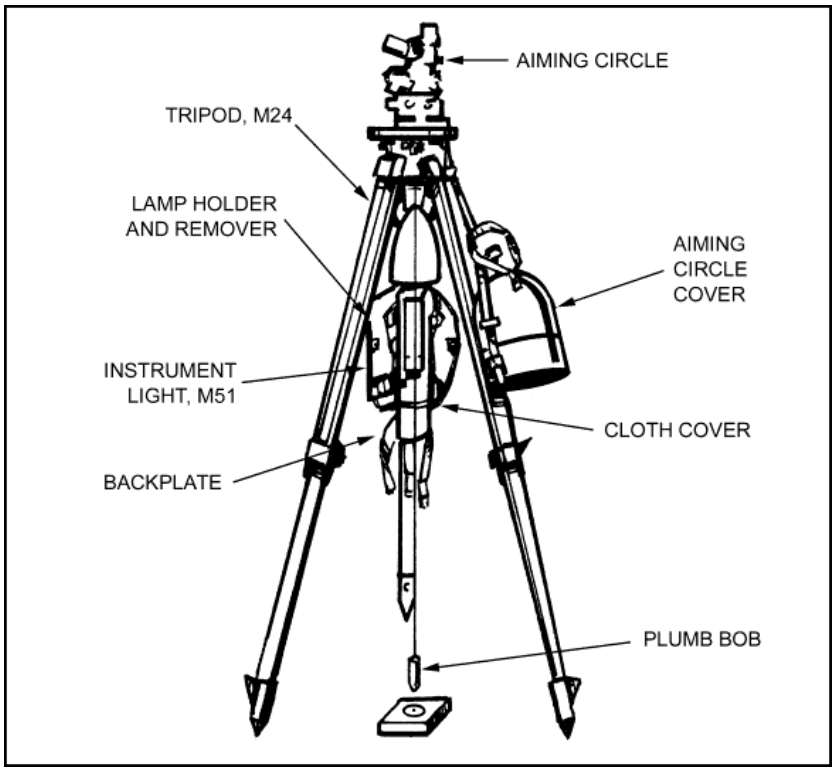

Figure 2-4. Aiming circles, M2 and M2A2, and accessory equipment.

Note: For detailed information, see TM 9-1290-262-15.

a. The orienting and elevating mechanisms permit unlimited azimuth orienting movement (360 degrees [6400 mils] and limited elevation and depression [M2, 1200 mils; M2A2, 1500 mils]). Azimuth orienting rotation is controlled by two orienting knobs (Figure 2-5). Azimuth measurement is controlled by the micrometer knob. Elevation and depression movement are controlled by the elevation micrometer knob. The azimuth micrometer worm can be disengaged to

provide rapid azimuth measurement of movement by exerting pressure on the azimuth micrometer knob against the pressure of an internal spring-loaded plunger. Releasing the pressure on the azimuth micrometer knob allows the mechanism to reengage. A similar throw-out mechanism permits the azimuth orienting worm to also be disengaged to provide rapid azimuth orienting movement.

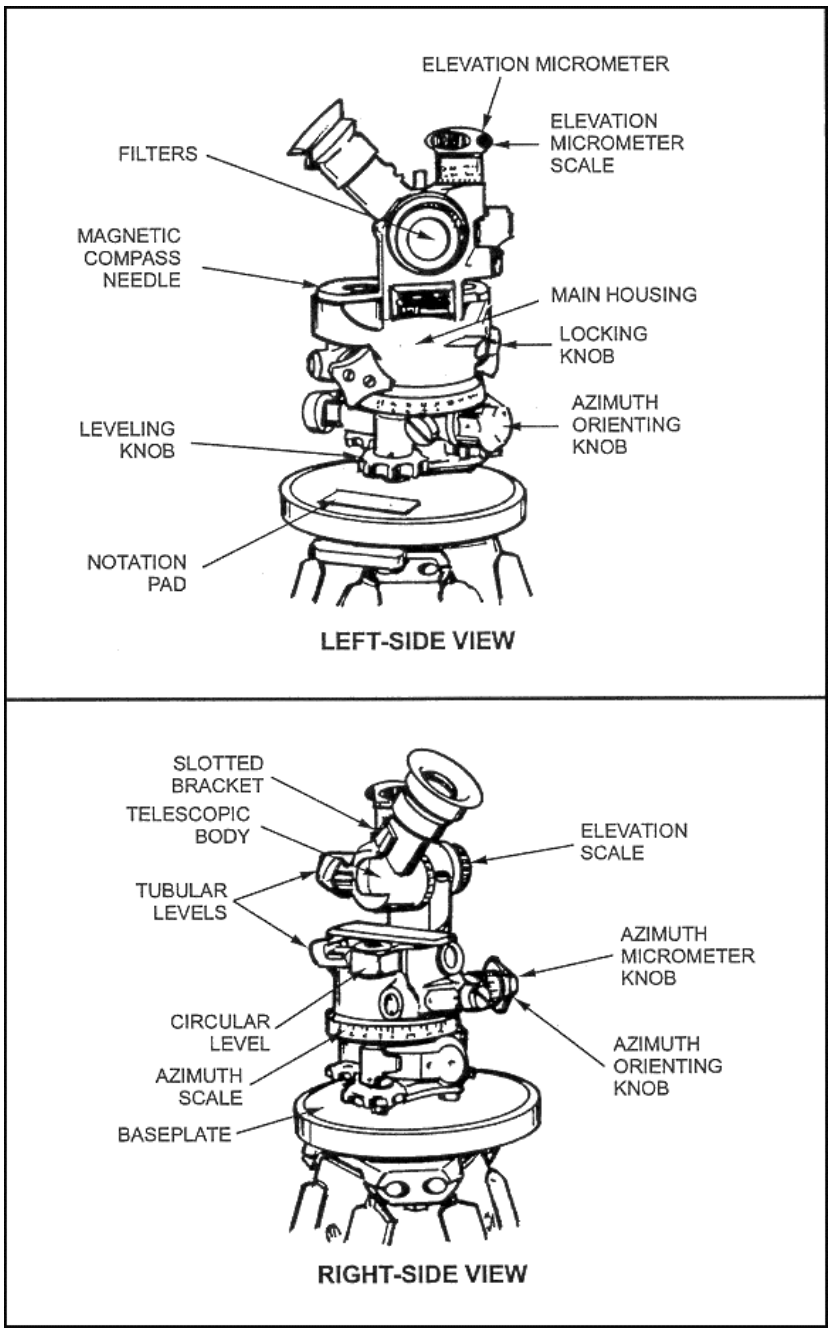
ELEVATION MICROMETER
ELEVATION MICROMETER SCALE
FILTERS
MAGNETIC COMPASS NEEDLE
MAIN HOUSING
LOCKING KNOB
AZIMUTH ORIENTING KNOB
LEVELING KNOB
NOTATION PAD
LEFT-SIDE VIEW
SLOTTED BRACKET
TELESCOPIC BODY
ELEVATION SCALE
TUBULAR LEVELS
AZIMUTH MICROMETER KNOB
CIRCULAR LEVEL
AZIMUTH SCALE
AZIMUTH ORIENTING KNOB
BASEPLATE
RIGHT-SIDE VIEW

Figure 2-5. Aiming circle, M2

b. The telescope of the aiming circle is a four-power, fixed-focus, elbow-type instrument. The reticle of the telescope contains cross lines graduated to give azimuth and elevation angular readings from 0 to 85 mils in 5-mil increments. Thus, the FO can read small angular values directly from the reticle without referring to the azimuth and elevation micrometer scales. An externally stowed filter is provided for protection against the rays of the sun. A slotted bracket provides the means of securing the lamp bracket on one lead wire of the M51 instrument light so that illumination of the reticle during night operation can be accomplished. The reflector can be illuminated and used in conjunction with the sightunits on the mortars during night operations to backlight the vertical centerline of the aiming circle.

c. Three levels are contained within the telescope body and main housing of the aiming circle. One tubular level, held between two bosses on the telescope body, is used to establish a true horizontal line-of-sight. The two bosses supporting this level are machined to form an open sight for approximate alignment of the telescope and target, and for quick or emergency sighting. One circular level and one tubular level are held within bosses on the main housing. The circular level is used for rough leveling of the aiming circle, and the tubular level is used for fine leveling adjustments. The three leveling screws on the baseplate are used to level the instrument and each is controlled by a leveling screw knob.

d. A magnetic compass needle is located in a recess in the top of the housing. A magnifier and rectangular reticle located at one end of the recess enable the FO to observe the end of the compass needle and to align the line of sight of the telescope with the needle. The compass needle can be locked in position by actuating the locking lever on the side of the housing.

e. Azimuth scales and elevation scales are employed to measure accurate azimuth or elevation angles. The scales provide coarse readings and the micrometer provides fine reading. The two readings added together give the angle. Graduation intervals and numeral scales are graduated into relatively large round number intervals for convenience in reading. The scale intervals are in graduations of 100 mils.

(1) The azimuth scale is graduated from 0 to 6400 mils (zero equals 6400). The upper series forms the main azimuth scale, colored black and numbered at 200-mil intervals. The lower series, colored red, is numbered from 0 to 3200 mils (the large zero in the main scale equals 3200). The red scale should only be used when verifying the lay of the aiming circle with another aiming circle.

(2) The azimuth micrometer scale is graduated at 1-mil intervals and numbered from 0 to 100 at ten 10-mil intervals.

(3) The elevation scale is graduated and numbered on both sides of 0. Minus (red) readings represent depression and plus (black) readings represent elevations at 100-mil intervals from minus 400 to 800 mils.

(4) The elevation micrometer scale is graduated at 1-mil intervals from 0 to 99 mils--large zero is designated 0 and 100. Red numerals represent depression and black numerals represent elevation.

f. A notation strip is provided on the baseplate. This strip is a raised and machined surface on which scale readings, settings, or other data can be recorded for reference.

2-7. ACCESSORY EQUIPMENT

The accessory equipment for the M2 aiming circle includes the aiming circle cover, M24 tripod, and the accessory kit which includes the M51 instrument light, backplate, cloth cover, plumb bob, and a lamp holder and remover. This equipment is mounted on the M24 tripod when the instrument is set up for use.

a. The *aiming circle cover* is a metal cover that protects and houses the aiming circle when not in use. It attaches to the baseplate of the aiming circle and can be carried by means of its strap. When the aiming circle is in use, the cover is placed on the tripod head cover.

b. The *M24 tripod* comprises three telescoping wooden legs hinged to a metal head, which contains a captive screw for attaching the aiming circle. When not in use, the tripod cover should be fitted on the head to protect the head and captive screw from damage, and the legs are held retracted by a strap. Attachments are provided so that the aiming circle cover and cloth cover with attached accessory equipment can be mounted on its legs when the aiming circle is set up for use. A hook is also provided from which the plumb bob can be suspended by means of its attaching thread when in use.

c. The *M51 instrument light* is a lighting device for use with the M2 aiming circle during night operations and for certain test and adjustment procedures. The light is flashlight battery-powered and contains two attaching lead wires. A lamp bracket attached to one lead wire can be inserted into the slotted bracket of the aiming circle telescope for illumination of the telescope reticle. A hand light, attached to the other lead wire, can be used for general-purpose illumination (scales, level vials, reflector, compass needle, and so forth). Rotation of the rheostat knob turns the two lamps on and off and increases or decreases the intensity of illumination.

d. The *backplate* provides the necessary clips and attachments for securing and protecting the instrument light and lamp bracket, hand light, and lead wires of the light. The plate with the attached instrument light is stored within the cloth cover.

e. The *cloth cover* is used to store the backplate and attached M51 instrument light. It is also used to store the plumb bob and a lamp holder and remover. When the aiming circle is set up for use, the cloth cover with attached equipment is mounted on one of the legs of the M24 tripod. When not in use, attached snap fasteners keep the cover in a closed position.

f. The *plumb bob* is used to aid in orienting the aiming circle over a certain grid point. It composes a pointed weight attached to a nylon thread that can be suspended from the hook under the tripod head when in use. The effective length of the thread can be adjusted by means of the slide. When not in use, the plumb bob is stored within the cloth cover.

g. A *lamp holder* and *remover* are used to hold spare incandescent lamps for the M51 instrument light. They also facilitate the removal and replacement of unserviceable lamps in the light.

2-8. SETUP AND LEVELING OF AIMING CIRCLE

The aiming circle must always be level during operation.

a. Unstrap the tripod legs, loosen the leg clamp thumbscrews, extend the legs so that the tripod is about chest high, and tighten the leg clamp thumbscrews. Spread the legs about 18 inches apart, adjust the legs so the tripod head is about level, and plant the feet firmly in the ground.

b. Remove the tripod head cover. Open the baseplate cover of the aiming circle head. Keeping the baseplate cover pointed toward you, thread the tripod guide screw assembly into the aiming circle until it is firmly seated. The base of the aiming circle should not protrude over the machine surface of the tripod head. Pull out and down on the strap latch assembly. Remove the cover and hang it on the tripod head cover.

c. If the instrument is to be set up over an orienting point, attach the plumb bob to the hook. Adjust the tripod legs and aiming circle head until it is over the point.

d. Loosen the leveling screws to expose sufficient threads (3/8 to 1/2 inch) on the three screws to permit the instrument to be leveled. Number the leveling screws clockwise, 1, 2, and 3 (Figure 2-6). Now place the tubular level vial over the notation pad. Grasp leveling screw number 1 between the thumb and forefinger of the right hand, and grasp leveling screw number 2 between the thumb and forefinger of the left hand. Turn the screws so that the thumbs move toward or away from each other. Using these two leveling screws, center the bubble. The bubble moves in the same direction as the left thumb.

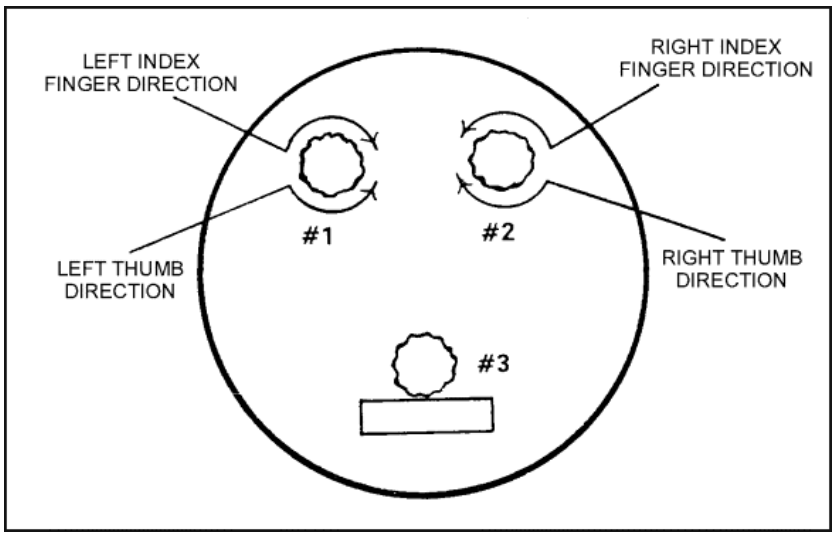

Figure 2-6. Leveling screws.

e. Rotate the aiming circle head until the magnifier is over the notation pad. Level the tubular level by turning only level screw number 3. The bubble should now remain level in any direction that the aiming circle is rotated. A variation of one graduation from the center of the vial is acceptable. If the bubble does not remain level, repeat this procedure.

Note: If the spring plate is bent, the aiming circle cannot be leveled and must be turned in to the DS maintenance unit.

f. The aiming circle should be set up at the distance indicated from the following objects:

OBJECT	DISTANCE (METERS)
High-tension power lines	150
Electronic equipment	150
Railroad tracks	75
Tanks and trucks	75
Vehicles	50
Barbed wire	30
Mortars or telegraph wire	25
Helmets, and so forth	10

2-9. DECLINATION CONSTANT

Since the magnetic needle of an aiming circle does not point to the grid north determined from a map, it is necessary to correct for this difference by using the declination constant. The declination constant of an instrument is the clockwise angle between grid north and magnetic north; that is, the grid azimuth of magnetic north. This constant differs slightly for different instruments and must be recorded on each instrument. The constant also varies for the same instrument in different localities. To determine the declination constant, proceed as follows:

a. **Declination Station**. Declination stations are established by corps artillery, division artillery, and artillery battalion survey teams to determine the declination constants of instruments and to correct for local attractions, annual variations, and instrument errors. When a unit moves from one locality to another, a station should be established where all instruments are declinated. If the declination constants for all instruments of a unit are determined at the same station, grid azimuths measured with each instrument will agree with the map grid, and all instruments will agree with each other. The point chosen for the declination station must have a view of at least two distant, well-defined points with a known grid azimuth. Two additional points are desirable, one in each quadrant, as a check.

b. **Procedure for Declinating Aiming Circle at a Declination Station**. Where a declination station is available, the procedure for declinating the aiming circle is as follows:

STEP 1. Set up and fine-level the aiming circle directly over the declination station marker using the plumb bob.

STEP 2. Place the grid azimuth of the first azimuth marker on the scales using the recording motion. Place the vertical cross line of the telescope on the azimuth marker using the nonrecording (orienting) motion. The aiming circle is now oriented on grid north.

STEP 3. With the recording motion, rotate the instrument to zero. Release the magnetic needle and look through the magnifier. Center the north-seeking needle using the recording motion, then relock the magnetic needle.

STEP 4. Notice the new azimuth on the scale, which is the declination constant--record it.

STEP 5. Recheck the aiming circle level and repeat steps 2 through 4 using the remaining azimuth markers until three readings have been taken. If there is only one marker, repeat the entire procedure twice using the same marker.

STEP 6. Find the average declination constant using these three readings.

EXAMPLE 1

1st point reading = 6399 mils
2d point reading = 6398 mils
3d point reading = 6398 mils

Total = 19195 mils

19195 ÷ 3 = 6398.3 (rounded off to the nearest whole number) = 6398 mils (average declination constant)

EXAMPLE 2

1st point reading = 0030 mils
2d point reading = 0031 mils
3d point reading = 0029 mils

Total = 0090 mils

0090 ÷ 3 = 0030 mils (average declination constant)

STEP 7. Record the average declination constant in pencil on the notation (strip) pad of the aiming circle as its declination constant. All readings should be within 2 mils of each other; if not, repeat steps 2 through 4. Ensure the aiming circle is directly over the station marker to obtain the 2-mil tolerance. If the desired 2-mil accuracy is not gained after two tries, the aiming circle is defective and should be turned in for repair.

c. **Use of the Grid-Magnetic Angle**. If an aiming circle is used in a new area without a declination station, a declination constant can be determined by using the grid-magnetic (GM) angle from a map. When the GM angle (converted to mils) is westerly, it is subtracted from 6400 mils. The remainder is the declination constant. When the GM angle is easterly, the angle (in mils) is the declination constant.

d. **Redeclination of an Aiming Circle**. An aiming circle is redeclinated when moved over 25 miles (40 kilometers) from the last declination station. It is also redeclinated upon initial issue, when returned from repair (if 30 days since last declinated), or if severely jolted.

e. **Procedure for Declinating an Aiming Circle When a Declination Station is Not Available**. This procedure is the least desirable and should be used only

when no other means are available. It does not compensate for the error that could be inherent in the aiming circle.

(1) Determine the GM angle from the map of the area in which the aiming circle is to be used. This GM angle is used as indicated below.

(2) In 1, Figure 2-7, the difference between grid north and magnetic north is 200 mils (westerly). This total is then subtracted from 6400 mils. The declination constant that can be used is 6200 mils.

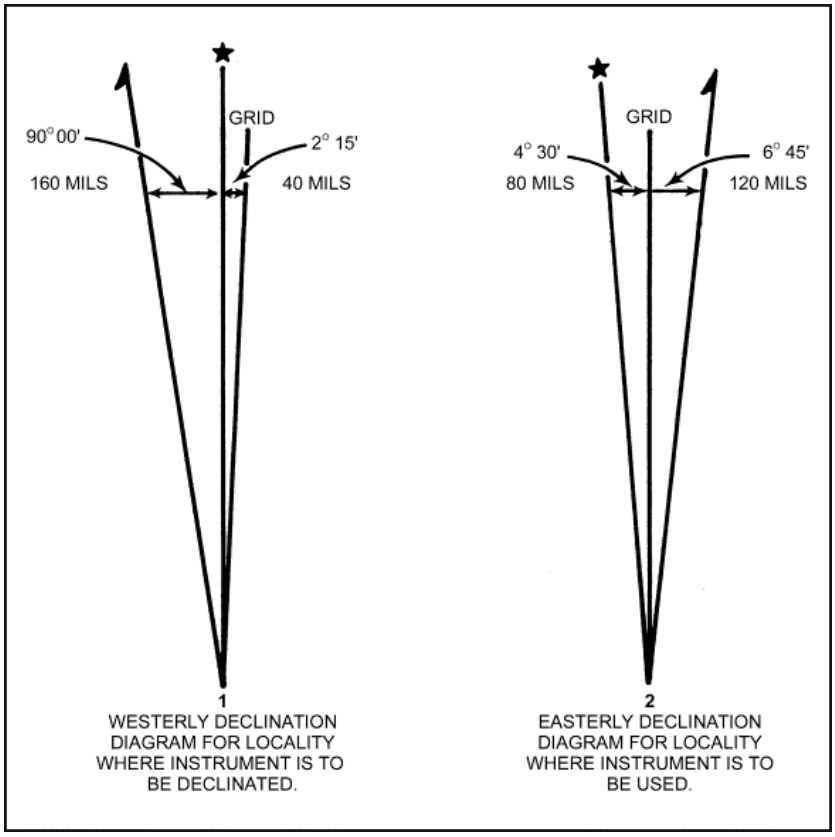

Figure 2-7. Marginal data from a map.

(3) In 2, Figure 2-7, the difference between grid north and magnetic north in a clockwise direction is 120 mils. This can be used as the declination constant.

f. **When to Declinate the Aiming Circle**. Certain rules prescribe how often and under what circumstances the aiming circle should be declinated to determine and keep the declination constant current. These rules are as follows:

(1) The aiming circle should be declinated when it is moved 25 miles or more from the area in which it was last declinated. A move of a few miles can change the relationship of grid north and magnetic north as measured by the instrument. In some locations, a move of less than 25 miles could require declination of the aiming circle.

(2) The aiming circle must be declinated after an electrical storm or after receiving a severe shock, such as a drop from the bed of a truck to the ground. The magnetic needle is a delicately balanced mechanism, and any shock can cause a significant change in the declination constant.

(3) The aiming circle should be declinated every 30 days to guard against changes that may have occurred due to unreported accidents to the instrument. If a radical change is observed, the instrument should be declinated again within a few days to determine if the observed change was due to a magnetic storm or is a real change in the characteristics of the instrument.

(4) The aiming circle should be declinated when it is initially received and when it is returned from support maintenance repair. Variations in the declination constant due to the time of day are not significant enough to warrant declinating again.

2-10. ORIENTING OF THE INSTRUMENT ON GRID NORTH TO MEASURE GRID AZIMUTH TO OBJECTS

The procedure to orient the aiming circle on grid north to measure grid azimuth to objects is as follows:

a. Level the instrument.

b. Set the azimuth micrometer and the azimuth scale on the declination constant of the instrument.

c. Release the magnetic needle.

d. With the orienting knob, align the south end of the needle accurately with the center etched line by using the magnetic needle magnifier.

e. Lock the magnetic needle and close the orienting knob covers.

f. Using the throw-out mechanism (azimuth knob), turn the telescope until the vertical line of the reticle is about on the object.

g. By rotating the azimuth knob, bring the vertical line exactly on the object.

h. Read the azimuth to the object on the azimuth and micrometer scales.

2-11. MEASUREMENT OF HORIZONTAL ANGLE BETWEEN TWO POINTS

To measure the horizontal angle between two points, at least two measurements should be made.

a. Set the azimuth micrometer and the azimuth scale at zero.

b. Rotate the instrument using the orienting knob throw-out mechanism until the vertical line of the telescope is about on the left edge of the left-hand object.

c. Lay the vertical line exactly on the right edge of the left-hand object by rotating the orienting knob.

d. Using the throw-out mechanism (azimuth knob), turn the telescope clockwise until the vertical line is about on the left edge of the right-hand object.

e. Lay the vertical line exactly on the left edge of the right-hand object by turning the azimuth knob.

f. Read the horizontal angle on the scales and record the value to the nearest 0.5 mil. This completes the first repetition.

g. Rotate the aiming circle, using the lower motion, until the vertical cross line is again on the rear station.

Note: The value obtained from the first repetition is still on the scales.

h. Rotate the aiming circle body, using the upper motion, until the vertical cross line is again on the forward station.

i. Read and record the accumulated value of the two measurements of the angle to the nearest 0.5 mil. This completes the second repetition.

j. Divide the second reading by 2 to obtain the mean angle to the nearest 0.1 mil. This mean angle must be within 0.5 mil of the first reading; if it is not, the measurement is void and the angle is measured again.

2-12. ORIENTING OF THE 0-3200 LINE ON A GIVEN GRID AZIMUTH

The procedure for orienting the 0-3200 line of the aiming circle on a given grid azimuth is illustrated below. In this example, the mounting azimuth is 5550 mils and the aiming circle is assumed to have a declination constant of 6380 mils.

a. Set up and level the aiming circle.

b. Subtract the announced mounting azimuth from the declination constant of the aiming circle (adding 6400 to the declination constant of the aiming circle if the mounting azimuth is larger). In this case, subtract the mounting azimuth 5550 from the declination constant 6380.

Solution:

Declination constant	6380 mils
Announced mounting azimuth	- 5550 mils
Remainder	830 mils

c. Set the remainder on the azimuth and micrometer scales of the aiming circle. In this case, the remainder is 830 mils (recording motion).

d. Release the compass needle. Look through the window in the cover housing and rotate the instrument until the needle floats freely using the orienting knob throw-out mechanism. For fine adjustments, use orienting knobs until the magnetic needle is exactly centered on the etched marks on the magnifier. Relock the compass needle to orient the 0-3200 line of the aiming circle on the mounting azimuth; in this case, grid azimuth of 5550 mils (Figure 2-8).

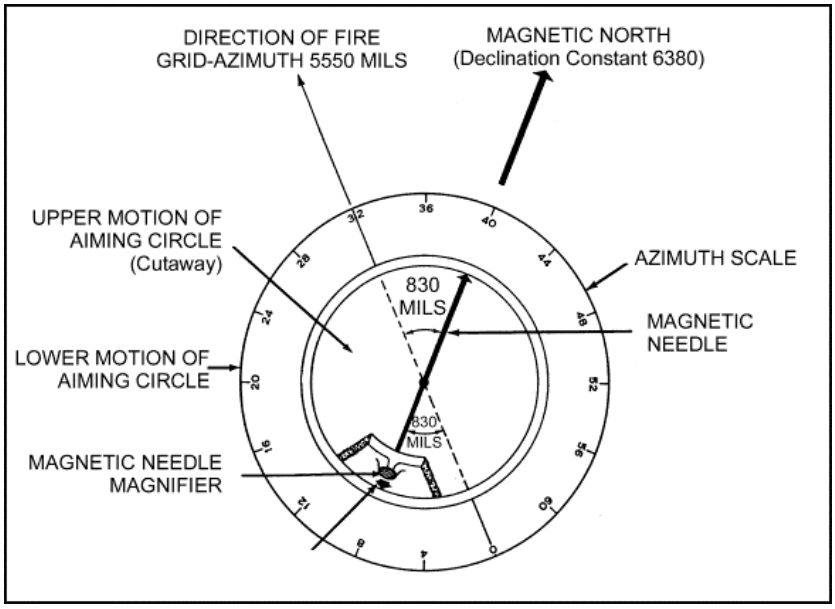

Figure 2-8. Aiming circle oriented in desired direction of fire.

e. Once the aiming circle is oriented, do not disturb the lower motion of the aiming circle.

2-13. ORIENTING OF THE 0-3200 LINE ON A GIVEN MAGNETIC AZIMUTH

The procedure for orienting the 0-3200 line of the aiming circle on a given magnetic azimuth is as follows:

a. Subtract the announced magnetic azimuth from 6400.

b. Set the remainder on the azimuth and micrometer scales of the aiming circle.

c. Release the compass needle and rotate the orienting knob until the magnetic needle is exactly centered in the magnetic needle magnifier. Lock the compass needle.

d. The 0-3200 line of the aiming circle is now oriented on a given magnetic azimuth.

2-14. VERIFYING THE LAY OF THE PLATOON

After the platoon is laid, the platoon leader verifies the lay by using another M2 aiming circle, which is referred to as the safety circle.

a. The platoon leader or designated safety officer sets up and orients an M2 aiming circle by using the method that was used with the lay circle (Figure 2-9). The aiming circle must be located where it can be seen by all mortars and should not be closer than 10 meters to the lay circle.

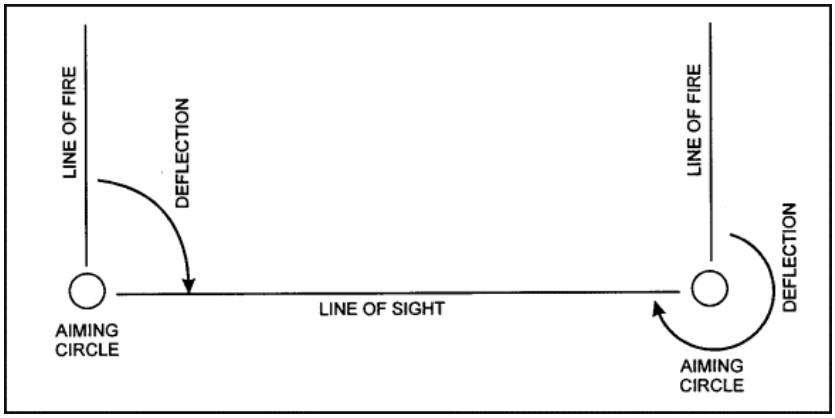

Figure 2-9. Method used to orient an M2 aiming circle.

b. After picking up a line of sight on the lay circle, the safety circle operator commands, LAY CIRCLE REFER, AIMING POINT THIS INSTRUMENT. The lay circle operator sights his instrument onto the safety circle by use of the recording motion.

c. When the aiming circle is used to orient another aiming circle for direction, the reading between the two circles will be 3200 mils apart, because both circles measure horizontal clockwise angles from the line of fire. To prevent confusion, remember that if you see red, read red. One half of the aiming circle azimuth scale has a second red scale that goes in the opposite direction of the black scale.

d. There should be no more than 10 mils difference between the circles.

e. If the lay circle and the safety circle deflection are within the 10-mil tolerance, the instrument operator on the safety circle places the deflection reading by the lay circle on the upper motion of the safety circle. With the lower motion, the instrument sights back on the lay circle. This serves to align the 0-3200 line of the safety circle parallel to the 0-3200 line of the lay circle.

f. The instrument operator on the safety circle commands, PLATOON, REFER AIMING POINT THIS INSTRUMENT. All gunners refer and announce the deflection to the safety circle. If the deflection referred by the mortar is within 10 mils, the operator on the safety circle announces that the mortar is safe. Once the mortars are safe, the operator announces, "The platoon is safe."

g. The platoon leader walks the gun line and visually checks the guns to ensure they are parallel. An M2 compass should also be used to ensure the guns are on the azimuth of fire.

2-15. ORIENTING BY ORIENTING ANGLE

Orienting by orienting angle eliminates magnetic errors that result from the use of the magnetic needle of the aiming circle.

a. An orienting angle is the horizontal clockwise angle from the mounting azimuth to the orienting line, the vertex being at the orienting station. It is a line of known direction established on the ground near the firing section which serves as a basis for laying for direction. This line is established by a survey team.

b. The instrument operator sets the aiming circle over the orienting station and levels it. He places the orienting angle on the azimuth scale. He then sights on the far end of the orienting line, using the lower motion. The magnetic needle is not used to orient the aiming circle. This eliminates any magnetic error that may exist in the instrument. The orienting knob cover is closed.

c. The 0-3200 line of the aiming circle is now oriented parallel to the mounting azimuth. Example azimuth of orienting line is 3200 mils. The azimuth on which the section leader wishes to lay the section is 1600 mils. The orienting angle is 1600 mils (Figure 2-10).

Azimuth of orienting line	3200 mils
Minus mounting azimuth	1600 mils
Orienting angle	- 1600 mils

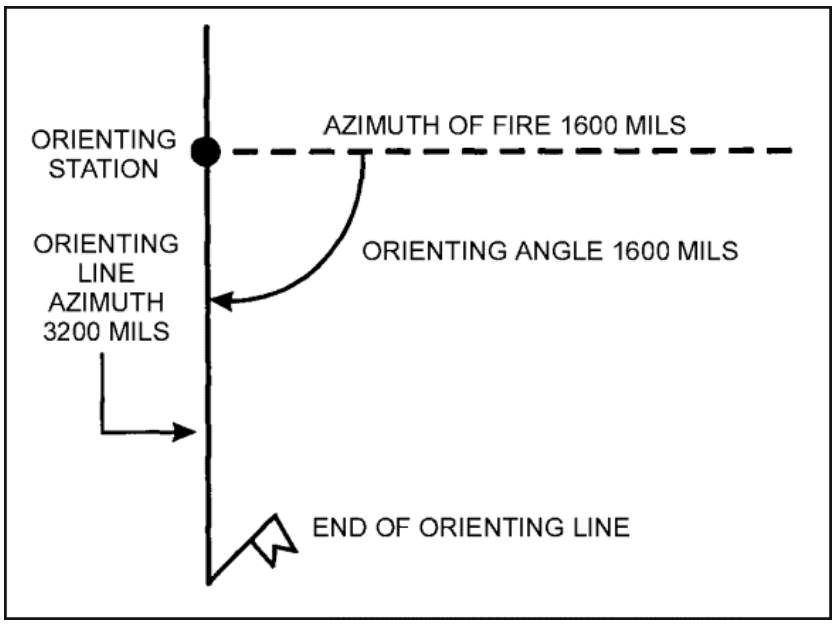

Figure 2-10. Orienting by orienting angle.

The aiming circle is set up over the orienting station by use of the plumb bob. The upper motion is used to set off 1600 mils on the aiming circle. The section leader sights on the end of the orienting line using the lower motion. The 0-3200 line of the aiming circle is now oriented.

2-16. DISASSEMBLY OF AIMING CIRCLE

Instructions for disassembling the aiming circle are located inside the circle cover.

2-17. CARE AND MAINTENANCE

The aiming circle cannot withstand rough handling or abuse. Proper care prolongs its life and ensures better results for the user. Inaccuracies or malfunctions result from mistreatment. The following precautions must be observed:

a. Since stops are provided on instruments to limit the travel of the moving parts, do not attempt to force the rotation of any knob beyond its stop limit.

b. Keep the instrument as clean and dry as possible. If the aiming circle is wet, dry it carefully.

c. When not in use, keep the equipment covered and protected from dust and moisture.

d. Do not point the telescope directly at the sun unless a filter is used; the heat of the focused rays can damage optical elements.

e. Keep all exposed surfaces clean and dry to prevent corrosion and etching of the optical elements.

f. To prevent excessive wear of threads and other damage to the instrument, do not tighten leveling, adjusting, and clamping screws beyond a snug contact.

Note: Only maintenance personnel are authorized to lubricate the aiming circle.

Section III. SIGHTUNITS

The M53-series and M64-series sightunits are the standard sighting devices used with the mortars. The sightunits are used to lay the mortar for elevation and deflection.

2-18. SIGHTUNIT, M53-SERIES

The sightunit, M53-series, consists of an M128 telescope mount and an M109 elbow telescope fastened together in one unit for operation (Figure 2-11). The elbow telescope provides magnification and a line of sight from which the weapon is aimed. The telescope mount secures the telescope in the correct position with respect to weapon azimuth and elevation axis).

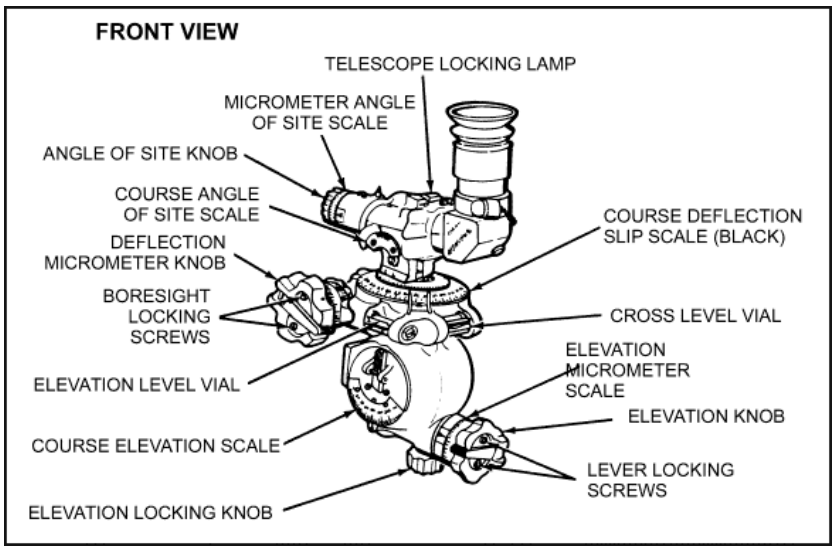

Figure 2-11. Sightunit, M53.

a. **Elbow Telescope, M109**. The elbow telescope (Figure 2-12) is a lightweight, 4-power, fixed-focus instrument with a 10-degree field of view that provides the optical line of sight for aiming the weapon in azimuth and elevation planes.

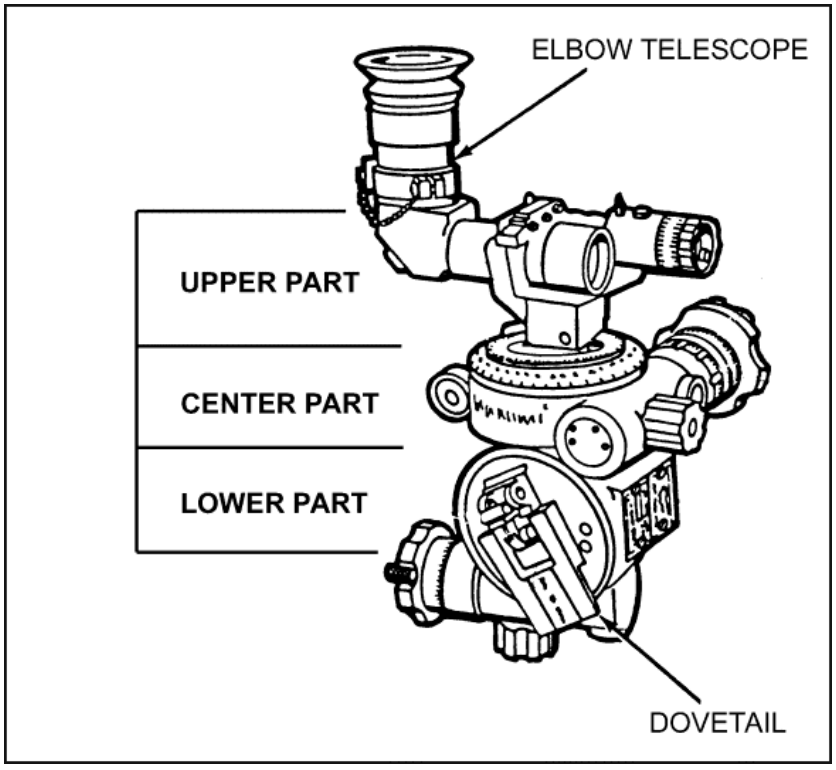

Figure 2-12. Sightunit with elbow telescope, M109.

(1) The telescope incorporates a cross- or lined-mil scale reticle that can be illuminated for night operations. The reticle pattern consists of two center lines at right angles to each other. Both center lines are graduated every 5 mils from 5 to 85 and are numbered every 10 mils in all four quadrants on both center lines.

(2) The telescope can be used in three positions: with the eyepiece to the left, right, or up. The eyepiece provides maximum comfort to the user. A telescope locking clamp permits the elbow telescope to be moved to any of the three positions and locked in these positions by the locking clamp. Indexes on the telescope and support indicate the horizontal and vertical positions of the center lines on the reticle when boresighted and the plumbed positions of the center lines. If the indexes are not lined up, the image is tilted.

(3) An angle-of-site mechanism, controlled by an angle-of-site knob, moves the telescope in a vertical plane.

b. **Telescope Mount, M128**. The telescope mount consists of three main parts: lower, center, and upper. The lower part contains a locking lever hatch, elevation micrometer knob with scales, and elevation locking knob. The center part contains a bushing for vertical axis, deflection micrometer knob and deflection locking knob, stationary and slip scales, and a pair of level vials. The upper part consists of a common horizontal axis. The telescope support is fitted with an open sight, light projection unit, and angle-of-sight knob with scales.

(1) *Lower part*. A dovetail located on the right side of the mount fits into the sight socket on the sight mount assembly to secure the sightunit to the weapon.

(a) A dual-purpose locking device in the lower section of the mount locks the dovetail of the sightunit into the sight socket of the sight mount assembly. The locking device is also used to unlock the connection between the dovetail parts for disassembly.

(b) A semicircular, course elevation scale on the left side has 18 graduations, each graduation representing 100 mils. The graduations are numbered every 200 mils, from minus 2 through 0 to 16. Negative (red) readings are for depression; positive (black) readings are for elevation settings. A reference index is inscribed on the lower part of the casting. The scale settings can be adjusted by loosening the two attaching screws, slipping the scale, and tightening the screws.

(c) The elevation knob elevates or depresses the line of sight and is fitted with a crank handle for large changes. Secured to the elevation knob is an adjustable micrometer scale consisting of positive and negative readings, numbered in black for elevation and red for depression. The scale has 100 graduations, each representing 1 mil, and is numbered every 10 mils from 0 to 90. A reference index is inscribed on the main casting. To release the scale for slipping, two screws at the front of the elevation knob must be loosened. A device controlled by a locking knob prevents the elevation knob from rotating during firing.

(2) *Center part*. The fixed deflection scale is a nonslip scale of 64 red graduations, with each 400 mils numbered in red from 0 to 60. The scale rotates with the upper part of the telescope mount when the deflection knob is turned.

(a) The deflection knob is fitted with a crank for large changes. The index for the scale is on a stationary bracket which is bolted to the main casting. The deflection micrometer scale consists of 100 red graduations numbered from 0 to 90 in increments of 10 mils. This scale is fastened to the deflection knob. To slip the micrometer scale, two screws at the front of the deflection knob must be loosened. The scale is pushed toward the sightunit and rotated to the desired setting.

(b) The coarse deflection slip scale is a large circular scale retained in place by friction and located adjacent to the fixed deflection scale. The slip scale has 64 black graduations numbered every 200 mils. The index for the scale is engraved on the main casting. The coarse deflection setting can be changed by depressing the scale and turning.

(c) The adjustable micrometer deflection slip scale, also located on the deflection knob, has 100 black graduations numbered from 0 to 90 in increments of 10 mils. The scale is retained in place by friction. The scale is fitted with an index attached to the main housing.

(d) Two level vials, located 90 degrees apart on the main housing, are used for leveling the sightunit. Both vials have rotating metal covers to protect them from damage.

(3) *Upper part*. The telescope support is equipped with an open sight, clamping mechanism, and mechanism for adjusting the angle-of-sight reading change.

2-19. OPERATION OF M53 SIGHTUNIT

Operation of the M53 sightunit is described herein.

a. **Attaching the Sightunit**. Insert the dovetail of the telescope mount into the sight socket. Press the locking lever inward, seat the mount firmly, and release the locking lever.

Note: Until the baseplate is firmly seated, remove the sight from the mortar before firing each round.

b. **Placing Sightunit Into Operation**. Place the sightunit into operation as follows:

(1) *Setting for deflection.*

(a) To place a deflection setting on the sight, turn the deflection knob. This turns the elbow telescope, the coarse deflection scales, and the deflection micrometer scales. Before attempting to place a deflection setting on the sightunit, ensure that the deflection locking knob is released. After placing a setting on the sight, lock the locking knob to lock the data onto the sight and to ensure that the scale does not slip during firing.

(b) When setting the deflection, it is necessary to use the red fixed coarse scale and the red fixed micrometer scale to obtain the desired setting. Set the first two digits of the deflection on the coarse scale and the last two on the micrometer scale.

Note: The black coarse scale and the black micrometer scale are slip scales.

(c) Setting a deflection on the deflection scale does not change the direction in which the barrel is pointing (the lay of the mortar). It only moves the vertical line off (to the left or right) the aiming line. The deflection placed on the sight is the deflection announced in the fire command. Place a deflection on the sight before elevation.

(2) *Setting the elevation.*

(a) To set for elevation, turn the elevation knob. This operates both the elevation micrometer and coarse elevation scales. Both scales must be set properly to obtain the desired elevation. For example, to place elevation 1065 mils on the M53 sightunit, turn the elevation knob until the fixed index opposite the moving coarse elevation scale is between the black 1000- and 1100-mil graduations on the scale (the graduations are numbered every 200 mils, from minus 2 through 0 to 16), and the 65-mil mark on the elevation micrometer is opposite the fixed index. When making elevation settings, remember that the black numbers are for elevation and the red numbers are for depression.

(b) Setting an elevation on the elevation scale does not change the elevation of the mortar barrel. The elevation to be placed on the sight is announced in the fire command.

(c) Before setting elevations on the sight, unlock the elevation locking knob. Once the elevation is placed on the sight, lock the elevation locking knob. This ensures the data placed on the sight do not accidentally change.

c. **Replacing the sightunit in the carrying case**. Before returning the sightunit to the carrying case, close the covers on the level vials and set an elevation of 800 mils and deflection of 3800 mils on the scales. Place the elbow telescope in the left horizontal position. All crank handles should be folded into the inoperative position. The M53 instrument light is stored in the same case with the rheostat knob down.

2-20. CARE AND MAINTENANCE OF M53 SIGHTUNIT

Although the M53-series sightunits are rugged, if abused or handled roughly, the unit could be inaccurate or malfunction.

a. Avoid striking or otherwise damaging any part of the sight. Be particularly careful not to burr or dent the dovetail bracket. Avoid bumping the micrometer knobs, telescope adapter, and level vials. Except when using the sight, keep the metal vial covers closed.

b. Keep the sight in the carrying case when not in use. Keep it as dry as possible, and do not place it in the carrying case while it is damp.

c. When the sight fails to function correctly, return it to the DS maintenance unit for repair. Members of the mortar crew are **not** authorized to disassemble the sight.

d. Keep the optical parts of the telescope clean and dry. Remove dust from the lens with a clean camel's-hair brush. Use only lens cleaning tissue to wipe these parts. Do not use ordinary polishing liquids, pastes, or abrasives on optical parts. Use only authorized lens cleaning compound for removing grease or oil from the lens.

e. Occasionally oil only the sight locking devices by using a small quantity of light preservative lubricating oil. To prevent accumulation of dust and grit, wipe off excess lubricant that seeps from moving parts. Ensure that no oil gets on the deflection and elevation scales. (Oil removes the paint from the deflection scale.) No maintenance is authorized.

2-21. SIGHTUNIT, M64-SERIES

The sightunit (Figure 2-13) is the device on which the gunner sets deflection and elevation to hit targets by using the elevation level vial and the cross-level vial. After the sight has been set for deflection and elevation, the mortar is elevated or depressed until the elevation bubble on the sight is level. The mortar is then traversed until a proper sight picture is seen (using the aiming posts as the aiming point) and cross-level bubble is level. The mortar is laid for deflection and elevation when all bubbles are level. After the ammunition has been prepared, it is ready to be fired.

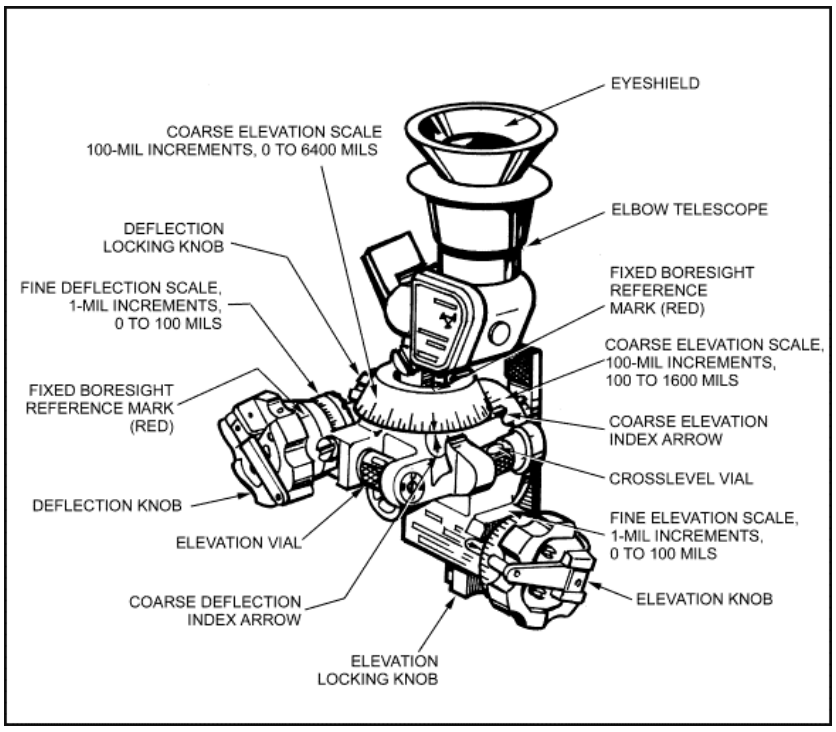

Figure 2-13. Sightunit, M64-series.

a. **Major Components**. The two major components are the elbow telescope and sight mount. The elbow telescope has an illuminated cross line. The sight mount has a dovetail, locking knobs, control knobs, scales, cranks, and locking latch.

(1) *Dovetail*. The dovetail is compatible with standard US mortars. When the dovetail is properly seated in the dovetail slot, the locking latch clicks. The locking latch is pushed toward the barrel to release the sight from the dovetail slot for removal.

(2) *Locking knobs*. The red locking knobs lock the deflection and elevation mechanisms of the sight during firing.

(3) *Micrometer knobs*. The elevation and deflection micrometer knobs are large for easy handling. Each knob has a crank for large deflection and elevation changes.

(4) *Scales*. All scales can be adjusted to any position. Micrometer scales are white. The elevation micrometer scale and fixed boresight references (red lines) above the coarse deflection scale and adjacent to the micrometer deflection scale are slipped by loosening slot-headed screws. Coarse deflection scales and micrometer deflection scales are slipped by depressing and rotating. The coarse elevation scale is factory set and should not be adjusted at crew level. (If the index does not align with the coarse elevation scale within ±20 mils when boresighting at 800 mils, DS-level maintenance should be notified.) The screws that maintain the coarse elevation scale are held in place with locking compound. If the screws are loosened and then tightened without reapplying the locking compound, the coarse elevation scale can shift during firing.

b. **Illumination**. Instrument lights are not needed when using the sightunit at night. Nine parts of the sight are illuminated by tritium gas.

- Telescope.
- Coarse elevation scale.
- Coarse elevation index arrow.
- Elevation vial.
- Fine elevation scale.
- Coarse deflection index arrow.
- Cross-leveling vial.
- Fine deflection scale.
- Coarse deflection scale.

c. **Tabulated Data**. The tabulated data of the M64-series sightunit are as follows:

Weight: 2.5 pounds (2.2 kilograms).
Field of view: 17 degrees (302 mils).
Magnification: 1.5 unity power.
Length: 4 3/8 inches (11 centimeters).
Width: 4 3/4 inches (12 centimeters).
Height: 7 3/8 inches (19 centimeters).
Light source: Self-contained, radioactive tritium gas (H3).

CAUTION
When not in use, store the sightunit in its carrying case.

d. **Safety Precautions**. The radioactive material used in the sightunit for illumination during night operations is tritium gas (H^3), which is sealed in glass tubes. The gas is not hazardous when intact. If there is no illumination, the RPO or NBC officer should be notified.

WARNING

Do not try to repair or replace the radioactive material. If skin contact is made with tritium, wash the area immediately with nonabrasive soap and water.

(1) *Identification.* Radioactive self-luminous sources are identified by means of warning labels (Figure 2-14), which should not be defaced or removed. If necessary, they must be replaced immediately.

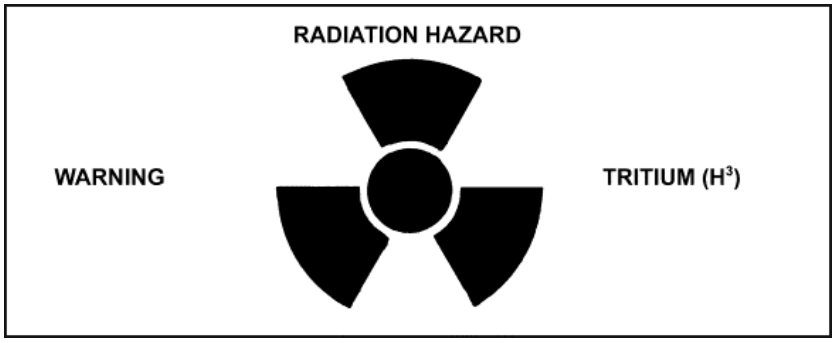

Figure 2-14. Warning label for tritium gas (H^3).

(2) *Storage and shipping.* All radioactively illuminated instruments or modules that are defective must be evacuated to a depot maintenance activity. Defective items must be placed in a plastic bag and packed in the shipping container from which the replacement was taken. Spare equipment must be stored in the shipping container as received until installed on the weapon. Such items should be stored in an outdoor shed or unoccupied building.

Note: For information on first aid, see FM 21-11.

2-22. SIGHTUNIT, M67

The M67 sightunit (Figure 2-15) is used to lay the M120/M121 mortar for deflection and elevation. Lighting for night operations using the sightunit is provided by radioactive tritium gas contained in phosphor-coated glass vials. The sightunit is lightweight and portable. It is attached to the bipod mount by means of a dovetail. Coarse elevation and deflection scales and fine elevation and deflection scales are used in conjunction with elevation and deflection knob assemblies to sight the mortar system.

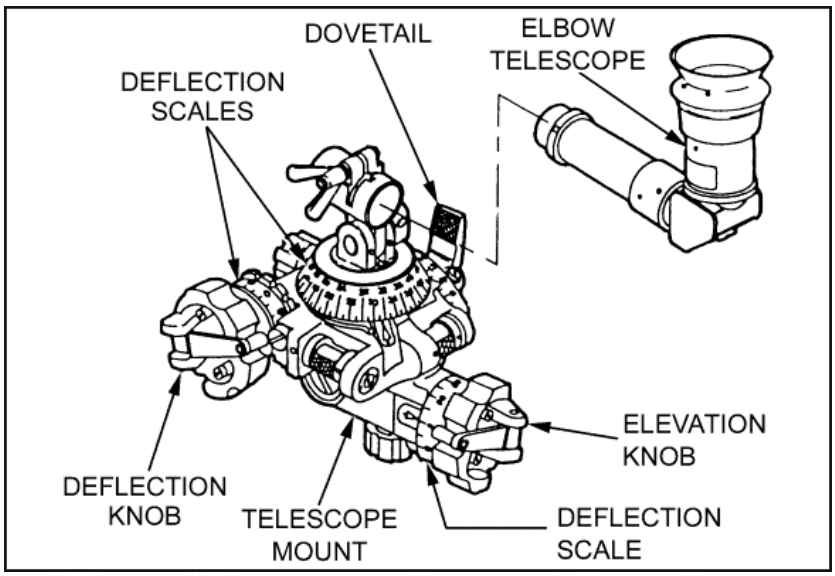

Figure 2-15. M67 sightunit.

a. **Major Components.** The M67 sightunit consists of two major components: the elbow telescope and the telescope mount.

(1) *Elbow telescope.* The elbow telescope is 4.0-power, hermetically sealed with a tritium illuminated crosshair reticle.

(2) *Telescope mount.* The telescope mount, provided with tritium back-lighted level vials, indexes, and translucent plastic scales, is used to orient the elbow telescope in azimuth and elevation.

CAUTION
When not in use, store the sightunit in its carrying case.

b. **Equipment Data.** The equipment data for the M67 sightunit are as follows:

Field of view	10 degrees
Magnification	4.0 X nominal 3.5 effective

Dimensions	4 3/8 x 5 3/8 x 8 1/2 inches (11.1 x 13.7 x 21.6 centimeters)
Illumination	Self-illuminated 6 to 8 years service life
Weight	2.9 pounds (1.3 kilograms)
Radioactive material	5.79 curies of tritium

c. **Safety Precautions.** The radioactive material used in the sightunit for illumination during night operations is tritium gas (H^3), which is sealed in glass tubes. The gas is not hazardous as long as the glass tubes are intact. If there is no illumination, the RPO or NBC officer should be notified. Radioactive self-luminous sources are identified by means of warning labels (Figure 2-14), which should not be defaced or removed. These warning labels should be replaced as necessary.

WARNING

Do not try to repair or replace the radioactive material. If skin contact is made with tritium, wash the area immediately with nonabrasive soap and water.

Section IV. BORESIGHTS

Boresights are adjusted by the manufacturer and should not require readjustment as a result of normal field handling.

2-23. BORESIGHT, M45-SERIES

The boresight, M45-series, detects deflection and elevation errors in the sight.

a. **Components**. The boresight, M45, (Figure 2-16) consists of an elbow telescope, telescope clamp, body, two strap assemblies, and clamp assembly.

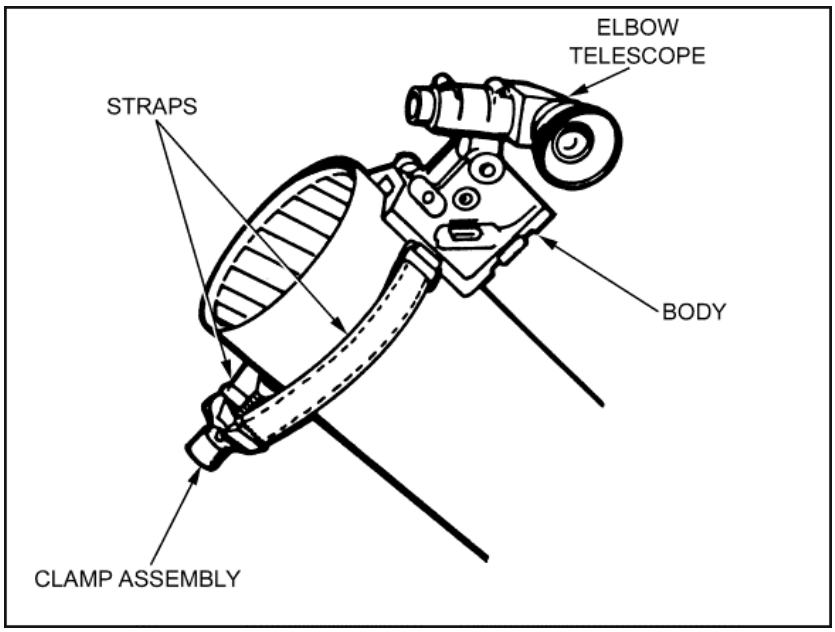

Figure 2-16. Boresight, M45.

(1) The elbow telescope establishes a definite line of sight.

(2) The telescope clamp maintains that line of sight in the plane established by the centerline of the V-slides.

(3) The body incorporates two perpendicular V-slides. It contains level vials (preset at 800 mils elevation) that are used to determine the angle of elevation of 800 mils and whether the V-slides are in perpendicular positions. It also provides the hardware to which the straps are attached.

(4) Two strap assemblies are supplied with each boresight and marked for cutting in the field to the size required for any mortar.

(5) The clamp assembly applies tension to the strap assemblies to secure the boresight against the mortar barrel.

b. **Tabulated Data**. The tabulated data of the M45-series boresight are as follows:

Weight: 2.5 pounds

Field of View: 12 degrees
Magnification: 3 power

2-24. BORESIGHT, M115

The boresight, M115, (Figure 2-17) detects deflection and elevation errors in the sight. The boresight has three plungers that keep it in place when mounted in the muzzle of the barrel. The telescope has the same field of view and magnification as the M64-series sightunit. The elevation bubble levels only at 0800 mils.

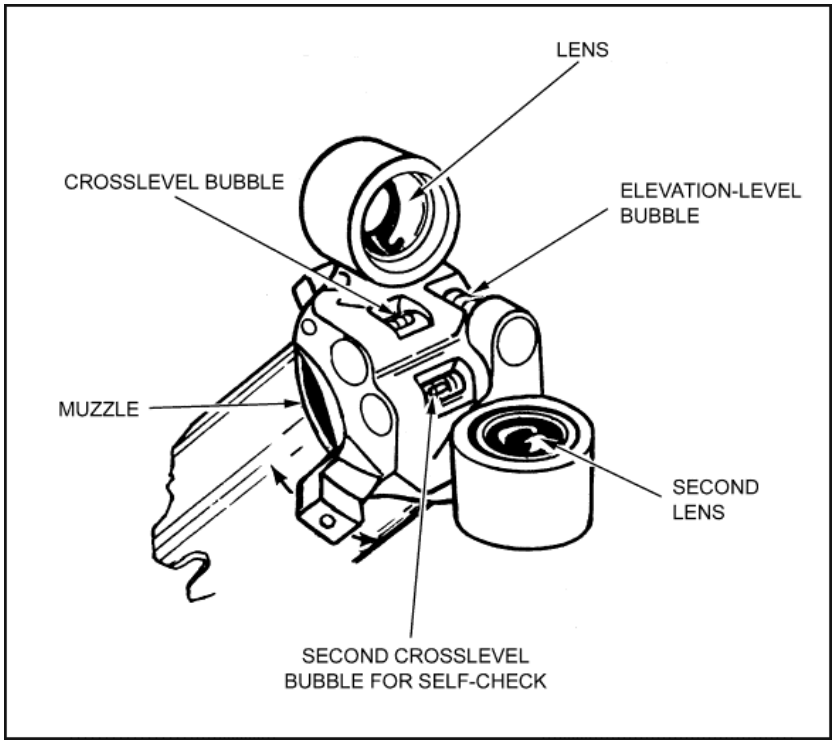

Figure 2-17. Boresight, M115.

a. **Second Cross-level Bubble**. A second cross-level bubble is used as a self-check of the M115. After leveling and cross-leveling, the M115 can be rotated 180 degrees in the muzzle until the second cross-level bubble is centered. The

image of the boresight target should not vary in deflection. A large deviation indicates misalignment between the cross-level bubble and lenses.

b. **Components**. The components of the M115 boresight are the body, telescope, and leveling bubbles (one for cross-leveling and one for elevation).

c. **Tabulated Data.** The tabulated data of the M115 boresight are as follows:

Weight:	5 ounces
Field of view:	17 degrees
Magnification:	1.5 power

2-25. PRINCIPLES OF OPERATION

The boresight is constructed so that the telescope line of sight lies in the plane established by the center lines of the V-slides. When properly secured to a mortar barrel, the centerline of the contacting V-slide is parallel to the centerline of the barrel. Further, the cross-level vial, when centered, indicates that the center lines of both slides, the elbow telescope, and the barrel lie in the same vertical plane. Therefore, the line of sight of the telescope coincides with the axis of the barrel, regardless of which V-slide of the boresight is contacting the barrel. The elevation vial is constructed with a fixed elevation of 800 mils.

2-26. INSTALLATION

Installation procedures for the M45 boresight are described herein.

a. Remove the boresight, clamp assembly, and straps from the carrying case. Grasp the boresight by the body to prevent damaging the telescope.

b. Place the ring over the hook and attach the strap snap to the eye provided on the strap shaft.

c. If necessary, release the catches and reset the straps to the proper length.

d. Remove any burrs or projecting imperfections from the seating area of the mortar barrel to ensure proper seating of the boresight. Attach the boresight to the barrel below and touching the upper stop band on the M252 mortar. However, attach the boresight about 1 inch from the muzzle of the barrel on all other mortars.

Note: For further information, see TM 9-1240-278-12.

2-27. SIGHT CALIBRATION

Always calibrate the mortar sight to the mortar on which it is to be mounted. This procedure is necessary since the sight socket that receives the sightunit is a machined part and varies in accuracy with each mortar. There is no set rule for frequency of calibration. The sight should be calibrated each time the mortar is mounted in a new location, since the movement might disturb the setting of the elevation and deflection scales. Time available and accuracy dictate the frequency of calibration.

2-28. BORESIGHT METHOD OF CALIBRATION

Once the mortar has been mounted, place the M53-, M64-, or M67-series sightunit into position in the sight socket. Using the M53- (fixed deflection [red] scale), the M64-, or the M67-series sightunit, place a deflection of 3200 mils and an elevation of 0800 mils on the scales. For the M252 mortar, place a deflection of 0 mils on the sight. Align the vertical cross line of the sight on an aiming point (at least 200 meters distant) by shifting the bridge assembly or bipod. If necessary use the traversing mechanism; however, keep the mortar within two turns of center of traverse (four turns of center of traverse for the 120-mm mortar). Make a visual check of the mortar for cant; if cant exists, remove this cant and re-lay, if necessary.

Note: For a detailed discussion of the boresight method of calibration, see applicable TM.

a. **Elevation Setting**.

(1) Install the boresight on the mortar barrel. Center the cross-level vial by rotating the boresight slightly around the outside diameter of the mortar barrel. Slight movements are made by loosening the clamp screw and lightly tapping the boresight body. When the bubble centers, tighten the clamp screw.

(2) Elevate or depress the mortar barrel until the boresight elevation level vial is centered. The mortar is now set at 800 mils (45 degrees) elevation.

(3) Using the elevation micrometer knob, elevate or lower the sightunit until the elevation level bubble is centered. If necessary, cross-level the sightunit.

(4) Recheck all level bubbles.

(5) The reading on the coarse elevation scale of the sightunit should be 800 mils and the reading on the elevation micrometer scale should be 0. If adjustment is necessary, proceed as indicated below.

(a) Loosen the two screws that secure the coarse elevation scale and slip the scale (for the M53-series sightunit only) until the 800-

mil mark on the scale coincides with the reference mark on the housing. Tighten the two screws to secure the scales.

Note: Do not adjust the M64-series sightunit coarse elevation scale. If it does not line up with the 0800-mil mark, turn it in to DS maintenance.

(b) Loosen the two screws on the elevation micrometer knob and slip the elevation micrometer scale until the 0 mark on the micrometer scale coincides with the reference mark on the housing. Tighten the two screws to secure the micrometer scale.

(6) Recheck all level bubbles.

b. **Deflection Setting**.

(1) Check again to ensure that the sight setting reads 3200 on the fixed deflection (red) scale and elevation 800 mils. Set zero deflection for the M252 mortar.

(2) Traverse the mortar no more than two turns of center of traverse (four turns for the 120-mm mortar) and align the vertical cross line of the boresight on the original aiming point. Adjust the boresight to keep the cross-level bubble centered since the mortar could cant during traversing. (If the mortar is initially mounted on the aiming point, it decreases the amount of traverse needed to align the cross line on the aiming point.) Also, the elevation level bubble may need to be leveled.

(3) After the boresight is aligned on the aiming point, level the sight by centering the cross-level bubble. Rotate the deflection micrometer knob until the sight is aligned on the aiming point. The coarse deflection scale should read 3200 mils and the micrometer scales should read 0. If adjustment is necessary, loosen the two screws on the deflection micrometer knob and slip the micrometer deflection scale until the arrow on the index is aligned with the zero mark on the micrometer scale.

(4) To ensure proper alignment, remove and place the boresight in position underneath the barrel as shown in Figure 2-18. Center the boresight cross-level bubble and check the vertical cross line to see if it is still on the aiming point. If cant exists, the vertical cross line of the boresight is not on the aiming point. This indicates that the true axis of the bore lies halfway between the aiming point and where the boresight is now pointing.

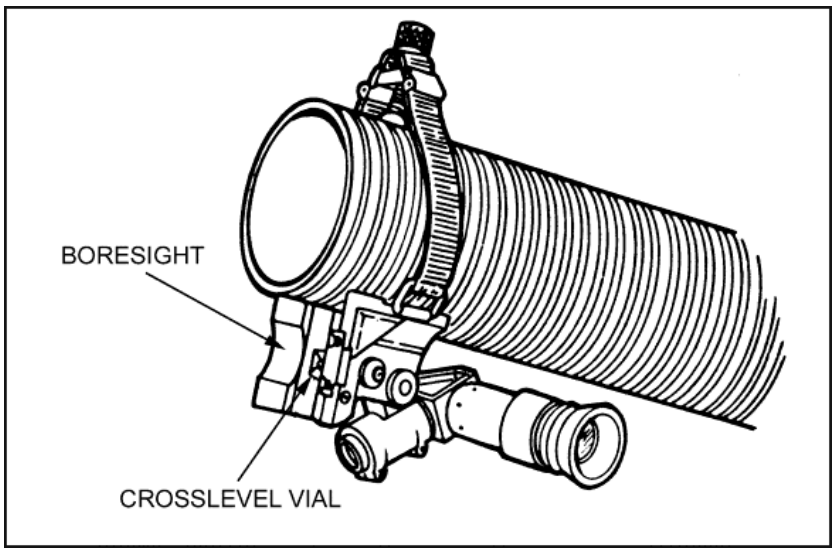

Figure 2-18. Checking for proper alignment with the boresight device.

(5) To correct this error, look through the boresight, traverse the mortar onto the aiming point. If bubbles are level, use the deflection micrometer knob and place the vertical cross line of the sight back onto the aiming point. With the sight in this position, index one-half of the mil variation between the sight and boresight. Slip zero on the micrometer scale to the index mark--for example, the mil variation is 10 mils and one-half of this value is 5 mils. Loosen the two screws on the deflection micrometer and index zero.

(6) Check all level bubbles, sightunit, and boresight.

(7) With a deflection on the micrometer scale of half the value of the original mil variation, both the sightunit and boresight are on the aiming point. If an error exists, repeat the procedure outlined above.

(8) Using the M64-series sightunit, adjust the deflection scale and micrometer scale of the sightunit to zero. To do this, loosen the deflection knob screws and slip the scale to zero. Adjust the deflection micrometer scale to zero by pushing in on the micrometer knob retaining button and slipping the scale to zero.

(9) Check again all level bubbles, and the lay of the sightunit and the boresight on the aiming point.

Note: The M53-series sightunit should be received from the manufacturer with the red deflection scale calibrated on 3200. If it is not, turn the sightunit in to DS maintenance for calibration.

c. **Removal**.

(1) Loosen the clamp screw, releasing the boresight from the barrel.

(2) Swing the elbow telescope until it is about parallel with the elevation level bubble.

(3) Release the clamp assembly and straps by removing the ring from the hook and strap shaft.

(4) Stow the clamp assembly and straps in the corner compartment. Put the boresight in the center compartment of the carrying case.

2-29. CALIBRATION FOR DEFLECTION USING THE M2 AIMING CIRCLE

Two methods can be used to calibrate the sight for deflection using the M2 aiming circle: the angle method (Figure 2-19) and the distant aiming point method (Figure 2-20).

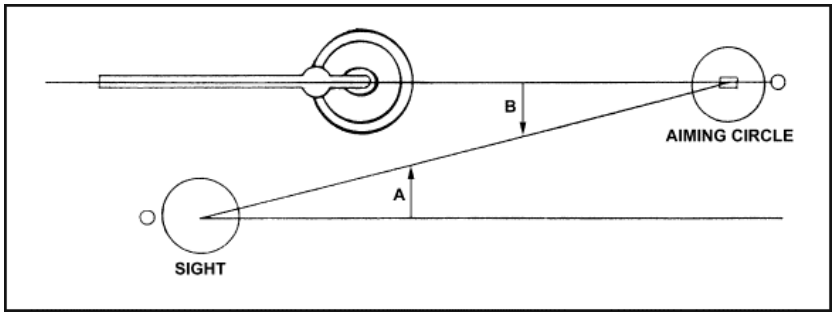

Figure 2-19. Calibration for deflection using the angle method.

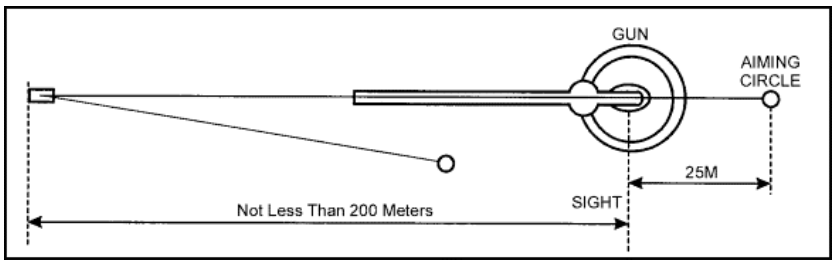

Figure 2-20. Calibration for deflection using the distant aiming point method.

a. **Calibration for Deflection Using the Angle Method.**

(1) Set up the aiming circle 25 meters to the rear of the mounted mortar. (The mortar is mounted at 800 mils elevation.)

(2) With the aiming circle fine leveled, index 0 on the azimuth scale and azimuth micrometer scale. Using the orienting motion (nonrecording motion) align the vertical line of the reticle of the telescope so that it bisects the baseplate.

(3) Traverse and cross-level the mortar until the center axis of the barrel from the baseplate to the muzzle is aligned with the vertical line of the aiming circle telescope reticle.

(4) Turn the deflection knob of the sight until the vertical line is centered on the lens of the aiming circle and read angle A, opposite the fixed index.

(5) Turn the azimuth micrometer knob of the aiming circle until the vertical line of the telescope is laid on the center of the sight lens and read angle B, opposite the azimuth scale index. If the sight is in calibration, angles A and B will be equal. If they are not equal the sight is adjusted by loosening the two screws in the face of the deflection knob of the sight and slipping the micrometer deflection scale until the scale is indexed at the same reading as angle B of the aiming circle.

b. **Calibration for Deflection Using the Aiming Point Method.**

(1) Set up the aiming circle and fine level. Align the vertical line of the telescope on a distant aiming point (a sharp, distinct object not less than 200 meters in distance).

(2) Move the mortar baseplate until the baseplate is bisected by the vertical line of the telescope of the aiming circle. Mount the mortar at an elevation of 800 mils. Traverse and cross-level the mortar until the axis of

the barrel from the baseplate to the muzzle is bisected by the vertical line of the aiming circle (the mortar should be mounted about 25 meters from the aiming circle).

Note: Indexing the aiming circle at 0 is not necessary; only the vertical line is used to align the mortar with the distant aiming point.

(3) The aiming circle operator moves to the mortar and lays the vertical line of the sight on the same distant aiming point. If the sight is calibrated, the deflection scales of the sight are slipped to a reading of 3200.

Section V. OTHER EQUIPMENT

Other equipment required to operate and employ mortars are discussed in this section.

2-30. INSTRUMENT LIGHT, M53E1

The instrument light (Figure 2-21) illuminates the reticle of the M109 elbow telescope and scales of the M128 telescope mount during night operations. This instrument light is the standard night light used with the 4.2-inch and 120-mm mortars.

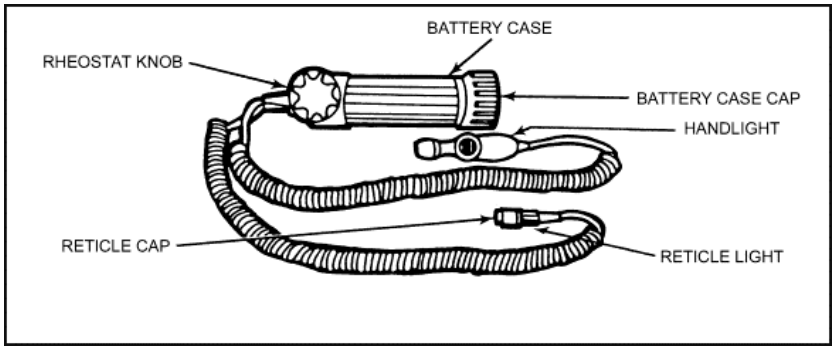

Figure 2-21. Instrument light, M53E1.

a. The light consists of mainly two flashlight batteries, battery case, rheostat knob, and two separate light assemblies attached to a pair of flexible lead wires that extend from one end of the battery case. Because the wires are coiled, the leads can be extended from a normal length of 2 feet to about 6 feet.

b. One light assembly consists of a bracket assembly that can be screwed into the lamp bracket holder for lighting the elbow telescope reticle. This light is turned on/off by the rheostat knob. The knob is also used to increase or decrease the

intensity of the illumination. The second light assembly is a hand light that can be directed upon the telescope mount scales or the level vials as required. The on/off switch for this light is located on the hand light.

c. To place the instrument light into operation (Figure 2-22), the cap is pressed inward at the end of the battery case and turned counterclockwise until free. Two BA-30 batteries are inserted terminal ends first. The cap is installed by turning clockwise until finger tight. Install the battery case of the light in the carrying case with the rheostat knob accessible. The carrying case is positioned so the lead wires reach the sightunit. The dust cover is removed from the lamp bracket holder of the M109 elbow telescope, and the protective cap is removed from the end of the light assembly lead. The end of the light assembly is threaded into the socket on the elbow telescope for illuminating the telescope reticle. The hand light is retained in the case until required for use. DO NOT ATTEMPT TO USE THE M53 LIGHT ON THE LIGHT PROJECTOR OF THE M53 SIGHT.

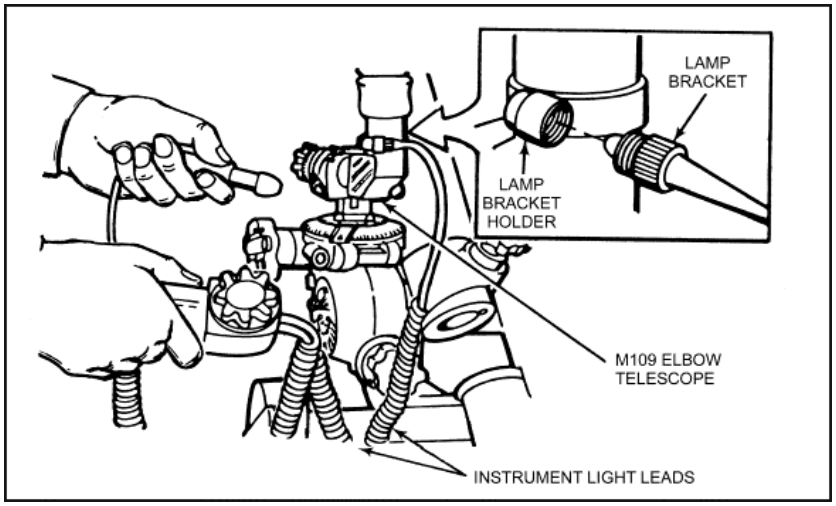

Figure 2-22. Installation of instrument light.

d. The M166 carrying case is a lightweight, sturdy case with an isofoam bed that provides storage for the M53 sightunit and the M53 instrument light (Figure 2-23).

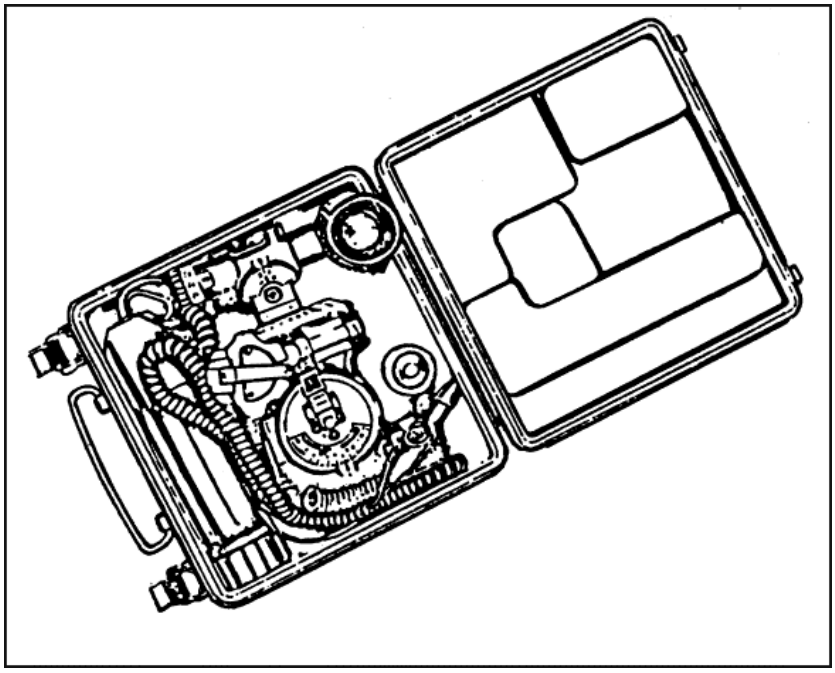

Figure 2-23. Carrying case, M166.

2-31. AIMING POSTS, M14 and M1A2

The M14 aiming posts (Figure 2-24) are used to establish an aiming point (reference line) when laying the mortar for deflection. They are made of aluminum tubing and have a pointed tip on one end. Aiming posts have red and white stripes so they can be easily seen through the sight. The M14 aiming post comes in a set of eight segments, plus a weighted stake for every 16 segments to be used as a driver in hard soil. The stake has a point on each end and, after emplacement, it can be mounted with an aiming post. The segments can be stacked from tip to tail, and they are carried in a specially designed case with a compartment for each segment. Four M1A2 aiming posts are provided with the mortar. They may be stacked end to end (two at most).

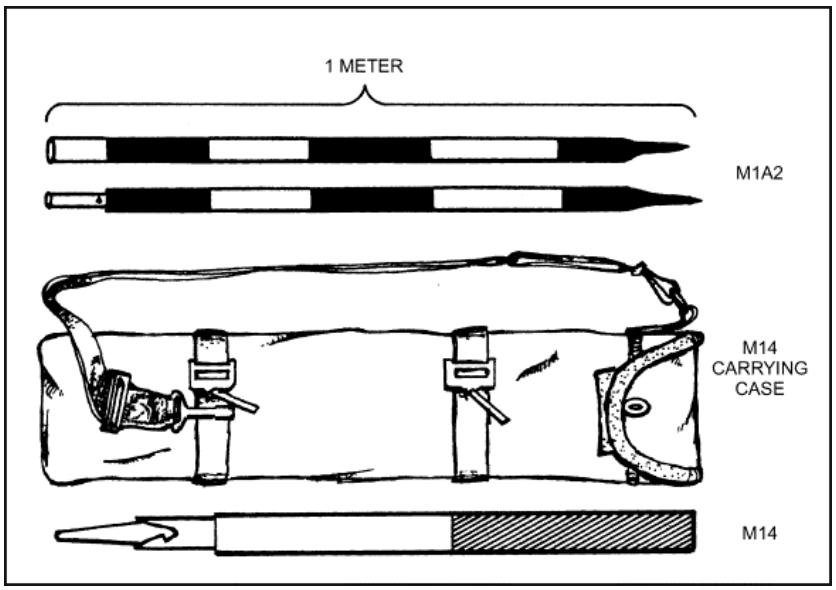

Figure 2-24. Aiming posts, M14 and M1A2.

2-32. AIMING POST LIGHTS, M58 and M59

Aiming post lights (Figure 2-25) are attached to the aiming posts so they can be seen at night through the sight. The near post must have a different color light than that of the far post. Aiming post lights come in sets of three--two green (M58) and one orange (M59). An extra third light is issued for the alternate aiming post. Each light has a clamp, tightened with a wing nut, for attachment to the aiming post. The light does not have a cover for protection when not in use and does not need batteries.

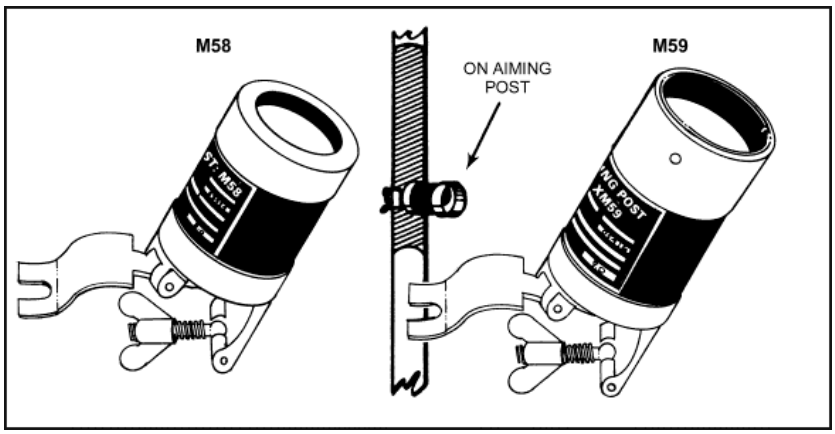

Figure 2-25. Aiming post lights, M58 and M59.

WARNING

Radioactive material (tritium gas [H3]) is used in the M58 and M59 aiming post lights. Radioactive leakage may occur if M58 and M59 aiming post lights are broken or damaged. If exposed to a broken or damaged M58 or M59 aiming post light or if skin contact is made with any area contaminated with tritium, immediately wash with nonabrasive soap and water, and notify the local RPO.

Section VI. LAYING THE SECTION

When all mortars in the section are mounted, the section leader lays the section parallel on the prescribed azimuth with an aiming circle. The mortar section normally fires a parallel sheaf (Figure 2-26). To obtain this sheaf, it is necessary to lay the mortars parallel. When a section moves into a firing position, the FDC determines the azimuth on which the section is to be laid and notifies the platoon sergeant (section sergeant). Before laying the mortars parallel, the section leader must calibrate the mortar sights. All mortars are then laid parallel using the aiming circle, mortar sight, or compass. The section is normally laid parallel by following two steps:

STEP 1: Establish the 0-3200 line of the aiming circle parallel to the mounting azimuth.

STEP Lay the section parallel to the 0-3200 line of the aiming circle

2: (reciprocal laying).

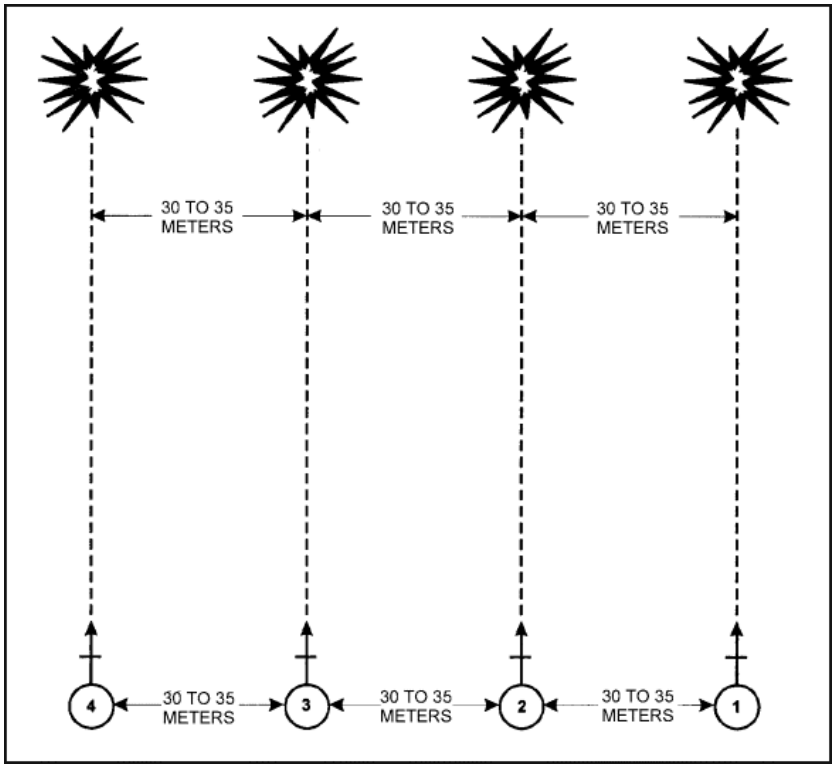

Figure 2-26. Parallel sheaf.

2-33. RECIPROCAL LAYING

Reciprocal laying is a procedure by which the 0-3200 line of one instrument (aiming circle) and the 0-3200 line of another instrument (sightunit) are laid parallel (Figure 2-27). When the 0-3200 lines of an aiming circle and the 0-3200 line of the sightunit are parallel, the barrel is parallel to both 0-3200 lines, if the sight has been properly calibrated. The principle of reciprocal laying is based on the geometric theorem that states if two parallel lines are cut by a transversal, the alternate interior angles are equal. The parallel lines are the 0-3200 lines of the instruments, and the transversal is the line of sight between the two instruments. The alternate interior angles are the equal deflections placed on the instruments

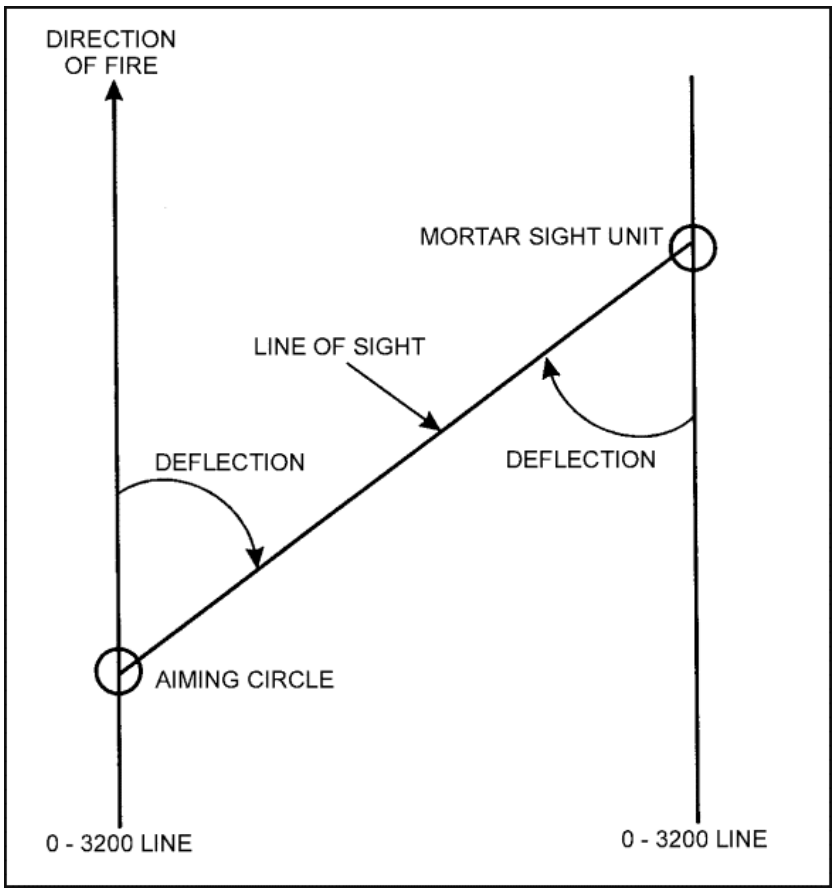

Figure 2-27. Principles of reciprocal laying.

a. Orient the aiming circle so that the 0-3200 line of the aiming circle is parallel to the mounting azimuth. The section leader announces to the mortar gunners (either by voice or visual signal), "Section, aiming point this instrument." The gunners turn their sights until the vertical cross line of the sight is sighted on the lens of the aiming circle and the mortar is level. The gunners announce (either by voice or visual signal), "Number (1, 2, and so on), aiming point identified." The section leader, using the upper motion, sights on the lens of the sightunit, reads the deflection on the azimuth micrometer scales, and announces the deflection to the gunner on the mortar. The gunner sets the deflection on the sightunit and causes

the mortar to be moved until the vertical cross line of the sight is sighted on the lens of the aiming circle and the mortar is level.

b. When the sight has been sighted on the aiming circle, the gunner reports, "Ready for recheck." The platoon sergeant (section sergeant) again sights on the lens of the sightunit, and reads and announces the deflection. This procedure is repeated until the gunner reports a difference of ZERO (or ONE) MIL between successive deflections. The mortar has then been laid.

2-34. RECIPROCAL LAYING ON A GRID AZIMUTH

This paragraph discusses the commands and procedures used in reciprocal laying of the mortar section on a given grid azimuth.

a. The FDC normally directs the section to lay the mortar parallel on a mounting (grid) azimuth.

b. The platoon sergeant (section sergeant) receives the command MOUNTING AZIMUTH FIVE FIVE FIVE ZERO (5550 mils) from the FDC.

(1) The mounting azimuth is 5550 mils, and the aiming circle has a declination constant of 450 mils.

Declination constant	450 mils
	+ 6400 mils
	6850 mils
Minus the mounting (grid) azimuth	- 5550 mils
Remainder to set on aiming circle	1300 mils

(2) The platoon sergeant (section sergeant) mounts and levels the aiming circle at a point from which he can observe the sights of all the mortars in the section (normally the left front or left rear of the section).

(3) He places 1300 mils on the azimuth and micrometer scales of the aiming circle (recording motion).

(4) Using the orienting knob, he centers the magnetic needle in the magnetic needle magnifier. This orients the 0-3200 line of the aiming circle in the desired direction (mounting azimuth 5550 mils).

(5) The platoon sergeant (section sergeant) announces, "Section, aiming point this instrument."

(6) All gunners refer their sights to the aiming circle with the vertical cross line laid on the center of the aiming circle. The gunner then announces, "Number two (one or three), aiming point identified."

(7) To lay the mortar barrel parallel to the 0-3200 line of the aiming circle (Figure 2-28), the platoon sergeant (section sergeant) turns the upper motion of the aiming circle until the vertical cross line is laid on the center of the lens of the mortar sight. He reads the azimuth and micrometer scales and announces the deflectionXfor example, "Number two, deflection one nine nine eight (1998)."

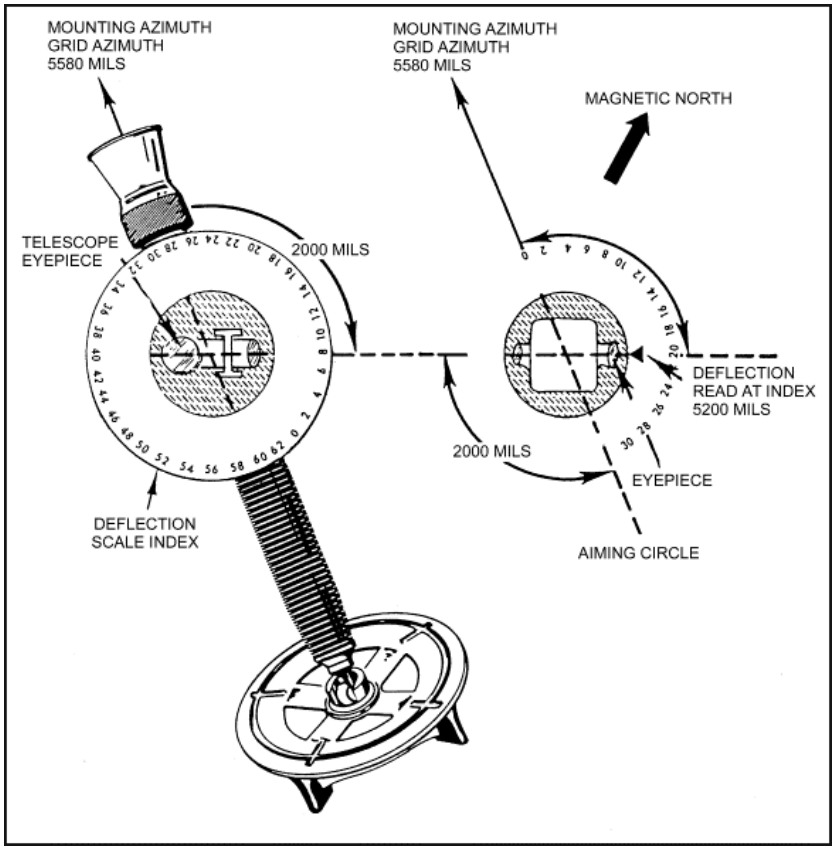

Figure 2-28. Mortar laid parallel with the aiming circle.

Note: When the M53 sightunit is used, it is calibrated at 3200 mils on the red deflection and micrometer scales. All readings from the aiming circle to the sight are placed on the red deflection scale and the mortar is laid on the aiming circle using this scale.

(8) The gunner repeats the announced deflection, "Number two, deflection one nine nine eight," and places it on his sight. Assisted by the assistant gunner, he lays the mortar so that the vertical line is once again laid on the center of the aiming circle after the gunner announces, "Number two, ready for recheck."

(9) Using the upper motion, the platoon sergeant (section sergeant) again lays the vertical cross line of the aiming circle on the lens of the mortar sight. He reads the new deflection from the azimuth and micrometer scales and announces the reading--for example, "Number two, deflection two zero zero zero."

(10) The gunner repeats the new deflection (Number two, deflection two zero zero zero) and places it on his sight. Assisted by the assistant gunner, he lays the mortar with the vertical cross line of the sight on the center of the aiming circle and announces, "Number two, ready for recheck."

(11) The above procedure is repeated until the mortar sight and aiming circle are sighted on each other with a difference of not more than ONE mil between the deflection readings. When so laid, the gunner announces, "Number two (one or three), zero mils (one mil), mortar laid." The mortar barrel is now laid parallel to the 0-3200 line of the aiming circle.

(12) The platoon sergeant (section sergeant) uses the same procedure to lay each of the other mortars in the section parallel. When all mortars are parallel to the 0-3200 line of the aiming circle, they are parallel to each other and laid in the desired azimuth (Figure 2-29).

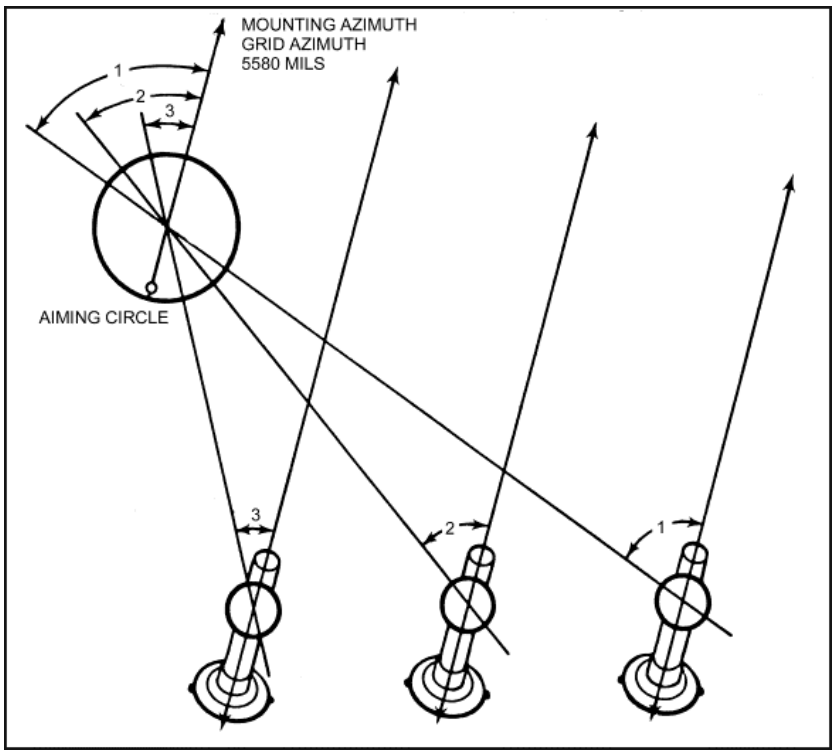

Figure 2-29. Mortars laid parallel in the desired azimuth.

Note: The section can be laid parallel by laying all mortars at the same time. The instrument operator reads deflections to each of the mortars in turn. As soon as the gunner of any mortar announces, "Ready for recheck," the instrument operator reads the new deflection to that mortar. By laying all mortars at the same time, the section is quickly ready to fire.

(13) As soon as each mortar is laid, the platoon sergeant (section sergeant) commands DEFLECTION TWO EIGHT ZERO ZERO (2800), REFER, PLACE OUT AIMING POSTS. (The aiming posts are normally placed out on a referred deflection of 2800 mils.) The gunner, without disturbing the lay of the mortar, places the announced deflection on his sight and aligns the aiming posts with the vertical line of the mortar sight. He then announces, "Up."

(14) When all mortar gunners announce, "Up," the instrument operator covers the head of the aiming circle, but leaves the instrument in position to permit a rapid recheck of any mortar, if necessary.

2-35. RECIPROCAL LAYING ON A MAGNETIC AZIMUTH

Although the section is normally laid parallel on a grid azimuth, it can be laid parallel on a magnetic azimuth by subtracting the magnetic mounting azimuth from 6400 mils and by setting the remainder on the azimuth and micrometer scales of the aiming circle. The section leader orients the instrument and lays the section.

2-36. RECIPROCAL LAYING USING THE ORIENTING ANGLE

The mortars of each section can be laid parallel more accurately if the instrument operator lays the section parallel by using the orienting angle. He sets up and levels the aiming circle; orients the aiming circle, and lays the section.

2-37. RECIPROCAL LAYING USING THE MORTAR SIGHTS

The mortar section can be laid parallel by using the mortar sights. For this method, it is best to have the mortars positioned so that all sights are visible from the base mortar. The base mortar (normally No. 2) is laid in the desired direction of fire by compass or by registration on a known point. After the base mortar is laid for direction, the remaining mortars are laid parallel to the base mortar as follows:

a. The platoon sergeant (section sergeant) moves to the mortar sight of the base mortar and commands SECTION, AIMING POINT THIS INSTRUMENT. The gunners of the other mortars refer their sights to the sight of the base mortar and announce, "Aiming point identified."

b. The platoon sergeant reads the deflection from the red scale on the sight of the base mortar. He then determines the back azimuth of that deflection and announces it to the other gunners.

Note: A back azimuth is determined by adding or subtracting 3200 to the initial deflection--for example, "Number three, deflection one two zero zero."

c. Each gunner repeats the announced deflection for his mortar, places the deflection on his sight (using the red fixed scale), and re-lays on the sight of the base mortar. When the lens of the base mortar sight is not visible, the gunner lays the vertical cross line of his sight on one of the other three mortar sights (Figure 2-30). He is laid in by this mortar once it is parallel to the base mortar sightunit. He then announces, "Number one (or three), ready for recheck."

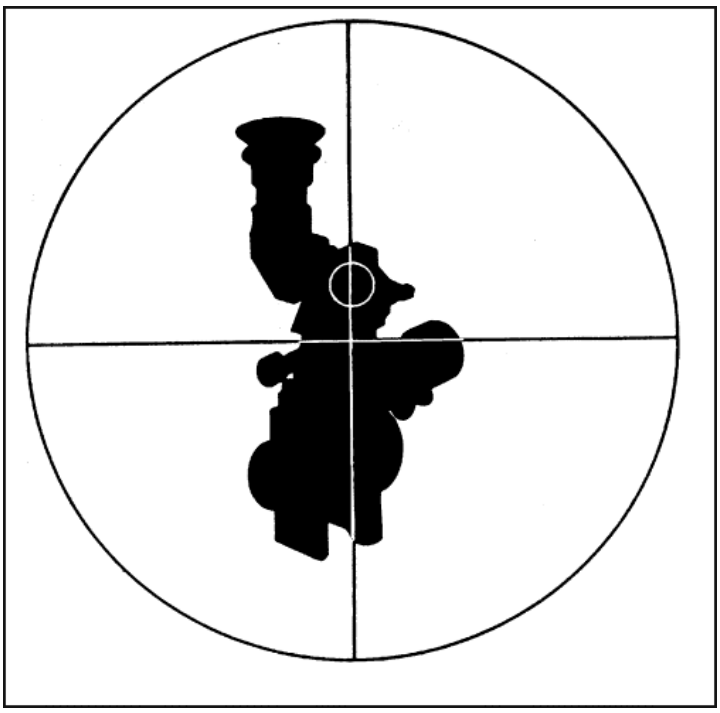

Figure 2-30. Sighting on the mortar sight.

d. After each mortar has been laid parallel within zero (or one mil), the mortar barrels are parallel to the base mortar (Figure 2-31).

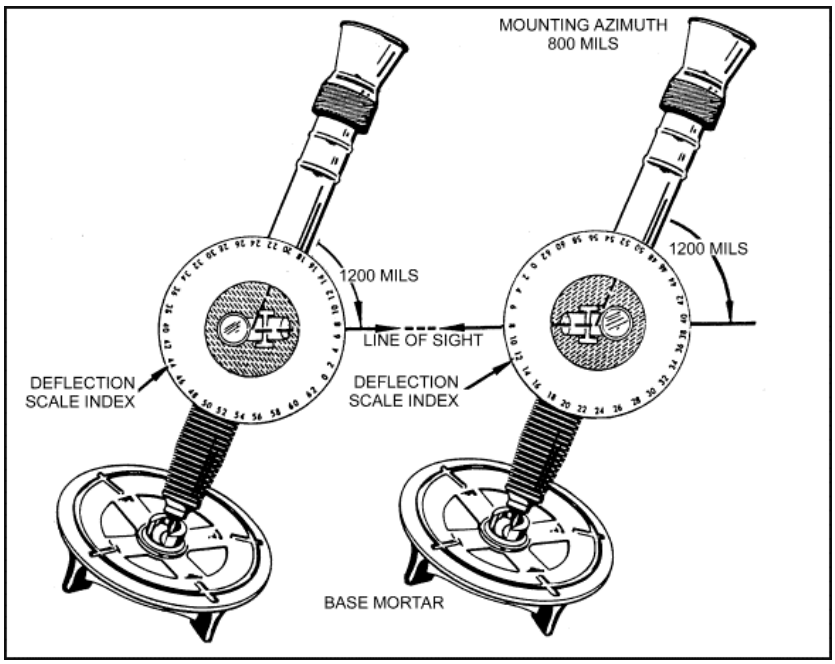

Figure 2-31. Mortar laid parallel with sights.

e. As soon as each mortar is laid, the platoon sergeant (section sergeant) commands NUMBER THREE, DEFLECTION TWO EIGHT ZERO ZERO (2800), REFER, PLACE OUT AIMING POSTS.

2-38. RECIPROCAL LAYING USING THE M2 COMPASS

A rapid means of laying the section parallel is by using the compass. This is an alternate means and is used only when an aiming circle is not available or when time dictates. It is not as accurate as the methods previously described.

a. Before mounting the mortars, each squad leader places a base stake in the ground to mark the approximate location of the mortar.

b. The platoon sergeant (section sergeant) announces the desired mounting azimuth--for example, "Mount mortars, magnetic azimuth two two one two."

c. Each squad leader places his compass on the base stake marking the location of his mortar, and orients the compass on the desired mounting azimuth. By sighting

through the compass, he directs the second ammunition bearer in aligning the aiming posts along the mounting (magnetic) azimuth.

d. Each mortar is then mounted and laid on the aiming posts with a deflection of 3200 (zero on the M64-series sight) placed on the sight. If no mechanical or human error exists, the mortar barrels are now laid parallel. (This is normally not true, however, since both mechanical and human error usually exist.)

Note: Recognizing the difference in individual compasses, the platoon sergeant (section sergeant) can prescribe that all mortars be laid with one compass. This eliminates some mechanical error. It is also possible to lay only the base mortar as described above and then lay the remaining mortars parallel using the mortar sight method. The compass method is used only when the aiming circle or mortar sight method is not practical.

2-39. PLACING OUT AIMING POSTS

When a firing position is occupied, the gunner must determine in which direction the aiming posts are to be placed out. Factors to consider are terrain, sight blockage, and traffic patterns in the section area. If possible, the aiming posts should be placed out to the left front. This direction gives a large latitude in deflection change before sight blockage occurs. Also, the aiming posts do not interfere with the traffic pattern of troops and vehicles within the section area. Under normal conditions the front aiming post is placed out 50 meters and the far aiming post 100 meters.

a. When the black deflection scales and red line scales numerically coincide, local terrain features may not permit placing out the aiming posts at a referred deflection of 2800 mils. When this occurs, the following procedure is used:

Note: This is constant only with the M64 sightunit.

(1) Determine the general direction to properly place out aiming posts that allows a maximum traverse before encountering a sight block.

(2) Refer the sight to that general direction and index any deflection to the nearest 100 mils.

(3) Place out the aiming posts.

(4) Record the deflection reading on the red scales.

b. The black deflection scale of the M64 sightunit must be slipped when the mortar section is being used in a 6400-mil capability.

(1) After the mortar is initially laid for direction, rotate the deflection micrometer knob until the deflection scale is set on 2800 mils. Place out two aiming posts to the left front.

(2) Using the deflection course scale, index a deflection of 700 mils and place out two more aiming posts to the right rear.

(3) Be sure to use ONLY the aiming posts placed out at 2800 mils for the front reference points. Use the aiming posts placed out at 700 mils for the rear reference points.

Note: To ensure that the gunners are on the appropriate aiming posts, the section leader may direct that each mortar squad place out cardinal direction stakes around its mortar position. He should also announce the general direction of fire before giving the initial fire command.

c. When the M64 sightunit is used within the same firing section that is being used in a 6400-mil capability, the gunner must slip the black deflection scale of the sightunit so that 0 mils on the black deflection scale coincides with the red 3200-mil line.

d. When the section is laid parallel, the rounds usually land in the impact area the same distance apart as the mortars are mounted (25 to 30 meters). When they do not, the FO must adjust the sheaf.

(1) Sheaf adjustment is normally accomplished after the base mortar is adjusted on the registration point. The section leader has the section fire a section right (left) with the same charge and deflection setting as the base mortar (No. 2). The FO adjusts mortar No. 1 until it is in its proper position in the sheaf. Any adjustment of either mortar results in that mortar having a different deflection. This makes it necessary to announce a different deflection for each mortar to fire two mortars as a section. To avoid that complication, the sights are referred so that each sight has the same deflection reading.

(2) At the completion of the adjustment, the FDC commands SECTION, REFER DEFLECTION, (FDC gives the deflection of the base No. 2 mortar), REALIGN AIMING POSTS. The gunner refers his sight to the deflection setting and, without disturbing the lay of the mortar, directs the ammunition bearer in moving the aiming posts until they are aligned with the vertical cross line of the sight. The barrels of the mortars are parallel, and each mortar has the same deflection reading.

2-40. ALTERNATE METHOD OF PLACING OUT AIMING POSTS

After the section leader has laid the section for direction, he commands SECTION, REFER DEFLECTION (normally, TWO EIGHT ZERO ZERO), PLACE OUT AIMING POSTS. The gunner determines which general direction will enable him to place out his aiming posts and still allow a maximum traverse before encountering a sight block. He refers the sight to that direction and indexes any deflection to the nearest 100 mils. He then places out the aiming posts, assisted by the ammunition bearer, and informs the section leader of his deflection (Figure 2-32).

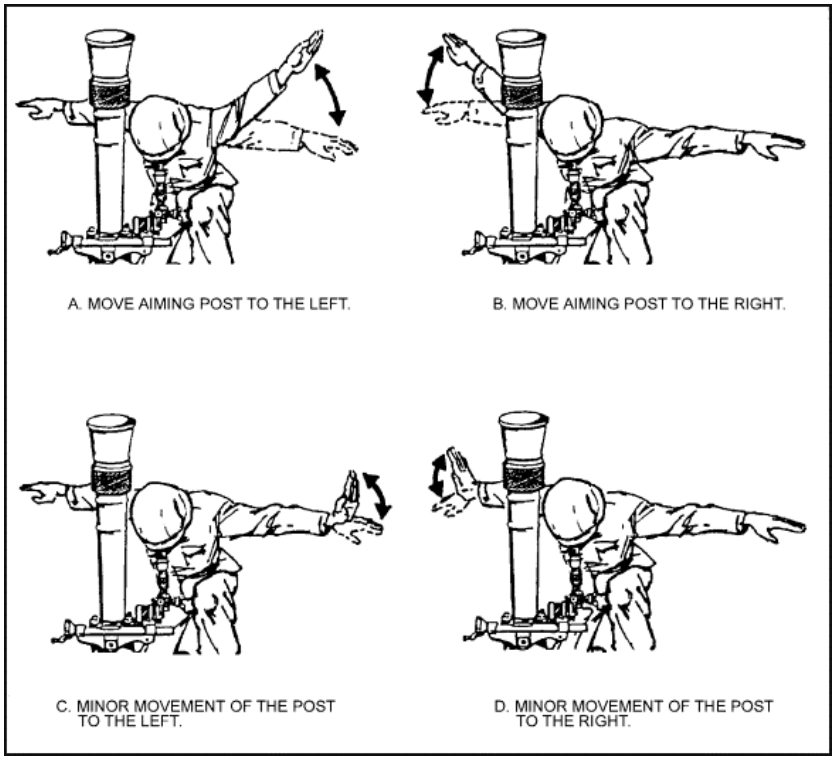

Figure 2-32. Arm-and-hand signals used in placing out aiming posts.

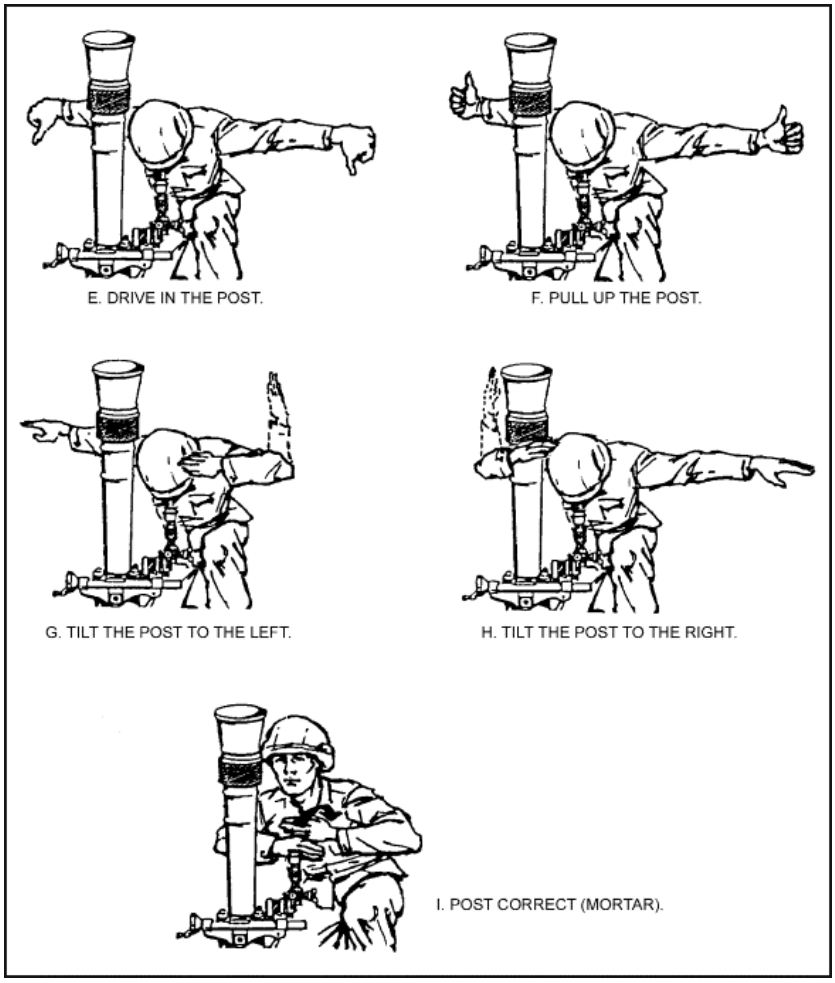

Figure 2-32. Arm-and-hand signals used in placing out aiming posts (continued).

a. Two more aiming posts must be placed out to prevent a sight block if the mortar is used in a 6400-mil capability. The section sergeant must then select an area to the rear of each mortar where aiming posts can be placed on a common deflection for all mortars. A common deflection of 0700 mils is preferred; however, any common deflection to the rear may be selected when obstacles,

traffic patterns, or terrain prevent use of 0700 mils. If the black deflection scale is moved, it can easily be re-indexed on the referred deflection.

b. After the section leader has laid the section for direction, he commands SECTION, REFER DEFLECTION (normally, TWO EIGHT ZERO ZERO), PLACE OUT AIMING POSTS. The initial steps are the same as those given above. The gunner refers the sight to the back deflection of the referred deflection and directs the ammunition bearer to place out two aiming posts 50 and 100 meters from the mortar position. If the gunner receives a deflection that would be obscured by the barrel, he indexes the referred back deflection, and lays in on the rear aiming post.

2-41. CORRECTION FOR DISPLACEMENT OF SIGHT

In laying the mortar for direction, the two aiming posts do not always appear as one when viewed through the sight(s). This separation is caused by one of two things: either a large deflection shift of the barrel or a rearward displacement of the baseplate assembly caused by the shock of firing.

a. When the aiming posts appear separated, the gunner cannot use either one as his aiming point. To lay the mortar correctly, he takes a compensated sight picture. Then, he traverses the mortar until the sight picture appears with the left edge of the far aiming post placed exactly midway between the left edge of the near aiming post and the vertical line of the sight. This corrects for the displacement. A memory trick for correcting displacement is: *Hey diddle diddle, far post in the middle.*

b. The gunner determines if the displacement is caused by traversing the mortar or by displacement of the baseplate assembly. To do so, he places the referred deflection on the sight and lays on the aiming posts. If both aiming posts appear as one, the separation is caused by traversing. Therefore, the gunner continues to lay the mortar as described and does not realign the aiming posts. When the posts appear separated, the separation is caused by displacement of the baseplate assembly. The gunner notifies his squad leader, who requests permission from the section/platoon leader to realign the aiming posts. (For more information, see Chapter 3, paragraph 3-14.)

Section VII. LOADING AND FIRING

Upon receiving a fire command from the section leader, the gunner repeats each element of it. He places the firing data on the sight and, assisted by the assistant gunner, lays the mortar. The first ammunition bearer repeats the charge element when announced by the gunner and prepares the round with that charge. (If a fuze setting is announced, the first ammunition bearer also repeats the setting and places it on the fuze.) He completes his preparation of the cartridge to include safety checks. The squad leader spot-checks the data on the sight and the lay of the mortar. He then commands FIRE.

2-42. FIRING THE MORTAR

The crew fires the mortar as follows:

a. The gunner removes the sight, being careful not to disturb the lay of the mortar. He continues to remove the sight until the baseplate assembly is settled and there is no danger of the sight becoming damaged from the recoil of the mortar. The bipod assembly can slide up the barrel when the gunner fires the 81-mm mortar, M252 or the 120-mm mortar, M120. The gunner must not try to place the mortar back into position until the baseplate is settled.

b. The first ammunition bearer passes a round to the assistant gunner. He holds the round with the palms of both hands up and near each end of the round so that the fuze is pointing in the general direction of the mortar.

c. The assistant gunner takes the round from the first ammunition bearer with his right hand, palm up, and his left hand, palm down. He grasps the body of the round near the center, guides it into the barrel to a point beyond the narrow portion of the body of the shell, and releases the round. He cuts both hands sharply away and down along the barrel. At the same time, he pivots to the left and bends toward the first ammunition bearer, extending his hands to receive the next round. He is careful not to disturb the lay of the mortar as he loads the round (the round can bind as the base end enters the barrel). This can cause considerable dispersion in the target area and can create unsafe conditions due to erratic fire.

Note: See Chapter 6 for loading and firing the M329A2 round.

CAUTION
Do not load or fire the mortar while wearing gloves.

2-43. TARGET ENGAGEMENT

Target engagement is achieved through fire commands, which are the technical instructions issued to mortar crews. The basis for these commands is the data processed in the FDC. There are two types of commands: initial fire commands, issued to start a fire mission; and subsequent fire commands, issued to change firing data and to cease firing. The elements of both commands follow the same sequence. However, subsequent commands include only such elements that are changed, except for the elevation element, which is always announced. A correct fire command is brief and clear, and includes all the elements necessary for accomplishing the mission. The commands are sent to the platoon sergeant (section sergeant) by the best available means. To limit errors in transmission, the person receiving the commands at the mortar position repeats each element as it is received. The sequence for the transmission of fire commands is:

SEQUENCE	EXAMPLE
Mortars to follow	Section
Shell and fuze	HE quick
Mortars to fire	Number two
Method of fire	One round
Deflection	Deflection two eight hundred
Charge	Charge eight and four eighths
Time	
Elevation	Elevation nine hundred

Note: All fire commands follow this sequence. Elements not necessary for the proper conduct of fire are omitted.

2-44. EXECUTION OF FIRE COMMANDS

The various fire commands are explained herein.

a. **Mortars to follow**. This element serves two purposes: it alerts the section for a fire mission and it designates the mortars that are to follow the commands. The command for all mortars in the section to follow the fire command is SECTION. Commands for individual or pairs of mortars are given a NUMBER (ONE, TWO, and so forth).

b. **Shell and fuze.** This element alerts the ammunition bearers as to what type of ammunition and fuze action to prepare for firing--for example, HE QUICK; HE DELAY; HE PROXIMITY; and so forth.

c. **Mortar(s) to fire**. This element designates the specific mortar(s) to fire. If the mortars to fire are the same as the mortars to follow, this element is omitted. The command to fire an individual mortar or any combination of mortars if NUMBER(s) (ONE, THREE, and so forth).

d. **Method of fire**. In this element, the mortar(s) designated to fire in the preceding element is told how many rounds to fire, how to engage the target, and any special control desired. Also included are the number and type ammunition to be used in the fire-for-effect phase.

(1) *Volley fire.* A volley can be fired by one or more mortars. The command for volley fire is (so many) ROUNDS. Once all mortars are reported up, they fire on the platoon sergeant's (section sergeant's) command. If more than one round is being fired by each mortar, the squads fire the first round on command and the remaining as rapidly as possible consistent with accuracy and safety, and without regard to other mortars. If a specific time interval is desired, the command is (so many) ROUNDS AT (so many) SECONDS INTERVAL, or (so many) ROUNDS PER MINUTE. In this case, a single round for each mortar, at the time interval indicated, is fired at the platoon sergeant's (section sergeant's) command.

(2) *Section right (left).* This is a method of fire in which mortars are discharged from the right (left) one after the other, normally at 10-second intervals. The command for section fire from the right (left) flank at intervals of 10 seconds is SECTION RIGHT (LEFT), ONE ROUND. Once all mortars are reported up, the platoon sergeant (section sergeant) gives the command FIREX for example, SECTION RIGHT, ONE ROUND; the platoon sergeant (section sergeant) commands FIRE ONE; 10 seconds later FIRE TWO, and so forth.

(a) If the section is firing a section left, the fire begins with No. 3 and works to the right. The command LEFT (RIGHT) designates the flank from which the fire begins. The platoon sergeant (section sergeant) fires a section right (left) at 10-second intervals unless he is told differently by the FDC--for example, SECTION LEFT, ONE ROUND, TWENTY-SECOND INTERVALS.

(b) When it is desired to fire continuously at a target, the command is CONTINUOUS FIRE. When it is desired to maintain a smoke screen, it may be necessary to fire a series of sections right (left). In this case, the command is CONTINUOUS FIRE FROM THE RIGHT (LEFT). The platoon sergeant (section sergeant) then fires the designated mortars consecutively at 10-second intervals unless a different time interval is specified in the command.

(c) Changes in firing data (deflections and elevations) are applied to the mortars in turns of traverse or elevation so as not to stop or break the continuity of fire--for example, NUMBER ONE, RIGHT THREE TURNS; NUMBER TWO, UP ONE TURN. When continuous fire is given in the fire command, the platoon sergeant (section sergeant) continues to fire the section until the FDC changes the method of fire or until the command END OF MISSION is given.

(3) *Traversing fire.* In traversing fire, rounds are fired with a designated number of turns of traverse between each round. The command for traversing fire is (so many) ROUNDS, TRAVERSE RIGHT (LEFT) (so many) TURNS. At the platoon sergeant's (section sergeant's) command FIRE, all mortars fire one round, traverse the specified number of turns, fire another round, and continue this procedure until the number of rounds specified in the command have been fired.

(4) *Searching fire*. Searching fire is fired the same as volley fire except that each round normally has a different range. No specific order is followed in firing the rounds. For example, the assistant gunner does not start at the shortest range and progress to the highest charge or vice versa, unless instructed to do so. Firing the rounds in a definite sequence (high to low or low to high) establishes a pattern of fire that can be detected by the enemy.

(5) *At my command*. If the FDC wants to control the fire, the command AT MY COMMAND is placed in the method of fire element of the fire command. Once all mortars are reported up, the platoon sergeant (section sergeant) reports to the FDC: SECTION READY. The FDC then gives the command FIRE.

(6) *Do not fire*. The FDC can command DO NOT FIRE immediately following the method of fire. DO NOT FIRE then becomes a part of the method of fire. This command is repeated by the platoon sergeant (section sergeant). As soon as the weapons are laid the platoon sergeant (section sergeant) reports to FDC that the section is laid. The command for the section of fire is the command for a new method of fire not followed by DO NOT FIRE.

(7) *Deflection*. This element gives the exact deflection setting to be placed on the mortar sight. It is always announced in four digits, and the word DEFLECTION always precedes the sight setting--for example, DEFLECTION, TWO EIGHT FOUR SEVEN (2847). When the mortars are to be fired with different deflections, the number of the mortar is given and then the deflection for that mortar--for example, NUMBER THREE, DEFLECTION TWO FOUR ZERO ONE (2401).

(8) *Charge*. This element gives the charge consistent with elevation and range as determined from the firing tables--for example, CHARGE FOUR (4). The word CHARGE always precedes the amountXfor example, ONE ROUND, CHARGE FOUR (4).

(9) *Time.* The computer tells the ammunition bearer the exact time setting to place on the proximity, MTSQ, and the MT fuze. The command for

time setting is TIME (so much)-- for example, TIME TWO SEVEN. The command for a change in time setting is a new command for time.

(10) *Elevation*. This element serves two purposes: first, it gives the exact elevation setting that is to be placed on the mortar sight; second, it serves as the command to fire, if no restrictions are placed on method of fire. When no restrictions are announced in the method of fire, the section, when laid, fires at the platoon sergeant's (section sergeant's) command FIRE. The platoon sergeant (section sergeant) may allow the mortar(s) to fire when ready. The elevation element is always given in a fire command. It is announced as, "Elevation (so many mils)."

2-45. ARM-AND-HAND SIGNALS

When giving the commands FIRE or CEASE FIRING, the section leader or squad leader uses both arm-and-hand signals and voice commands (Figure 2-33).

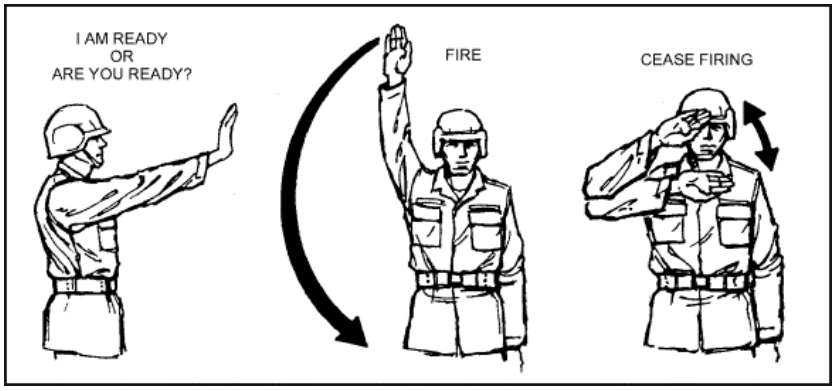

Figure 2-33. Arm-and-hand-signals for ready, fire, and cease firing.

a. **Ready**. The signal for "I am ready" or "Are you ready?" is to extend the arm toward the person being signaled. Then, the arm is raised slightly above the horizontal, palm outward.

b. **Fire**. The signal to start fire is to drop the right arm sharply from a vertical position to the side. When the section leader desires to fire a single mortar, he points with his arm extended at the mortar to be fired, then drops his arm sharply to his side.

c. **Cease Firing**. The signal for cease firing is to raise the hand in front of the forehead, palm to the front, and to move the hand and forearm up and down several times in front of the face.

2-46. SUBSEQUENT FIRE COMMANDS

Only the elements that change from the previous fire command are announced in this command. However, the elevation element (command to fire) is always announced in the subsequent fire command.

a. Changes in direction are given in total deflection to be placed on the sight--for example, DEFLECTION TWO EIGHT ONE TWO (2812).

b. When a change is made in mortars to fire or in the method of fire, the subsequent command includes one or both of these elements and the elevation. When the elevation does not change, the command ELEVATION (so many mils) is given (same as that given in the previous command).

c. To interrupt firing, CEASE FIRING or CHECK FIRE is commanded.

(1) CEASE FIRING indicates to the section the completion of a fire mission, but not necessarily the end of the alert. Firing is renewed by issuing a new initial fire command.

(2) CHECK FIRE indicates a temporary cessation of firing and allows firing to be resumed with the same data by the command RESUME FIRING or by a subsequent fire command.

d. So that the mortar crews can relax between fire missions, the end of the alert is announced by the command END OF MISSION. All gunners then lay their mortars as directed by the FDC. Upon completion of a fire mission, all mortars normally lay on final protective fire data unless otherwise directed. It is the responsibility of the platoon sergeant (section sergeant) to ensure that the mortars are laid on final protective fire data and that the prescribed amount of ammunition for the final protective fire is prepared and on position.

2-47. REPEATING AND CORRECTING OF FIRE COMMANDS

If the platoon sergeant (section sergeant) or squad member fails to understand any elements of the fire command, he can request that element be repeated by starting--for example, "Say again deflection, elevation," and so forth. Misunderstanding is avoided when the repeated element is prefaced with "I say again deflection (repeats mils)."

a. In an initial fire command, an incorrect element is corrected by stating, "Correction," and giving only the corrected element.

b. In a subsequent command, an incorrect element is corrected by stating, "Correction," and then by repeating all of the subsequent commands. (The term "correction" cancels the entire command.)

2-48. REPORTING OF ERRORS IN FIRING

When any squad member discovers that an error has been made in firing, he immediately notifies his squad leader, who in turn notifies the FDC. Such errors include, but are not limited to, incorrect deflection or elevation settings, incorrect laying of the mortar, or ammunition improperly prepared for firing. Misfires are also reported this way. Errors should be promptly reported to the FDC to prevent loss of time in determining the cause and required corrective action.

2-49. NIGHT FIRING

When firing the mortar at night, the mission dictates whether noise and light discipline are to be sacrificed for speed. To counteract the loss of speed for night firing, the gunner must consider presetting both fuze and charge for illumination rounds with the presetting of charges for other rounds. The procedure for manipulating the mortar at night is the same as during daylight operations. To assist the gunner in these manipulations, the sight reticle is illuminated, and the aiming posts are provided with lights.

a. The instrument lights illuminate the reticle of the sights and make the vertical cross lines visible. The hand light on the flexible cord is used to illuminate the scales and bubbles.

b. An aiming post light is placed on each aiming post to enable the gunner to see the aiming posts. Aiming posts are placed out at night similar to the daylight procedure. The lights must be attached to the posts before they can be seen and positioned by the gunner. The gunner must issue commands such as NUMBER ONE, MOVE RIGHT, LEFT, HOLD, DRIVE IN, POST CORRECT. Tilt in the posts is corrected at daybreak. Some of the distance to the far post can be sacrificed if it cannot be easily seen at 100 meters. However, the near post should still be positioned about half the distance to the far post from the mortar. The far post light should be a different color from the one on the near post and be positioned so it appears slightly higher. Adjacent squads should alternate post lights to avoid laying on the wrong posts--for example, 1ST SQUAD, NEAR POST--GREEN LIGHT, FAR POST--RED LIGHT; 2D SQUAD, NEAR POST--RED LIGHT, FAR POST--GREEN LIGHT. (The M58 light is green and the M59 light is orange.)

c. The mortar is laid for deflection by placing the vertical cross line of the sight in the correct relation to the center of the lights attached to the aiming posts. The procedure for laying the mortar is the same as discussed in Section VI.

d. The night lights can be used to align the aiming posts without using voice commands.

(1) The gunner directs the ammunition bearer to place out the aiming posts. The ammunition bearer moves out 100 meters and turns on the night

light of the far aiming post. The gunner holds the instrument night light in his right (left) hand and, by moving the light to the right (left), directs the ammunition bearer to move to the right (left). To ensure that the ammunition bearer sees the light moving only in the desired direction, the gunner places his thumb over the light when returning it to the starting position. The gunner continues to direct the ammunition bearer to move the aiming post until it is properly aligned.

(2) The gunner moves the instrument light a shorter distance from the starting position when he desires the ammunition bearer to move the aiming post a short distance.

(3) The gunner holds the light over his head (starting position) and moves the light to waist level when he desires to have the ammunition bearer place the aiming post into the ground. In returning the instrument light to the starting position, the gunner covers the light with his thumb to ensure that the ammunition bearer sees the light move only in the desired direction.

(4) The gunner uses the same procedure described above when he wants the ammunition bearer to move the aiming post light to a position corresponding to the vertical hairline in the sight after the aiming post has been placed into the ground.

(5) The gunner reverses the procedure described above when he wants the ammunition bearer to take the aiming post out of the ground. The gunner places the uncovered light at waist level and moves it to a position directly above his head. He then directs alignment as required.

(6) When the gunner is satisfied with the alignment of the aiming posts, he signals the ammunition bearer to return to the mortar positions by making a circular motion with the instrument light.

Note: When the night light is used to signal, the gunner directs the light toward the ammunition bearer.