CHAPTER 5

TECHNIQUE OF FIRE

Section I. GENERAL

70. Definitions and Scope

a. Terms.

(1) *Technique of fire.* Placing effective fire on a target.

(2) *Direct laying.* Pointing a weapon for direction and elevation by laying on a target visible to the gunner as he looks through the sight.

(3) *Direct fire.* Firing conducted when the gunner is using direct laying.

b. Scope. Training in marksmanship is a prerequisite for instruction in direct laying. Direct laying involves a knowledge of the following subjects:

(1) Characteristics of fire.

(2) Range, apparent speed, and lead determination.

(3) Fire commands.

(4) Fire control.

71. Characteristics of Fire

a. Trajectory.

(1) The trajectory of a projectile is the curve traced by the center of gravity of the projectile in its flight from the muzzle of the gun to the point of impact. A knowledge of the trajectory is important, especially in firing antitank weapons and when firing over the heads of friendly troops.

(2) The 90mm rifle is classified as a flat trajectory weapon. The muzzle velocity and the weight of the projectile are the more important factors in determining the flatness of the trajectory. In all cases, however, due to the action of the force of gravity and air resistance, the trajectory of projectiles is actually a curve and not a straight line. Air resistance retards the projectile during its flight, causing the angle of fall to be greater than the angle of elevation. Therefore, the projectile reaches its maximum ordinate (highest point) closer to the point of impact than to the rifle (fig. 36).

(3) A line tangent to the trajectory at the point of impact is called the *line of fall.* The vertical angle between the line of fall and the ground at the point of impact is called the *angle of fall.*

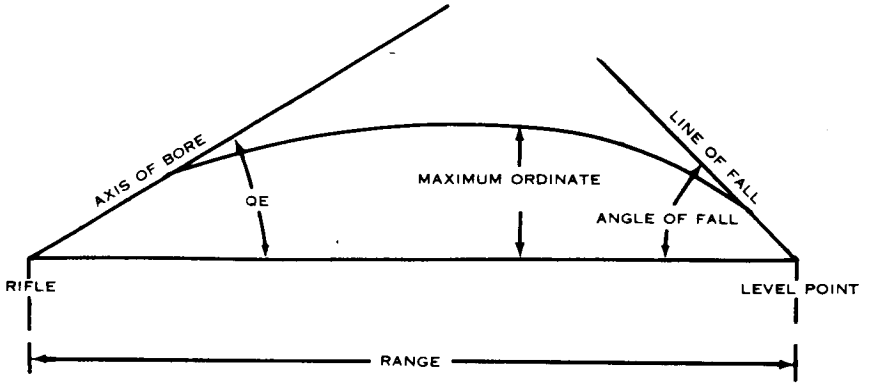

Figure 36. Elements of trajectory.

b. Dispersion.

(1) When firing a large number of rounds from a rifle having elevation, direction, and other conditions as nearly identical as possible, the points of impact of the projectile are scattered both in range and deflection. This scattering is called *dispersion.* The greatest concentration of points of impact is near the center of the group. Approximately as many points fall short of the center as fall beyond, and a few will fall to the right or to the left.

(2) Among factors that cause dispersion are variations in weight and composition of the propellant, weight and balance of the projectile, and atmospheric condition.

c. Dispersion Rectangle and Probable Error. In general, the points of impact of projectiles fired from a rifle, using the identical sight picture for each cartridge fired, may be included in a rectangle with its longer axis along the gun-target line. This is called a *dispersion rectangle.* If this rectangle is divided into eight equal parts by lines drawn perpendicular to the line of fire, the percentage of points of impact to be expected in each part is as shown in figure 37. Notice that each of the two segments nearest the center of the dispersion rectangle contain 25 percent of all impacts. The length (in the direction of fire) of each of the segments of the dispersion rectangle represents one range probable error. The value in meters of one range probable error, which varies with the range from the rifle to the center of impact, is given in the firing table pertaining to the type of ammunition being fired.

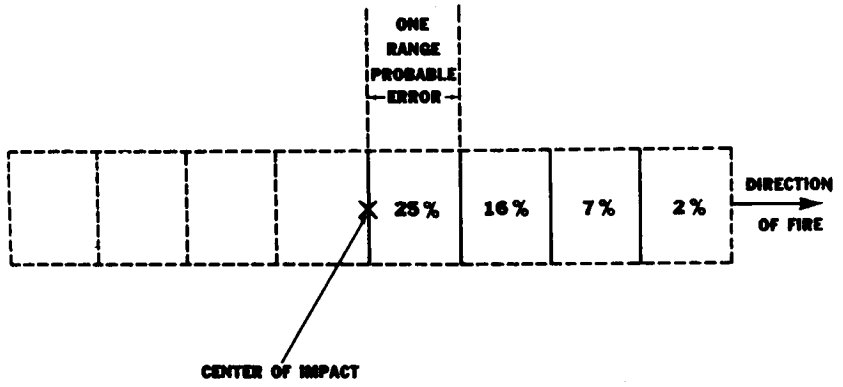

Figure 37. Dispersion rectangle.

Section II. RANGE DETERMINATION, AND ESTIMATING LEAD AND APPARENT SPEED

72. Range Determination

a. General.

(1) Ability to accurately estimate range is essential to achieve first round hits. The length of time available to fire is in many cases limited; therefore, quick and accurate determination of range is extremely important.

(2) The methods used to determine range to a given target are:

(a) Using stadia lines in the sight reticle.

(b) Using map distance.

(c) Estimating by eye.

(d) Obtaining the range from other units.

(e) Firing other weapons.

(f) Measuring ground distmce.

(g) Using binoculars.

b. Stadia Lines. The stadia lines in the sight reticle are a readily available means of estimating range (fig. 38). These lines are developed from the mil relation formula and are designed to enable the gunner to estimate range to targets having a 10- or 20-foot dimension. Most tanks are approximately 10 feet wide and 20 feet long. To

estimate range, the gunner adjusts the lay of the rifle until the target exactly fits between the stadia lines. The point on the vertical (range) line of the reticle, that corresponds to the center of mass of the target, indicates the range. The target in figure 38 is at a range of 275 meters. On targets showing more of the flank than the front, a full stadia picture is used. If more of the front than the flank is shown, a half stadia picture is necessary (fig. 39). It is important to remember that a deflection adjustment must be made from a half stadia picture to obtain the correct sight picture for target engagement.

c. Map Distance. Accuracy of determining range from a map depends on skill in map reading and the accuracy of the map (FM 21–26).

d. Estimating Range by Eye. See FM 23-71 for explanation.

e. Obtaining the Range From Other Units. Often, a unit relieved from a combat position possesses range cards and other information that may be of use to the relieving unit. Also, other units of the same organization as the relieving unit may have the desired information. This latter source of information is usually reliable, especially if the unit has previously engaged targets in the area.

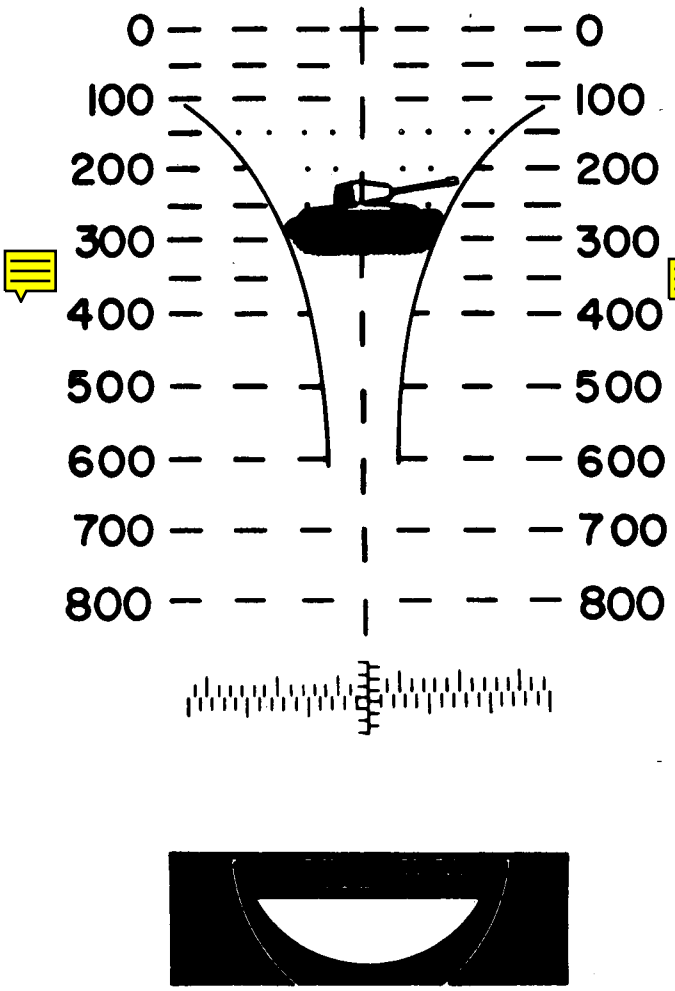

Figure 38. Full stadia picture.

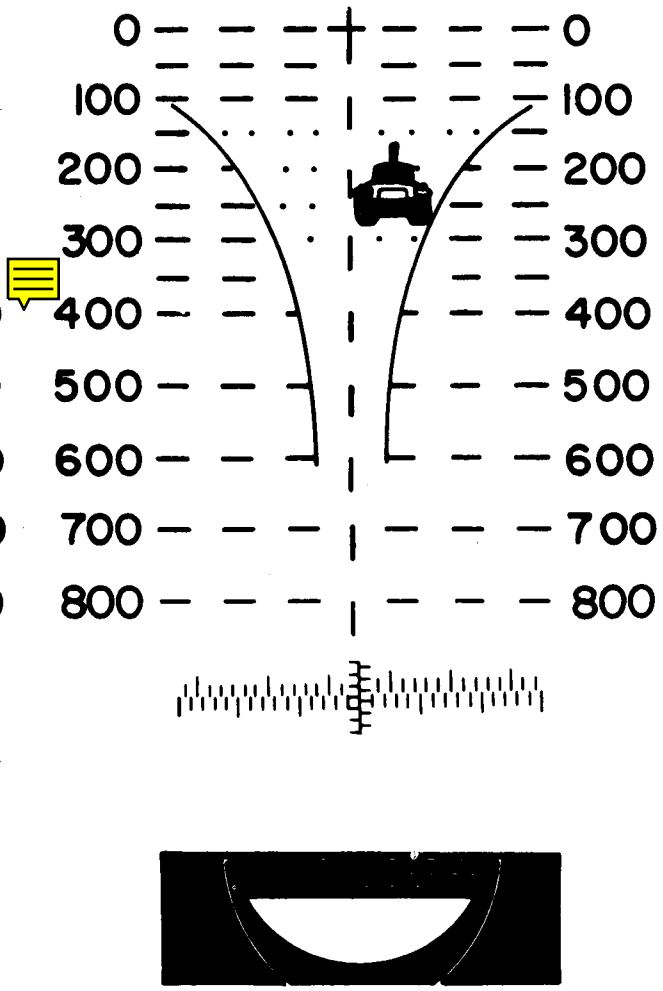

Figure 39. Half stadia picture.

In many cases, other weapons have been fired at targets near the target being engaged by the 90mm rifle, and their range data may be useful in determining the desired range.

f. Firing Other Weapon. You may use the fire of other weapons to determine range. The fire of smaller individual weapons, such as the M14 rifle using tracer ammunition, does not disclose the position as readily as do larger type weapons and is effective to ranges of approximately 500 meters.

g. Measuring Ground Distance. If the situation permits freedom of movement, pace off the distance or measure it with tape or speedometer.

h. Using Binoculars. Binoculars, used in conjunction with the mil relation (WORM) formula, are useful in determining ranges. To use this method, select a house, door, window, highway, or a telephone pole—something which has a known size or can be closely estimated. Using the mil scale in the binoculars, measure the height or width of the object. Then substitute in the mil relation formula: $R = \frac{W}{m}$, where R equals range in thousands of meters, m equals width in mils, and W equals width of the object in meters.

73. Determining Leads

The primary method of determining leads for the 90mm rifle is as follows:

a. Estimate apparent speed of the target.

b. Convert the apparent speed to leads.

74. Apparent Speed Estimation

The speed at which a target seems to move toward or away from the line of sight is called apparent speed. It is determined by establishing a line of sight and then estimating the target's speed as it moves toward or away from this line of sight. In figure 40, tank A has no apparent speed no matter how fast it is moving because it is moving directly toward the gunner. The same applies if the tank is moving directly away from the gunner. Tank B has an apparent speed equal to its actual

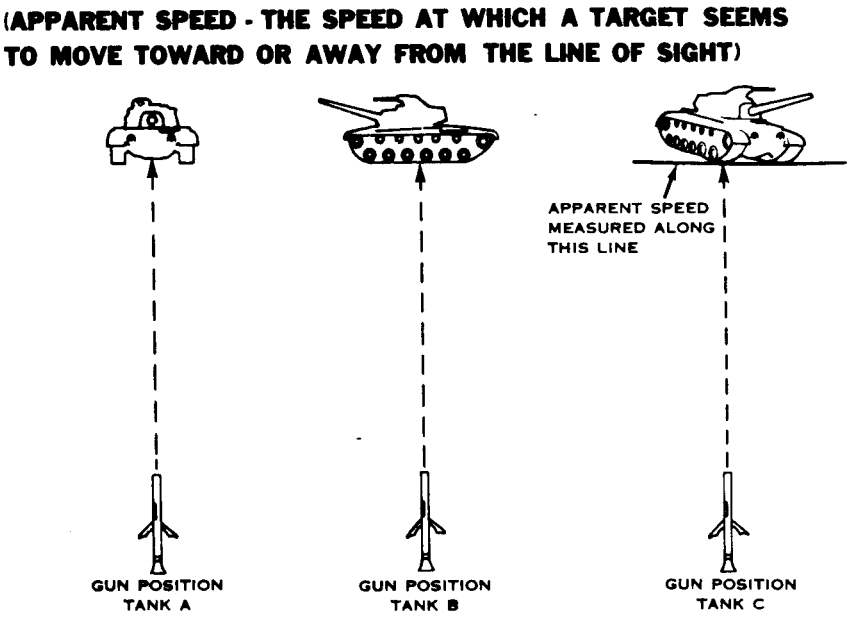

Figure 40. Determining apparent speed.

speed, because it is moving perpendicular to the gunner's line of sight. Tank C, moving at the oblique, has an apparent speed less than its actual speed. Constant practice is the only method by which the gunner can acquire proficiency in estimating apparent speed.

75. Lead Estimation

a. A moving target is led by the distance it travels from the time the rifle is fired until the projectile crosses the path of the target. Angular leads are measured with the direct fire sight M103, 5 mils being equal to one lead. The number of leads applied varies with the apparent speed of the target, but not the range.

b. Ballistic characteristics of the 90mm rifle are such that one lead is applied on the sight reticle for each 2½ miles per hour of apparent speed of the target.

c. An alternate means of determining leads is the common lead rule. The number of leads required is determined by the direction the target is moving in relation to the gun position (fig. 41). Target speed is assumed to be 15 miles per hour. If the target is moving directly toward or away from the gun position, no leads are required. If the target is moving from 1 or 11 o'clock, two leads are used; from 2 or 10 o'clock, four leads; and from 3 or 9 o'clock, six leads.

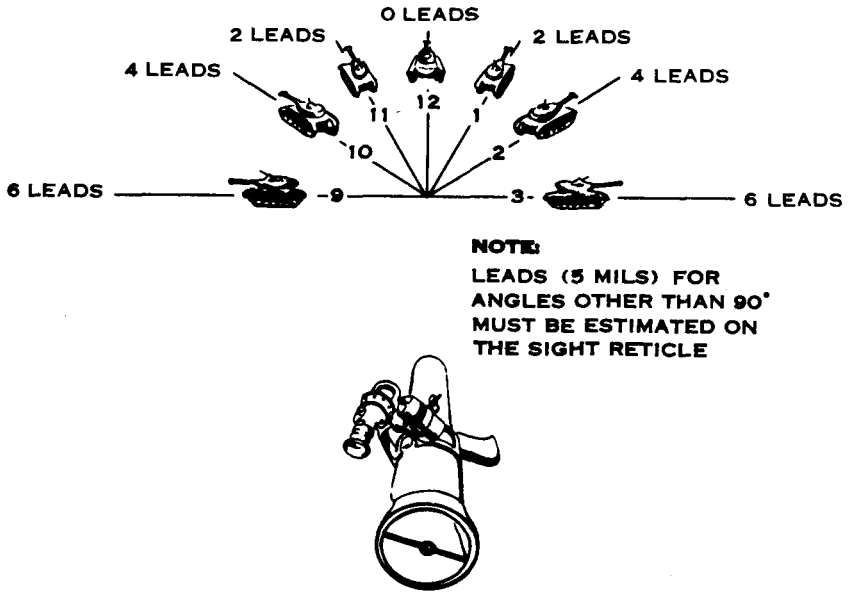

Figure 41. Common lead rule.

Section IV. FIRE COMMANDS

76. General

a. Fire commands are instructions issued to enable a weapons crew to engage a target. The squad leader normally issues the fire commands. In some cases, however, the time element involved may require the gunner to issue an abbreviated command. In either case, a standard sequence is followed (para 78).

b. Training in fire commands is designed to develop squad proficiency to such a degree that all fire after the initial shot can be adjusted without command from the squad leader, until the target is destroyed or the squad leader decides to resume adjustment.

c. There are two kinds of fire commands: initial and subsequent. Initial fire commands include all data necessary for laying, loading, and firing the rifle. Subsequent fire commands include those

commands issued to adjust, shift, cease, or suspend fire. They normally include only those elements necessary to accomplish these actions.

d. A correct fire command is as brief as clarity permits. It includes all the elements needed to accomplish the fire mission and is given in logical sequence to accustom the crew to executing instructions in a definite order. It is transmitted at a rate that permits receipt and application of instructions without confusion. Any unnecessary elements are omitted.

e. Fire commands are usually given orally. When oral delivery is not practicable, they may be transmitted by telephone, radio, messenger, or arm-and-hand signals worked out with the crew.

f. Numbers are announced as illustrated in the following examples:

10	ONE ZEREO
25	TWO FIVE
300	THREE HUNDRED
475	FOUR SEVEN FIVE

g. When the squad leader issues fire commands, the gunner repeats all commands except when firing at a moving target.

77. Sequence of Initial Fire Commands

a. Sequence. The following sequence is prescribed for the initial fire command. Any of these elements that do not pertain to a specific fire command are omitted.

(1) Alert.
(2) Type of ammunition.
(3) Direction.
(4) Target description.
(5) Range.
(6) Leads.
(7) Control.

b. Alert. The alert is always the first element of the initial fire command. It consists of the command FIRE MISSION in the case of a stationary target or the command MOVING TARGET in the case of a moving target. The alert puts the rifle crew in readiness to execute a fire command with the least practicable delay.

c. Ammunition. This element may be omitted unless TP ammunition is to be fired. When this element is omitted, HEAT will be loaded as soon as the alert is given.

d. Direction. Direction may be given either orally, by pointing, or by a combination of these two methods. The squad leader may use a reference point in designating those targets that are difficult for the gunner to locate. The clock system of indicating direction may also be used.

e. Target Description. Targets are described as quickly and simply as is consistent with clarity. The squad leader uses the following word or words to designate targets:

Any tank	T A N K
Any unarmored vehicle	TRUCK
Personnel	TROOPS
Automatic weapon	MACHINEGUN
Any antitank or artillery piece	ANTITANK
Any other target	Briefest descriptive form.

If several targets are in view, he designates the particular target or part of target to fire on; for example, LEADING TANK or LAST TRUCK.

f. Range. Range is announced in meters (estimated or determined) either orally or by signals.

g. Leads. This element has application only in the case of moving targets. Leads are announced in units of 5-mil angular leads, as: TWO LEADS, or THREE AND ONE-HALF LEADS.

h. Control. This element is given as FIRE, or when a short delay is necessary, AT MY COMMAND. This is followed at the desired time by the command FIRE.

78. Examples of Initial Fire Commands

a. Stationary Target at 400 Meters.
FIRE MISSION
HEAT
RIGHT FRONT
TANK
FOUR HUNDRED
FIRE

b. Moving Target at 300 Meters and 15 Miles Per Hour Apparent Speed.
MOVING TARGET
HEAT
FRONT
TANK
THREE HUNDRED
SIX LEADS
FIRE

c. Examples of Initial Fire Commands When the Gunner is Issuing the Command.

MOVING TARGET
HEAT
LEFT FRONT

Note. The gunner issues only those elements that affect other members of the squad.

79. Subsequent Fire Commands

a. Sensing. In direct fire, sense each burst for deflection and range. Do not announce either sensing. See paragraph 89 for a discussion of sensing and conduct of fire.

b. Elements. Elements of a subsequent fire command generally include only those elements in which there is a change from the previous fire command. Range and control elements are always included.

c. Announcing Subsequent Fire Commands. Give subsequent commands as corrections to the previous sight picture. Use the following terms to announce these corrections:

Fire at the same range---	REPEAT RANGE
Increase range----------	ADD
Decrease range----------	DROP
Move the burst or strike to right-----	RIGHT
Move the burst or strike to left----	LEFT
Increase leads ----------	MORE
Decrease leads----------	LESS

80. Corrections

a. Deflection. When firing on stationary targets, give corrections in deflection (in mils) as RIGHT FIVE, LEFT ONE ZERO. When deflection is correct, omit this element from subsequent fire command.

b. Range. Always include this element in the subsequent fire command. If a correction is needed announce it as ADD ONE HUNDRED, DROP FIVE ZERO. If the range is correct, give this element as REPEAT RANGE.

c. Leads. When firing at moving targets, give the correction leads as TWO MORE, ONE LESS. Include this element in subsequent fire commands only when necessary.

81. Subsequent Fire Commands for Stationary Targets When the Squad Leader Is Adjusting the Fire

a. LEFT TWO ZERO
DROP ONE HUNDRED
FIRE

b. RIGHT FIVE
ADD ONE HUNDRED
FIRE

c. REPEAT RANGE
FIRE

82. Subsequent Fire Commands for Moving Targets When the Squad Leader Is Adjusting the Fire

a. DROP ONE HUNDRED
ONE LESS
FIRE

b. ADD ONE HUNDRED
TWO MORE
FIRE

c. REPEAT RANGE
ONE LESS
FIRE

83. Gunner's Subsequent Commands

When the gunner issues the initial fire command and adjusts his own fire, there is no subsequent fire command. It is desirable that all subsequent fire adjustments be made by the gunner in order to save time. When such adjustments are being made, firing continues uninterrupted until the mission is accomplished.

84. Repeating and Correcting Commands

a. Repeating. If the loader or gunner fails to understand any element of the fire command, he requests a repetition of that element by announcing DEFLECTION, RANGE, or AMMUNITION. He uses a rising inflection in his voice to denote a question. When any crew member asks that an element be repeated, misunderstanding is avoided by prefacing the repeated element or elements with the phrase THE COMMAND WAS _____. This phrase is used only when repeating an element of an unexecuted fire command.

b. Corrections. In all initial fire commands, correct or erroneous command by saying CORRECTION, and give the new command. To correct an erroneous range command of 200 meters to 300 metes, the procedure is: CORRECTION, THREE HUNDRED, FIRE. *(NOTE* that the corrected initial fire command is followed by the

command to FIRE.) To correct an error in a subsequent fire command, the observer says CORRECTION and repeats the entire subsequent command correctly.

85. Cease Firing

CEASE FIRING is announced when the squad leader desires to interrupt firing for any reason. It indicates the completion of firing with the data in the gunner's possession. Firing is then renewed by an initial fire command. SUSPEND FIRING is the command for a temporary halt in firing a particular mission. Given COMMENCE FIRING after SUSPEND FIRING, the crew continues to fire the mission under the previous fire command.

86. Termination of Alert

To allow the crew to relax between missions so its response to subsequent alerts is more complete, termination of the alert is announced as CEASE FIRING, END OF MISSION. If oral commands are not practicable, appropriate (arm-and-hand) signals may be used.

Section V. FIRE CONTROL

87. General

Fire control implies the ability of a leader to open fire at the instant he desires, adjust the fire of his rifle or rifles upon the target, shift fire from one target to another, regulate the rate of fire, and to cease firing at will. A leader must accomplish these promptly if the fire is to be effective. Lack of good fire control results in loss of surprise effect, premature disclosure of position, and fire on unimportant targets. It also results in a loss of time in securing adjustment and a waste of ammunition. Fire control depends on thorough discipline, technical training, and the initiative of crew members. Because of noise, semi-isolation of firing position limited vision, and fleeting opportunity, fire control must be simple to insure effective execution of the mission and the engagement of new and unexpected targets.

88. Chain of Fire Control

The commander responsible for employment of the rifle issues the necessary orders directly to the platoon leader. The platoon leader, in turn, gives his orders to his squad leaders. The squad leader is responsible for the ultimate control of the crew and the accomplishment of its mission.

89. Adjustment of Fire

a. General.

(1) Adjustment of fire is one of the most important phases of fire control. If first round hits are not achieved during firing, rapid adjustments of fire are made with subsequent rounds.

(2) Target misses are sensed prior to issuance of subsequent corrective fire adjustments. The term *sensing* means that the person controlling the fire of the weapon notes where the projectile bursts in relation to the target. His sensing includes both range and deflection observations. After the observer has made his sensing, he determines the corrections necessary to obtain a target hit, and gives the appropriate subsequent fire command. For example, if the miss was sensed 10 mils to the left and 100 meters over the target the correct subsequent fire command would be-

RIGHT ONE ZERO
DROP ONE HUNDRED
FIRE

b. Burst-On-Target Method.

(1) This method is primary with the 90mm rifle. It may be used up to the maximum range graduation of the sight reticle. With a well-trained gunner, it is the most accurate and rapid system of fire adjustment. The gunner has complete control over the adjustment of his fire. This system cuts the time lag between firing, and eliminates time required for the observer to sense the burst and formulate and issue a subsequent fire command. It also eliminates time required by the crew to interpret and execute the command.

(2) The burst-on-target method is based on the fact that the rifle is boresighted. As long as this condition exists, the burst of each round fired at a given range will ap-

pear on the same place in the sight reticle. If the gunner moves the point-of-burst on the sight to the center of mass of the target, a hit will be obtained with the next round.

(3) In using the burst-on-target method, the gunner makes his own sensings and then applies the corrected data to the rifle. The squad leader, after issuing the initial fire command, remains silent. He is ready, however, to take over if the gunner needs help or if the gunner cannot see the burst-on-target relationship through the sight. In this case, the squad leader issues normal subsequent commands to adjust the fire. The gunner uses a sight picture for his initial firing from the elements of the squad leader's initial fire command.

FIRE MISSION
HEAT
FRONT
TANK
TWO HUNDRED
FIRE

(a) The gunner fires the rifle and, while the projectile is on the way to the target, he checks his sight picture and makes any corrections necessary because of the movement of the weapon when fired.

(b) He notes the point on the sight reticle where the burst appears and moves this point onto the center of mass of the target.

(c) He again fires. This should give him a target hit; if not, he applies the same principle and fires again; this time he should have a target hit.

(4) The most difficult step to achieve in the burst-on-target method is the movement of the burst point to the target. The burst indication is either a puff of smoke or a cloud of dust which settles rapidly. The gunner chooses some mark on his sight reticle in the center of burst before the burst indication disappears. He then moves that exact point to the center of mass of the target to fire his subsequent round. In selecting this point, the gunner chooses a lead line, a range graduation, or interpolates between lines. A failure to hit with the second round normally indicates an inaccurate movement of the center of burst. Should the gunner fail to achieve a hit with his second round, he repeats the process moving the new center-of-burst to the center of the target by manipulation of the bipod or moving the rifle right or left, whichever the case may be.

90. Neutralization Fire

The squad leader or gunner may desire to place a number of rounds on the target to destroy or neutralize it. Because of the ammunition resupply problem, he does *not* command FIRE FOR EFFECT. He estimates the number of rounds needed for neutralization or destruction checks the ammunition on hand, and issues a subsequent fire command for each additional cartridge to be fired. Example: REPEAT RANGE, FIRE.

Section VI. BORESIGHTING

91. General

Accurate marksmanship with the weapon requires accurate boresighting. Improper boresighting or zeroing results in an inability to hit the target. To aline the axis of the 90mm bore (extended) and the telescopic line of sight, converge both on some distant aiming point beyond 500 meters.

92. Procedure

a. Four notches, 90° apart, are located on the muzzle end of the 90mm rifle. Place two pieces of thread or some similar material across opposite notches. The point of intersection marks the axis of the bore at the muzzle end of the weapon.

b. Insert a boresight disc, issued with each weapon, in the chamber to determine the axis of the bore at the breech.

c. In the event the boresight disc is not available, insert the breechblock into the chamber, after removing the firing pin, so the axis of the bore at the breech is defined by the firing pin hole in the breechblock.

d. Select an aiming point beyond the range to any likely target. With the eye held several inches behind the breech, aline the axis of the bore on the aiming point by elevating and traversing the rifle.

e. Look through the telescope and insure that the boresight cross of the sight reticle is alined on the same aiming point. If the boresight cross is not alined, bring it to the aiming point by rotating the elevation and azimuth correction screws with the screwdriver end of the combination wrench. Recheck the alinement through the bore and through the sight. When the sight and the bore are properly alined on the aiming point, the 90mm rifle is foresighted (fig. 42).

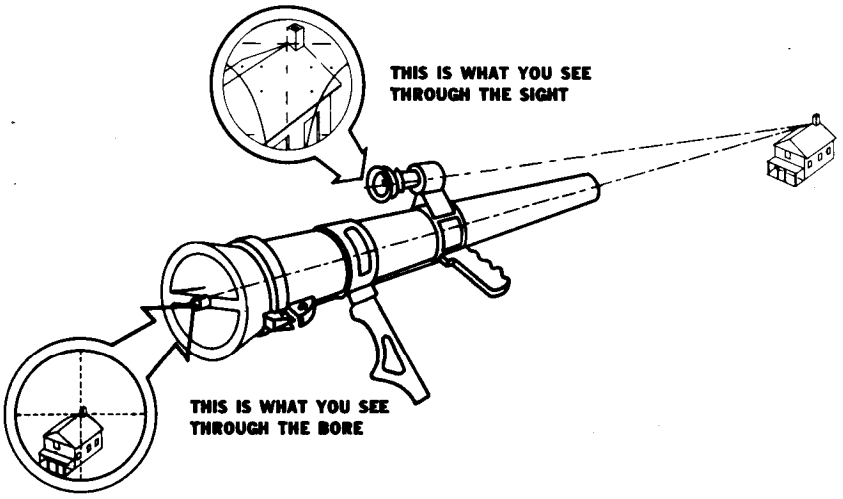

Figure 42. Sight picture in boresighting.

Section VII. ZEROING THE SUBCALIBER DEVICE

93. Target Selection

a. Accuracy with the subcaliber device depends on the zeroing procedures followed.

b. The subcaliber device for the 90mm rifle is zeroed at a greater range than the targets to be engaged. After selecting a target, place that segment of the range line which corresponds to the range of the target, over the visible center of mass of the target.

94. Firing

The gunner fires two rounds and observes their impact. While the loader holds the weapon steady, the gunner moves that range which corresponds to the range of the target to the center of impact of the two rounds. He does this with the azimuth and elevation screws located under the sight. He then resumes his original sight picture and fires two more rounds. He continues this process until he is hitting the visible center of mass of the target using his original sight picture, at which time the weapon is zeroed.