PROVISIONAL
MACHINE-GUN FIRING MANUAL

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The following Provisional Machine Gun Firing Manual, 1917, is published for the information and guidance of all concerned.
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BY ORDER OF THE SECRETARY OF WAR:

TASKER H. BLISS,
Major General, Acting Chief of Staff.

OFFICIAL:
H. P. McCAIN,
The Adjutant General.

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PROVISIONAL MACHINE-GUN FIRING MANUAL.

DEFINITIONS.

Aiming device: A device to be attached to the machine gun whereby the soldier's aim can be verified.

Anemometer: An instrument for measuring the velocity of the wind.

Automatic fire: Continued pressure on the trigger results in continuous or automatic fire to the limit of the belt, magazine, or strip. To have automatic fire with the Benet gun the cocking handle must first be set at "A."

Battle sight: The position of the rear sight in which the leaf is laid down.

Beaten zone: The intersection of the cone of dispersion with the surface on which the objective of the fire stands, or the space on the ground in which the bullets strike, in a series of shots fired by a body of soldiers with the same aiming point and the same rear-sight setting.

Bore: The cylindrical cavity in the machine-gun barrel.

Butt: The embankment or other means used to stop bullets in rear of the target. The plural "butts" is used to designate collectively the parapet, the pit, and back stop of a group of targets.

Caliber: The interior diameter of the small-arms barrel, measured between the lands.

Classification: The arranging of the individuals of an organization in groups or classes according to the degree of skill displayed in record practice on the range with the machine gun.

Combat practice: The prescribed firing at targets which simulate the appearance of an enemy under conditions approaching those found in war, and the application of this class of fire to tactical exercises.

Combined sights: Are used for the same purpose as searching fire, i. e., to secure distribution in the direction of depth. For this fire two or more guns must be employed, and such differences made in the elevation of the guns or each pair of guns that their beaten zones will overlap and a greater total depth of beaten zone be thus secured.

Cone of dispersion: A term applied to the figure formed in space by the trajectories considered together of a series of shots fired by a body of troops at a common objective and with the same rear-sight setting.

Danger space: The sum of the distances in the path of the bullet in which an object of given height will be struck. At long ranges the danger spaces at the farther end of the range alone is considered.

Defilade: An obstacle either natural or artificial of sufficient thickness to intercept projectiles and afford shelter from fire delivered from a given point.

Distributed fire: Is that in which the fire is distributed along a line, a number of different aiming points being used. These points must be selected close together to insure the target being covered with fire.

Drift: The lateral deviation of the bullet caused by the resistance of the air and the rotation of the bullet on its longer axis.

Estimating distance: Judgment by the eye of the distance of an object from the observer. Distance may also be judged by sound.

Expert rifleman, machine gun: The highest grade or classification for skill displayed in the qualification test.

Fire for effect: Has for its object the infliction of losses upon the enemy.

Fire control: Or conduct of fire, is the exercise by a commander, over his unit or units, of that power which enables him to regulate the fire in obedience to his will. It pertains especially to the technicalities immediately involved in delivery of fire.

Fire direction: Or employment of fire, is a general term embracing the various steps, including tactical disposition, which enable the commander of one or more fire units to bring an effective fire to bear upon the desired target at the proper time. It pertains especially to preparation of fire.

Fire discipline: Is that condition of the personnel of a fire unit, resulting from training and practice, which enables the commander to obtain an orderly and efficient delivery of fire.

Fixed fire: Is that class of fire in which the gun is directed and fire delivered at a small target, or at a single aiming point on a large target.

Insignia: Badges or distinguishing marks issued for expertness with the machine gun.

Instruction practice: The prescribed firing on the range which precedes record practice and which is devoted to the instruction of the soldier.

Line of aim: The imaginary right line joining the middle point of the horizontal line of the open sight, or the center of the peep sight, and the point of aim.

Marksman, machine gun: The grade of machine-gun man just below that of sharpshooter.

Mil: Is that angle whose tangent is 0.001. Is used for the computations required in the control of fire. Its value in conventional angular measure is 3′ 26.2″.

Mirage: A word used to designate the heat waves observed on the target range on warm days. The waves indicate the direction in which the air is moving.

Mil scale: In an instrument for the measurement of angles.

Parapet: An elevation of earth or other material thrown up in front of the targets to protect the markers.

Prone: Lying flat on the belly. The only position with the body extended on the ground authorized in known distance firing.

Range: Any tract of land over which firing with small arms is conducted. This term is also used to signify the distance of the objective from the firer.

Range officer: A commissioned officer charged with the care, police, etc., of a target range and its accessories.

Ranging fire: Has for its object the determination or verification of the firing data when no range-finding instrument is available.

Richochet shots: Bullets which rebound after striking the ground or any other obstacle and continue their flight are said to ricochet.

Searching fire: Is that in which the fire of the gun is distributed in the direction of depth.

Sharpshooter, machine gun: A grade of machine-gun man just below that of expert rifleman, machine gun.

String or bursts: A certain number of shots fired in strings (or bursts) of 3, 5, 10, etc., with a slight pause between each string.

Telescopic sight: A telescope or other magnifying device attached to the machine gun for getting, while aiming, a better definition of a distant objective, provision being made for adjustments in elevation and for windage.

Trajectory: The path described by a bullet in the air moving under the combined influences of the force of propulsion, the force of gravity, and the resistance of the air.

Twist: The spiral formed by the grooves in the barrel of a rifled piece. In the barrel of the machine guns this twist is uniform, one turn in 10 inches.

Unqualified: Those who in the last practice season failed to qualify as a marksman, machine gun, or better, and those who for any reason did not fire the course and are not otherwise classified.

Windage: The influence of the wind in deflecting the bullet from the point at which it is aimed.

Wind gauge: A graduated attachment on the rear sight of the gun by which allowance may be made in aiming for the effect of the wind upon the bullet and for drift.

PART I.

GENERAL SCHEME.

1. OBJECT OF INSTRUCTION.—The machine gun is a weapon of remarkable powers and limitations. The ultimate purpose of machine-gun instruction is to insure, by means of a thoroughly trained personnel, a minimizing of the gun's limitations and a maximum effective utilization of its fire power on the field of battle.

A satisfactory course of instruction should therefore be progressive, treating first of the training of the individual and then of the organization as a whole.

2. SCHEME OF INSTRUCTION.—The course is arranged herein as follows:

(1) INDIVIDUAL.

(*a*) Nomenclature, use, care and repair of guns, and accessories.
(*b*) Physical training.
(*c*) Sighting, position, and aiming exercises.
(*d*) Use of instruments.
(*e*) The determination of ranges.
(*f*) Recognition and designation of targets.
(*g*) Known distance firing, instruction practice.
(*h*) Known distance firing, record practice.
(*i*) Determination of sight setting.
(*j*) Field firing, instruction practice.
(*k*) Indirect fire.
(*l*) Overhead fire.
(*m*) Night firing.

(*n*) Qualification tests:

A. Matériel.
B. Determination of ranges.
C. Sight setting and recognition of targets.
D. Record of known distance practice (taken from company records).
E. Field firing.

(2) COLLECTIVE.

(*a*) Combat firing, instruction practice.
(*b*) Combat firing, record practice.

3. THE COURSE IN PISTOL FIRING INCLUDES THE FOLLOWING (see S. A. F. M.):

(*a*) Nomenclature and care of the pistol, general facts and principles.
(*b*) Position and aiming drills and rapid-fire drills, dismounted.
(*c*) Individual firing, instruction practice.
(*d*) Individual firing, record practice.

4. PERIOD OF PRELIMINARY INSTRUCTION.—Instruction in the nomenclature, use, care and repair of guns, and accessories is given each man as soon as possible after he joins the organization. The portion of the year which immediately precedes the instruction of the soldier on the target range should be utilized in physical-training drills, sighting, position and aiming drills, use of instruments, determination of ranges, recognition and designation of targets and the theoretical principles of indirect fire, overhead fire, night firing, adjustment of fire, and fire for effect.

While it is essential that the gun crews, and especially the men who actually handle the guns, be trained to the highest degree of expertness in the firing of the guns, it must be emphasized that in battle the guns must never stop firing through lack of a trained personnel, hence every member of a machine-gun organi-

zation must be given an adequate course of instruction. Therefore, every officer and enlisted man in the organization is required each year to go through the course of preliminary training and, with the exception of the cooks, the sick, and those absent under proper authority, all officers and enlisted men who join prior to known distance firing will take part in the individual firing to include the known distance firing in the qualification test. The cooks are authorized but not required to fire.

5. SUPPLEMENTARY PRACTICE SEASON.—A supplementary course of instruction is prescribed for the benefit of recruits This practice is for the purpose of preventing an accumulation of recruits totally uninstructed.

6. DISCRETION ALLOWED INSTRUCTORS.—Standards of proficiency being set for the individual and the organization and the purposes of target practice being understood, it is expected that as far as practicable instructors will be given some latitude in methods to suit peculiarities of individuals and special conditions. Accordingly, while the methods laid down for the preliminary work and instruction courses are given in some detail, these need not necessarily be followed implicitly when departures therefrom appear to be justifiable or advantageous. The education and training of the soldier is a long and tedious process, consequently improvements in methods should be constantly sought by the instructor with a view to raising the standards of instruction, decreasing its cost, and shortening the time required for training. Reports should be made of new and successfully applied methods.

7. DUTIES OF COMPANY AND TROOP OFFICERS.—The company or troop commander is responsible for the training of the individuals of his organization. He is responsible that his organization attains a suitable standard of proficiency. He will be assisted by his lieutenants, noncommissioned officers, and such men of the organization as are experts in one or more phases of the work. These assistants must have the theoretical and

practical instruction necessary to fit them to be coaches and instructors.

8. DUTIES OF THE REGIMENTAL COMMANDER.—The regimental commander is the supervisor and inspector of the firing instruction of the machine-gun organization of his regiment. Through observation and supervision he assures himself that the organization is receiving proper instruction in accordance with the spirit of these regulations. He supervises the combat firing exercises of the machine-gun organization and endeavors to develop to the fullest extent the educational value of these exercises. The actual conduct of the exercises may be turned over by the regimental commander to a suitable officer, but in al such exercises in which the machine-gun organization participates as a whole he will be present whenever possible.

At the end of the target season he will submit, with the report of combat firing (pars. 287–293), a brief report upon the state of the instruction and training of the machine-gun organization with reference to its fire efficiency.

9. DUTIES OF THE POST, CAMP, OR CANTONMENT COMMANDER.—The post, camp, or cantonment commander will exercise a general supervision of the machine-gun practice of troops at his post and direct supervision over the machine-gun practice of troops pertaining to the tactical unit to which he belongs. When troops of different brigades are serving at the same post he will see that the approved programs with reference to machine-gun practice prescribed in accordance with instruction orders of the War Department are faithfully complied with.

He will designate the months of the year most suitable for machine-gun practice, including the supplementary practice season, for his command, and when combat-firing facilities do not exist on the reservation should use every effort to procure suitable grounds in the vicinity so that the advantage of this training may not be lost.

10. DUTIES OF THE DEPARTMENT COMMANDER.—The department commander will supervise the machine-gun training of the troops in his department, and will make every effort to have complete facilities for this instruction at every post. He will satisfy himself that the purposes of instruction in firing are fully understood and carried out, and to this end he will make the necessary examination of the firing records and order such test firings at the time of his annual inspection as he may deem advisable and of which the ammunition available will admit.

PART II.

INDIVIDUAL INSTRUCTION.

CHAPTER I.

NOMENCLATURE, USE, CARE, AND REPAIR OF MACHINE GUNS AND ACCESSORIES.

11. DEFINITION.—An automatic machine gun may be broadly defined as a device for firing small-arms ammunition at a high rate of speed, the operations of loading, firing, and ejection being performed by the gun itself.

It is desirable, however, to distinguish between the two types of weapons which conform to this general definition. A *machine gun* is a water-cooled gun, mounted on a tripod or other mount weighing approximately as much as the gun, and capable of a continuous fire limited only by the ammunition supply. The Maxim and Vickers are such guns. An *automatic rifle* is an air-cooled gun not capable of continuous fire both on account of the manner of loading and on account of the inability of the air-cooling system to take care of the heating caused by continuous fire and intended to be carried and fired approximately like an infantry rifle. The Lewis and Benet-Mercié are of the automatic-rifle type.

For convenience, the machine gun proper is designated herein as the *heavy gun* and the automatic rifle as the *light gun*, while the term "machine gun" includes both types.

12. Machine guns are again divided into two classes, depending upon the source of power used for performing the mechanical operations involved. These are (*a*) recoil-operated guns, which are operated by the movement of the barrel to the rear as the bullet leaves the muzzle, and (*b*) gas-operated guns, which utilize the pressure of the powder gas on a piston for motive power.

These weapons are nothing more than highly specialized gas engines with all the complications of this type of machine. It is therefore essential that there be a thorough familiarity with the operation of the gun as a piece of machinery before any attempt is made to utilize its fire effect.

13. INSTRUCTION IN THE MECHANICS OF THE GUN.—The soldier as soon as practicable after joining the organization will be given thorough training in the nomenclature, functions of the parts, and operation of the gun. The instructor will simulate jams and other gun troubles and will require the soldier to explain and correct them. Similar instruction will be given in the use and care of the accessories, such as the mount, loading machine, etc., and in the replacing of damaged and broken parts of the gun and accessories, using the spare parts furnished. Spare parts will, however, be habitually retained in their containers and not used in firing, except when necessary to replace damaged parts in the gun. In this way the spare parts on hand will always be new and serviceable. The instruction under this paragraph will be completed before the soldier begins individual firing on the range.

14. USE OF ORDNANCE HANDBOOKS AND MANUALS.—The ordnance publications on the nomenclature, use, care, and repair of the particular gun and equipment with which the organization is armed will be used as the text in the instruction to be given under the preceding paragraph.

CHAPTER II.

PHYSICAL TRAINING.

15. OBJECT.—Physical training is for the purpose of developing the soldier physically, especially the lungs and the muscles of the arms, hands, shoulders, chest, back, neck, and eye.

The muscles used in the act of firing a machine gun are not those in daily use in the ordinary walks of life. It is necessary therefore to train them in such manner as to assure their prompt and accurate obedience to the will.

The various calisthenic exercises in general use throughout the service, and outlined in the Manual of Physical Training, when carefully followed, give excellent results.

16. In calisthenic exercises it is advantageous to apply the principle of muscular opposition. For example, if the exercise is to bend the arm at the elbow, oppose that movement with the muscles which straighten the arm; if bending the body to the right, oppose the movement with the muscles which bend the body to the left; if bending the head to the front, oppose it with the muscles which move the head to the rear, etc. By this procedure, all the muscles are made to do a greater amount of work and hence development is quicker.

Muscular training is essential in order that prolonged firing may not result in movements becoming slow and inaccurate because of fatigue.

CHAPTER III.

SIGHTING, POSITION, AND AIMING DRILLS.

17. OBJECT.—These exercises are designed with a view to giving the soldier practice; in assuming the firing position quickly and correctly; in sighting quickly and with pre-

cision; in the use of the elevating and traversing mechanism thus insuring its movement in the proper direction without hesitation or error; in reloading to the point where this operation becomes almost automatic, and in making such changes in the point of aim as would be required in distributing fire over targets of various shapes and sizes.

A thorough course in preliminary exercises given the soldier prior to his known distance practice, should give a knowledge of what to do and the manual dexterity requisite to the accomplishment of his task.

SIGHTING AND AIMING DRILLS.

18. VALUE.—The value of sighting and aiming drills can not be too strongly emphasized.

19. TO WHOM GIVEN.—The sighting drills will be given to all soldiers who have not qualified as "marksmen" or better in the preceding target year.

20. PURPOSE.—Sighting drills.

(*a*) To show how to align the sights properly on the mark.

(*b*) To discover and demonstrate errors in sighting.

(*c*) To teach uniformity in sighting.

21. APPARATUS AND ITS USE—SIGHTING BAR.—(See Pl. I.) To consist of:

(*a*) A bar of wood about 1 inch by 2 inches by 4 feet, with a thin slot 1 inch deep cut across the edge about 20 inches from one end.

(*b*) A front sight of tin or cardboard ½ inch by 3 inches tacked to the end nearer the slot and projecting 1 inch above bar.

(*c*) An eyepiece of tin or cardboard 1 inch by 3 inches tacked to the other end of, and projecting 1 inch above, the bar, with a very small hole (0.03 inch) ½ inch from top of part projecting above the bar.

(*d*) An open rear sight of tin or cardboard 1½ by 3 inches, with a U-shaped notch ¾ inch wide cut in the middle of one of

the long edges. This is placed in the slot on the bar. A slight bend of the part of the tin fitting in the slot will give enough friction to hold the sight in any part of slot in which it is placed.

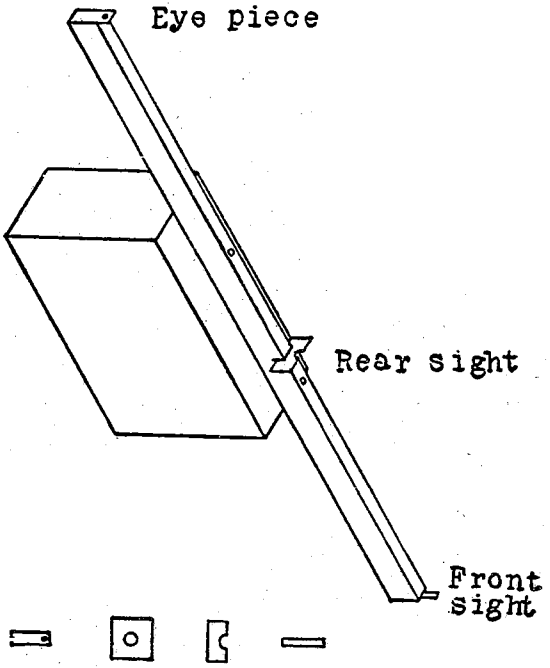

PLATE 1.

(*e*) A peep rear sight of tin or cardboard 3 by 3 inches, with a peep hole ¾ inch in diameter cut in the center. This replaces the open sight when the peep sight is shown.

Carefully blacken all pieces of tin or cardboard and the top of the bar. Nail the bar to a box about 1 foot high and place on the ground, table, or other suitable place. Then adjust the open or peep rear sight in the slot and direct the bar upon a bull's-eye (preferably a Y target) placed about 5 yards from the bar. No other than the sight desired can be seen. Errors, etc., are shown by manipulating the open and peep rear sights.

22. TARGET FOR SIGHTING DRILL AND ITS USE.—Nail a plank to a stake or wall at the proper height from the ground—about 30 inches for heavy-type gun and about 12 inches for light type of gun. Fasten a sheet of paper to the plank. Place the gun in position 100 yards from target, so that the gun is canted neither to right nor left, and without touching the gun sight it near the center of the blank sheet of paper. The distance of 100 yards places the objective far enough away to insure that the sights and the target can not all be seen distinctly and at the same time with a single focus of the eye, thus forcing the individual to focus the eye on the objective in order to secure accurate results. Changes in the line of sight are made by changing the elevating and traversing gears. Take the prone position with elbows on the ground, hands supporting the head. A soldier acting as a marker is provided with a pencil and a small rod bearing a disk of black cardboard about 4 inches in diameter, pierced in the center with a hole just large enough to admit the point of a lead pencil. The soldier sighting directs the marker to move the disk to the right, left, higher, or lower until the line of aim is established, when he commands "Mark" or "Hold." At the command "Mark," being careful not to move the disk, the marker records through the hole in its center the position of the disk and then withdraws it. At the command "Hold" the marker holds the disk carefully in place without marking until the position is verified by the instructor, and the disk is not withdrawn until so directed.

23. LINE OF SIGHT.—With the open sight the line of sight is determined by a point on the middle line of the notch of the rear sight and the top of the front sight. With the peep sight the line of sight is determined by the *center* of the peep and the top of the front sight.

24. POINT OF AIM.—The soldier will be informed that to give the greatest uniformity a point just below the mark, and not the mark, is taken as the *point of aim*, as it is impossible to always know, if touching the mark with the top of the front sight, how much of the front sight is seen; that the term "on the mark or bull's-eye" will be understood to mean an aim, taken just below the mark, showing a fine line of light between the mark and the top of the front sight.

25. THE NORMAL SIGHT.—Look through the rear sight notch at the bull's-eye or mark and bring the top of the front sight on a line with the top of and in the center of the rear sight notch and aligned upon the point of aim. (See fig. 1, pl. 2.)

26. THE PEEP SIGHT.—Look through the peep hole at the bull's-eye or mark and bring the top of the front sight to the center of the aperture and aligned upon the point of aim. (See fig. 2, pl. 2.)

The soldier should be informed that regular results in firing can be obtained only when the same amount of front sight is taken each time, and that this can be done only by using the normal sight with the open notch or the peep sight in the manner described above. He should understand that the effect of taking less than the normal amount of sight is to cause a point lower than that aimed at to be struck, and that taking too much of the front sight causes a higher point to be struck.

Although men will be found occasionally who can get excellent results by using the fine sight (fig. 3, pl. 2), the average man can not, and this form of sighting is not recommended. The so-called full sight should not be taught under any circumstances. If shown to the men at all, it should be for the purpose of pointing out a fault to be carefully avoided.

REMARKS.—The eye can be focused accurately upon objects at but one distance at a time; all other objects in the field of view will appear more or less blurred, depending on their distance from the eye. This can readily be seen if a pencil is placed in the field of view near the eye while looking at some distant object. The pencil will appear blurred. This is the condition met with by the normal eye in sighting a gun. If the eye is focused on one of the three points—the bull's-eye, the front sight, or the rear sight—the other two will appear blurred. This blurring effect is best overcome by using the "peep sight," as though looking through a window, and focusing the eye on the bull's-eye. The blurring of the peephole will be concentric, giving a clear and easily defined center. The blurring of the front sight will be less, but symmetrical on both sides, with very little blur on the top. It can be readily and naturally brought to the center of the peephole. Variations in light have less effect on the peep than on the open sight.

But the limited field of view and lack of readiness in getting a quick aim with the peep sight limit its use to those stages of the combat when comparative deliberation will be possible. In the later stages of the battle—especially when a rapid fire is to be delivered—the open sight will, in most cases, be used. In this case the normal sight should be used, as the horizontal line at the top of the notch of the rear sight affords a good guide for regularity.

Whatever sight is used, the eye must be focused on the bull's-eye, or mark, not on the front or rear sight.

27. METHODS OF SIGHTING.—The methods in sighting machine guns are not the same for the different types of gun.

The heavy gun (tripod mount) is laid on the target, i. e., sighted at the target before firing commences, but no attempt is made to keep the eye on the sights while firing, the aim being corrected between bursts or strings. On the other hand, with the light gun the general alignment of sights is maintained during the firing.

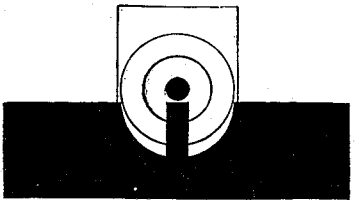

FIG. 1

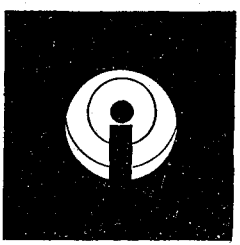

FIG 2.

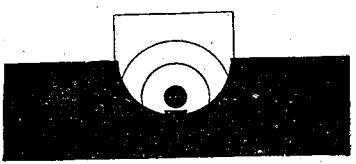

FIG. 3.

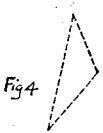

Fig 4

FIG. 5.

PLATE 2.

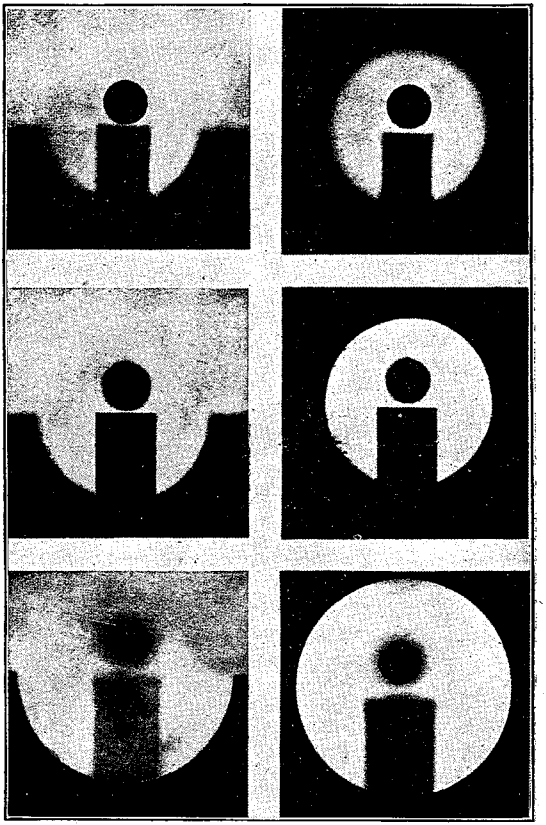

PLATE 3.

FIRST EXERCISE.

28. Using illustrations, describe the normal sight and the peep sight.

29. Using the sighting bar, represent the normal sight and the peep sight and require each man in the squad to look at them.

30. Using the sighting bar, describe and represent the usual errors of sighting and require each man in the squad to look at them.

SECOND EXERCISE.

31. Using the method described in paragraph 22, require each man to direct the marker to move the disk until the gun is directed on the bull's-eye with the normal sight and command "Hold." The instructor will verify this line of sight. Errors, if any, will be explained to the soldier and another trial made. If he is still unable to sight correctly, the first exercise will be repeated.

Soldiers will sometimes be found who do not know how to place the eye in the line of sight; they often look over or along one side of the notch of the rear sight and believe that they are aiming through the notch because they see it at the same time that they do the front sight. This error will probably be made evident by the preceding exercise. Some men in sighting will look at the front sight and not at the object. As this often occasions a blur, which prevents the object from being distinctly seen and increases both the difficulties and inaccuracies of sighting, it should be corrected.

32. Repeat the above, using the peep sight.

THIRD EXERCISE.

33. Using the method described in paragraph 22, require each man to direct the marker to move the disk until the gun is directed on the bull's-eye with the normal sight and command "Mark"; then, being careful not to move the gun or sights, repeat the operation until three marks have been made.

(*a*) THE TRIANGLE OF SIGHTING.—Join the three points determined as above by straight lines, mark with the soldier's name, and call his attention to the triangle thus formed. The shape and size of this triangle will indicate the nature of the variations made in aiming.

(*b*) ABNORMAL SHAPES, CAUSES.—If the longer sides of the triangle approach the vertical (see fig. 5, pl. 2), the soldier has not taken a uniform amount of front sight. If the sides of the triangle are more nearly horizontal (see fig. 4, pl. 2) the errors were probably caused by not looking through the middle of the notch or not over the top of the front sight. The instructor will explain that the sighting gains in regularity as the triangle becomes smaller.

(*c*) VERIFYING THE TRIANGLE.—If the sides of the triangle are so small as to indicate regularity in sighting, the instructor will mark the center of the triangle and then place the center of the bull's-eye on this mark. The instructor will then examine the position of the bull's-eye with reference to the line of sight. If the bull's-eye is properly placed with reference to the line of sight, the soldier aims correctly and with uniformity. If not so placed, he aims in a regular manner but with a constant error.

As a final test of the ability of the individual to use the sights with uniformity and precision, he should be required to make three "sighting triangles" in succession, no one of these triangles to be of such size that it can not be contained within the circumference of a circle 1 inch in diameter.

A convenient gage for measuring these triangles may be improvised by boring a 1-inch hole in a thin piece of sheet metal. By bending one edge of this piece of metal to form a convenient handle, this gage may be applied easily to the face of the surface on which the triangle was made and thus the instructor may determine by a quick inspection whether the result is within or without the prescribed limit.

34. (*d*) CAUSES OF ERRORS.—If the bull's-eye is directly above its proper position, the soldier has taken in aiming too little front sight, or if directly below too much front sight. If directly to the right or left, the soldier has not sighted through the center of the rear-sight notch and over the top of the front sight. If to the right he has probably either sighted along the left of the rear sight notch or the right side of the front sight, or has committeed both of these errors. If the bull's-eye is too

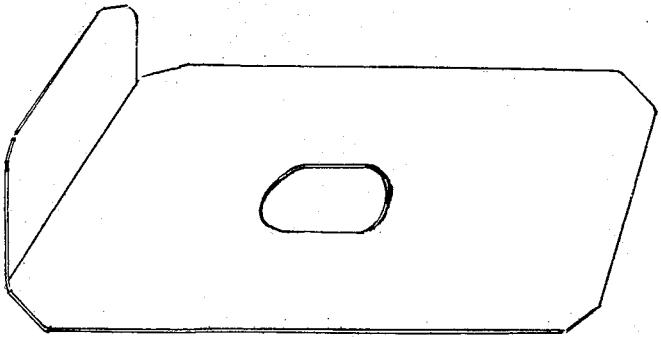

PLATE 4.
Sighting gage.

far to the left, he has probably sighted along the right of the rear sight notch or to the left of the front sight or has combined both of these errors.

If the bull's-eye is placed with reference to its proper position diagonally above and to the right, the soldier has probably combined the errors which placed it to high and too far to the right. Any other diagonal position would be produced by a similar combination of vertical and horizontal errors.

As the errors thus shown are committed when the gun is fixed in position, while that of the target or bull's-eye is altered,

the effect will be directly opposite to the changes in the location of a hit in actual fire, occasioned by the same errors, when the target will be fixed and the gun moved in aiming.

After the above instruction has been given to one man, the line of sight will be slightly changed by moving the gun or by changing the elevating and traversing gears, and the exercises similarly repeated with the other men of the squad.

35. Repeat the third exercise, using the peep sight.

FOURTH EXERCISE.

36. This exercise is a demonstration of the effect of canting the gun. The soldier must be impressed with the necessity of keeping the sights vertical when aiming, and not canting the gun to right or left. Explain to the soldier that if the gun is canted to the right, the bullet will strike to the right and below the point aimed at, even though the gun be otherwise correctly aimed and the sights correctly set. Similarly, if the gun is canted to the left, the bullet will strike to the left and low. This can be explained by showing that the elevating gear fixes the height of the point where the bullet will hit the target, and the traversing gear fixes the point to the right or left; i. e., elevating gives vertical and traversing horizontal effects. Let a pencil (or rod) held vertical represent the elevation; now if the pencil is turned to the right 90°, or horizontal, all of the elevation has been taken off, causing the shot to strike low and changed into traversing, causing the shot to strike to the right. Emphasis should be laid on the fact that this effect of canting increases with the distance from the target.

37. OTHER EXERCISES.—If time permits, the instructor may devise other exercises which suggest themselves as useful and beneficial to his men. The following are examples:

(*a*) In strong sunlight make a triangle by sighting, using a gun having sights worn bright. Then being careful not to move the gun blacken sights and make another triangle. Use dotted lines for the triangle made with bright sights and full lines for the triangle made with blackened sights. The position and size

of the two triangles will plainly show the advantage of blackened sights.

(*b*) In strong sunlight make a triangle by sighting; then, being careful not to move the gun, make another triangle having first shaded the target and the man sighting. The relative position of the triangles will show the importance of knowing the effects of varying degrees of light.

POSITION EXERCISES.

38. The instructor illustrates the proper firing position and explains the reasons for taking that particular position in preference to any other.

It is not considered desirable nor necessary to prescribe hard and fast rules as to all the details of all of the firing positions with the defferent types of guns.

The illustrations of positions given herein show those positions that have given the best results, and also show the most common faults.

39. BENET-MERCIÉ RIFLE.

CORRECT POSITION.

PLATE 5.

CORRECT POSITIONS.

PLATE 6.

PLATE 7.

CORRECT POSITION.

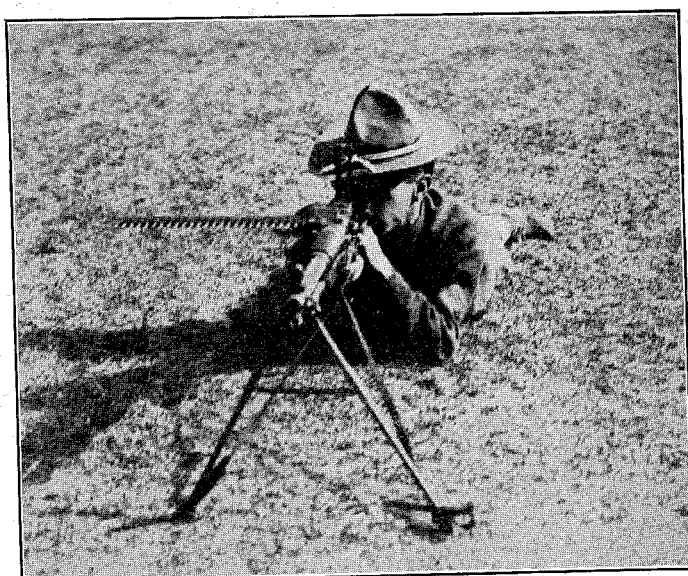

PLATE 8.

CORRECT POSITION.

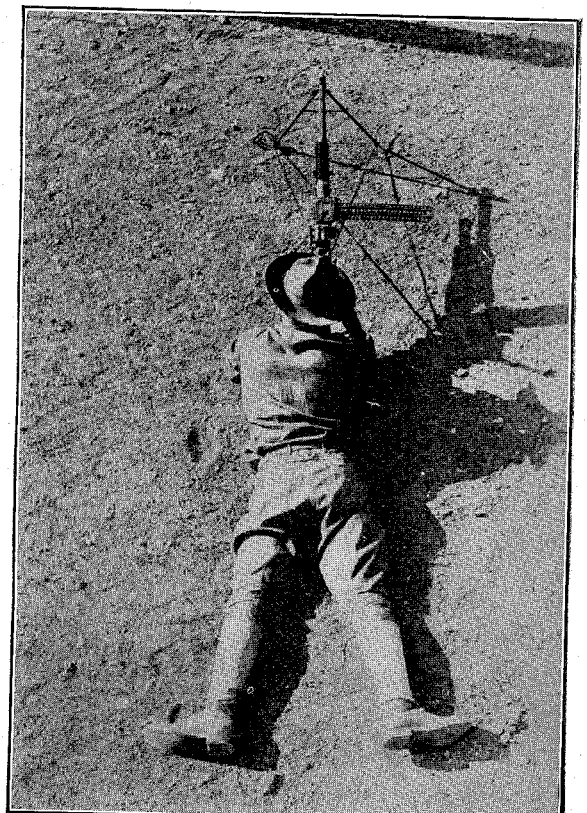

PLATE 9.

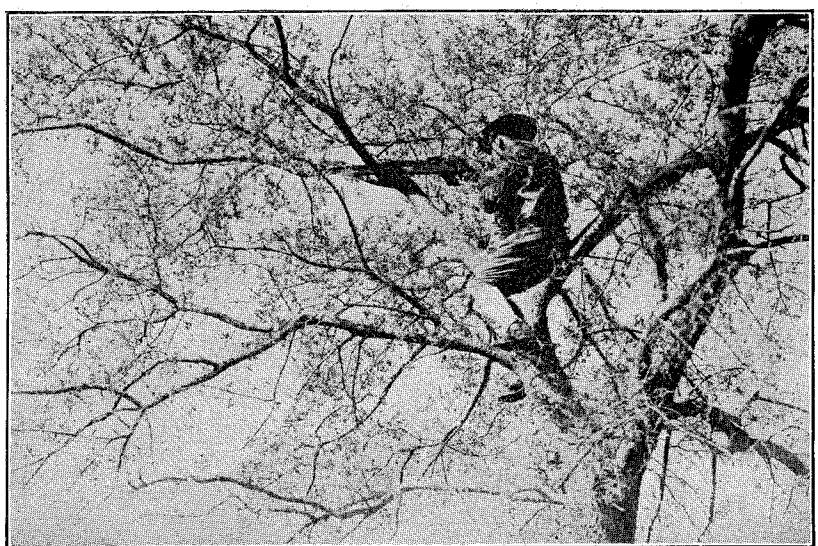

PLATE 10.
Good position in tree.

CORRECT POSITION.

PLATE 11.

On hillside.

INCORRECT POSITION.

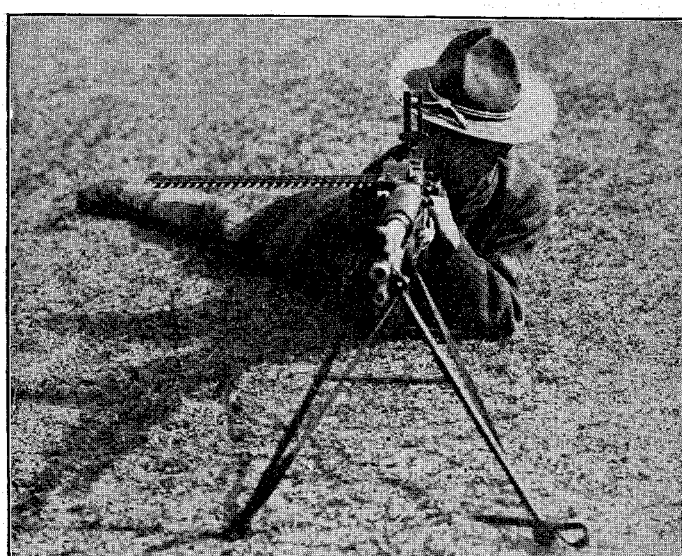

PLATE 12.

Body inclined to right—will cause gun to traverse.

INCORRECT POSITION.

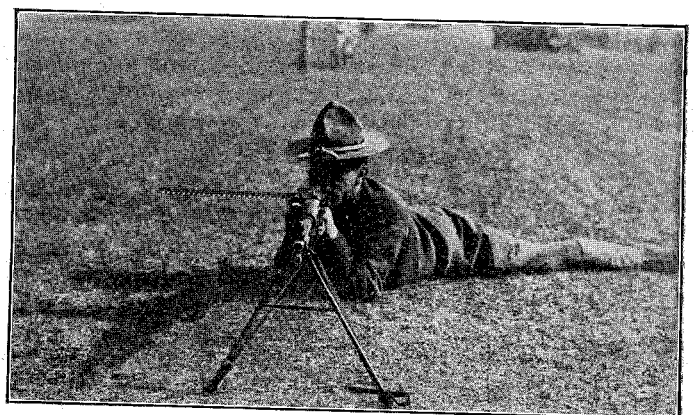

PLATE 13.

Body inclined to left—will cause gun to traverse.

INCORRECT POSITION.

PLATE 14.

Body inclined to left—will cause gun to traverse.

INCORRECT POSITION.

PLATE 15.

Piece canted on hillside.

PLATE 16.

Body inclined to right—head not in position to see sights.

PLATE 17.
Causes gun to traverse.

40. Lewis Machine Gun.

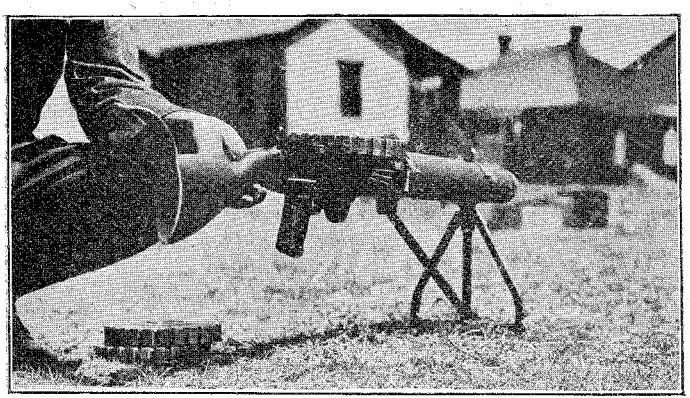

Plate 18.

Showing butt tang, disk on rear sight slide and front sight cover attached.

PLATE 19.

Body in prolongation of bore, feet slightly spread.

CORRECT POSITION.

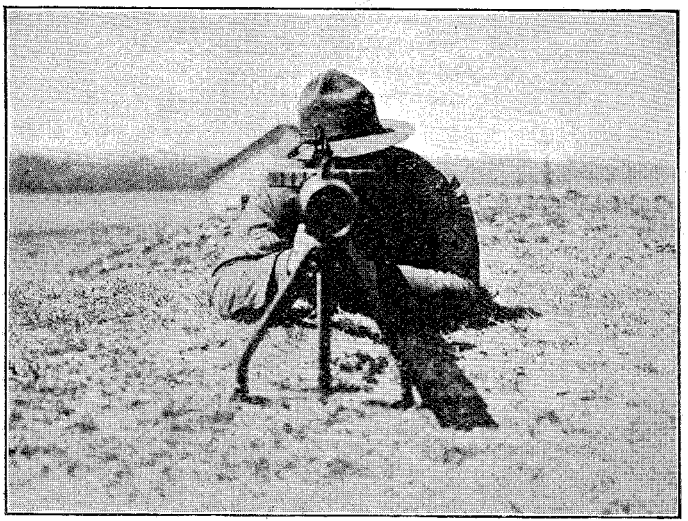

PLATE 20.

Front view; guard gripped with both hands, no exposure of body or legs.

INCORRECT POSITION.

PLATE 21.

Body at an angle with respect to the bore (as when firing infantry rifle).

INCORRECT POSITION.

PLATE 22.

Front view; exposure of body and leg.

PLATE 23.

Reloading. Loader changing magazines from prone position of gunner's left. Working on the gunner's left, the loader can rest on his left elbow and manipulate the magazine catch with his right hand from the prone position; further, he is not distracted by the empty cartridges which are ejected with considerable force from the right side of the receiver and slightly to the rear.

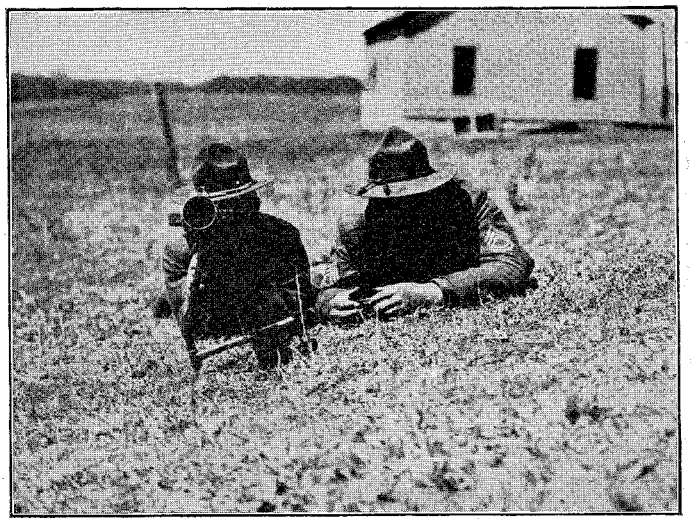

PLATE 24.

A correct position on a hillside. Field mount canted, barrel turned in yokes, bringing sights vertical.

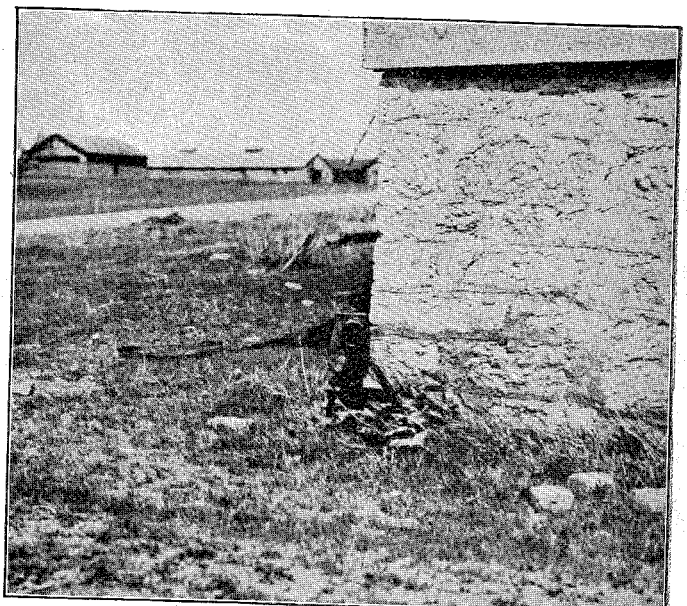

PLATE 25.

Correct firing around corner of building. Field mount legs in front of corner.

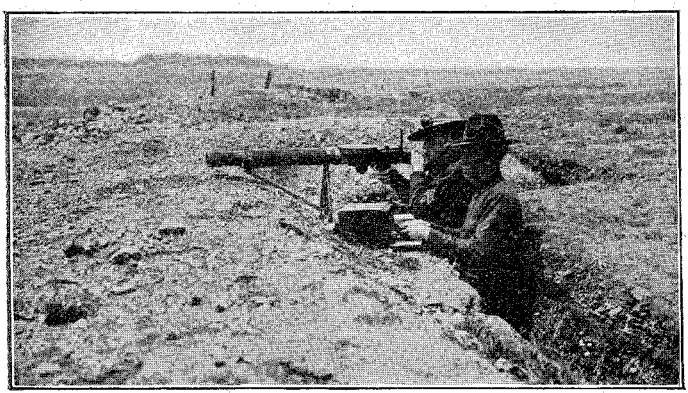

PLATE 26.

Correct firing over parapet of trench. Field mount reversed to permit wide distribution. Loader in incorrect position—fully exposed.

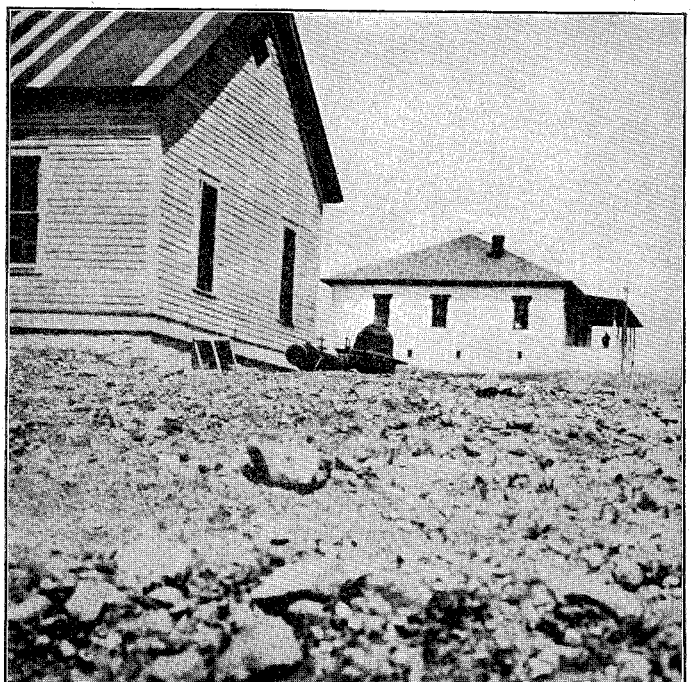

PLATE 27.

Correct firing over parapet. Front view.

PLATE 28.

Correct firing over parapet of trench. Barrel resting on parapet, field mount removed. Note loader taking advantage of cover and reducing visibility.

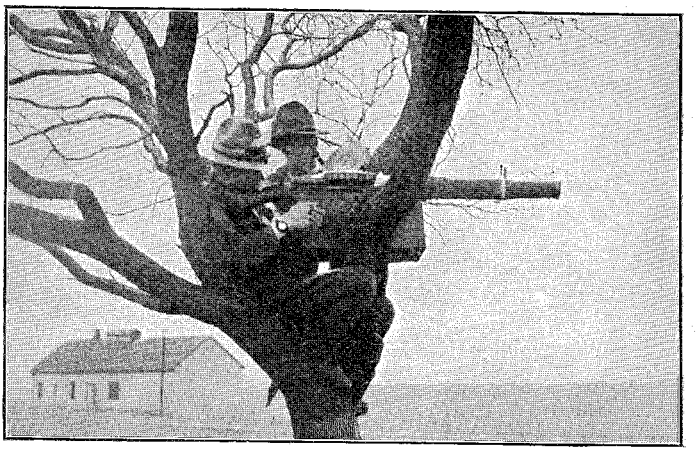

PLATE 29.

Correct firing from position in a tree.

41. With the Benet-Mercié, uniform support for the piece is secured to a great degree by the use of the barrel rest and the elevating mechanism. This uniformity is not absolute, however, unless the position of the barrel rest relative to the barrel is also uniform.

The most uniform results are obtained when the legs of the barrel rest—looking at the piece from the side—are at right angles to the axis of the bore. When the legs are inclined to the rear from their point of attachment to the barrel, the resulting shot group will be high, and when they are inclined to the front the shot group will be low. A uniform position of these legs may be secured by the use of the leather thong supplied for this purpose.

It may be necessary at times to dispense with the use of the elevating mechanism and the muzzle rest, and support the rifle merely on the parapet, a sandbag, or some other improvised mount. The use of such a support usually will be at short ranges where slight errors of elevation will be of little moment. In firing in this manner more satisfactory results are obtained when the point of support is at the balance of the piece than elsewhere.

When the tripod mount is not used the degree and direction of resistance to the recoil is dependent upon the position of the firer.

With the infantry rifle one is taught to incline the body to the left when firing in the prone position.

With the automatic rifle, either Benet-Mercié or Lewis, such a position results in the impact being to the left of the objective, as the recoil forces the shoulder to the right as well as to the rear, and the shots come in such quick succession that there is insufficient time between shots for the firer to resume or recover his original position.

Therefore the firer's body should be inclined neither to the right nor the left, but should be directly in prolongation of the plane of fire. This will assure the movement of the shoulder

being in the same direction as the recoil, i. e., straight to the rear. (See pl. 7.)

Additional steadiness is secured by pressure of the butt against the shoulder, this pressure being exerted by the right arm and, at times, by the left also.

In using the infantry rifle one is taught to seek a good position and then attempt to hold steadily by drawing his rifle *back* hard against the shoulder.

With the automatic rifle similar methods are used when the piece is fired from a parapet or sandbag rest. This he accomplishes by forcing the shoulder forward against the butt and at the same time drawing the piece back against the shoulder by pressure with the arms.

Care is taken in the beginning not to keep the individual too long in the firing position, for it is quite fatiguing to the untrained man.

Speed is next sought—never at the expense of accuracy, however—and the exercise continued until the desired standard is reached.

Speed and accuracy is next sought in taking the firing positions from the standing and from the crawling position.

42. VICKERS.

POSITION FOR FIRING.

PLATE 30.

Gun set up on fairly steep reverse slope.

POSITION FOR FIRING FROM ENTRENCHMENT.

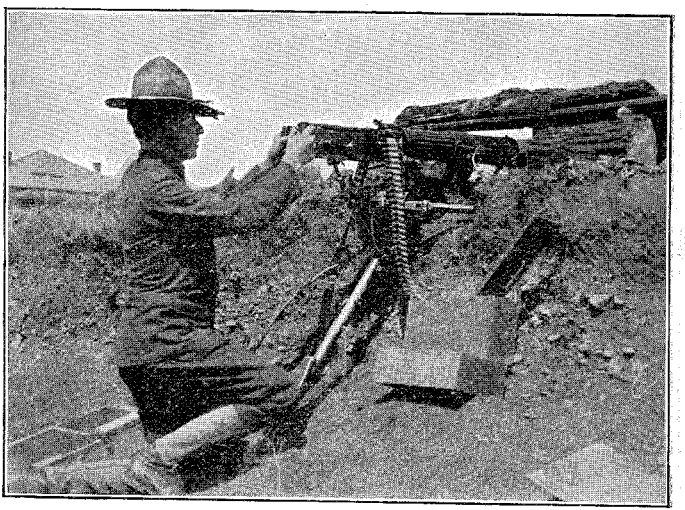

PLATE 31.

Front legs may be set into parapet or rest on top of parapet.

INCORRECT SET-UP.

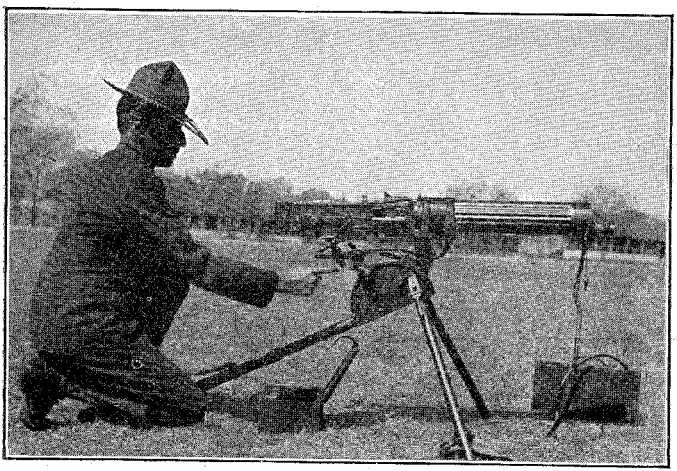

PLATE 32.

Top carriage too far to front; vertical axis of mount inclined to front and traversing surface not level.

CORRECT POSITION FOR EMERGENCY FIRE TO LEFT FLANK.

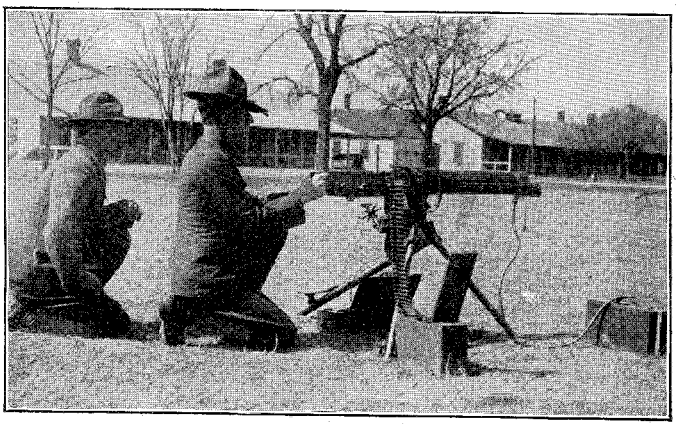

PLATE 33.

Gun released from elevating gear but still supported by tripod.

CORRECT POSITION FOR FIRING UP VERY STEEP SLOPE.

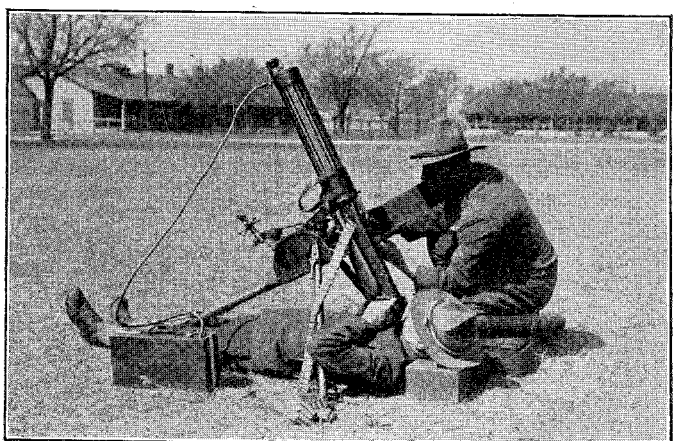

PLATE 34.

At top of high buildings, at aeroplanes, etc.

CORRECT POSITION FOR FIRING.

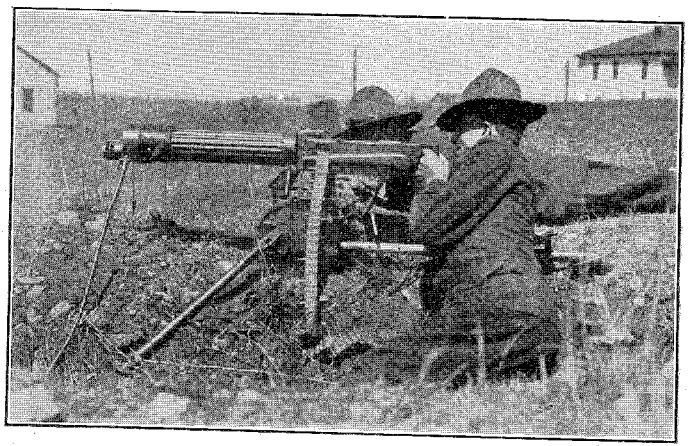

PLATE 35.

Gun set up on rough ground sloping to the front and left. Gunner utilizing slope of ground for partial cover.

CORRECT POSITION FOR FIRING.

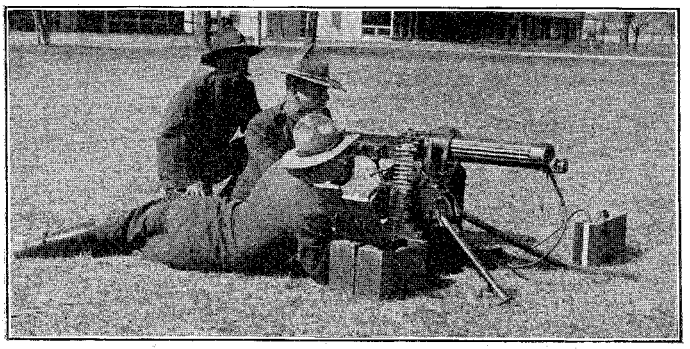

PLATE 36.

Mount in intermediate position. Squad leader kneeling. Gunner in crouching sitting position. Loader and No. 3 prone.

CORRECT POSITION FOR FIRING.

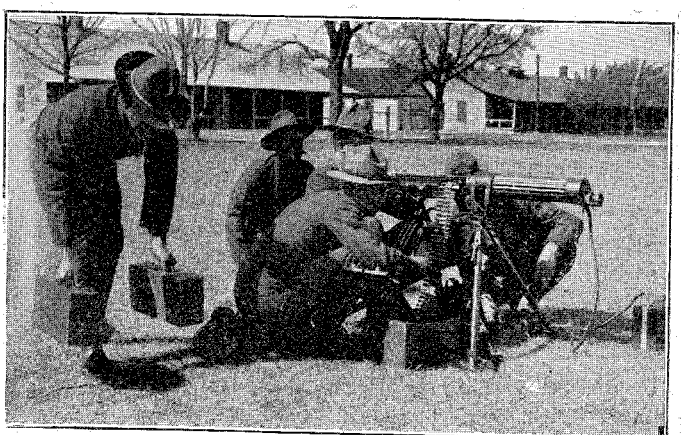

PLATE 37.

Mount in highest normal position. Crew kneeling.

Squad leader in rear.
Gunner on seat.
Loader on right side of gun.
No. 3 on left side of gun.
No. 4 bringing up ammunition.
No. 5 and No. 6 (not shown), ammunition bearers.

CORRECT POSITION FOR FIRING.

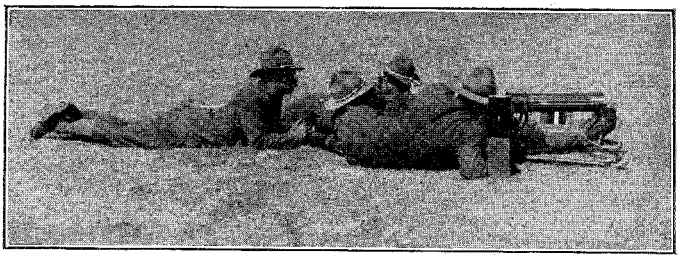

PLATE 38.

Prone, lowest position of mount. Gunner's head rests on loader's left leg.

CORRECT POSITION FOR FIRING.

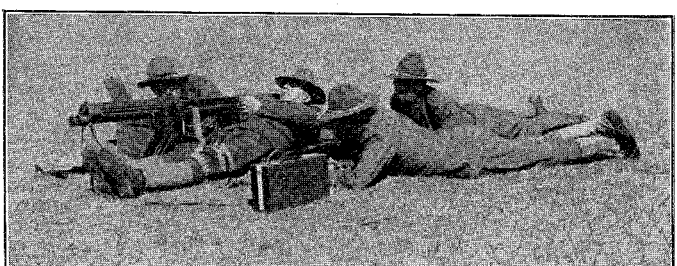

PLATE 39.

Prone, lowest position of mount. Gunner's head rests on loader's left leg.

INCORRECT SET-UP.

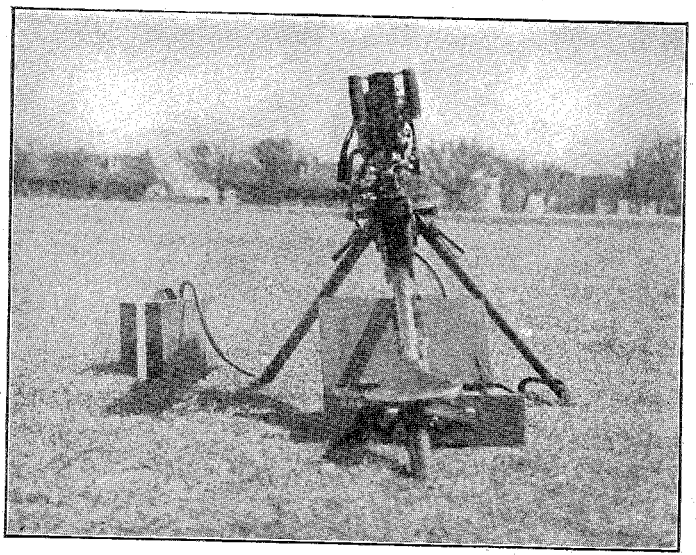

PLATE 40.

Left front leg too much inclined, throwing vertical axis of mount to left.

43. MAXIM.

Feet flat on ground. Weight of body entirely on seat. Elbows on knees. Both hands grasping handles firmly, both thumbs free to press trigger. Right thumb on safety catch, left thumb on trigger. Body inclined forward so as to bring the eye as near the rear sight as possible. Pull straight down with considerable force on the handles while firing and *hold* the gun firmly.

CORRECT POSITION.

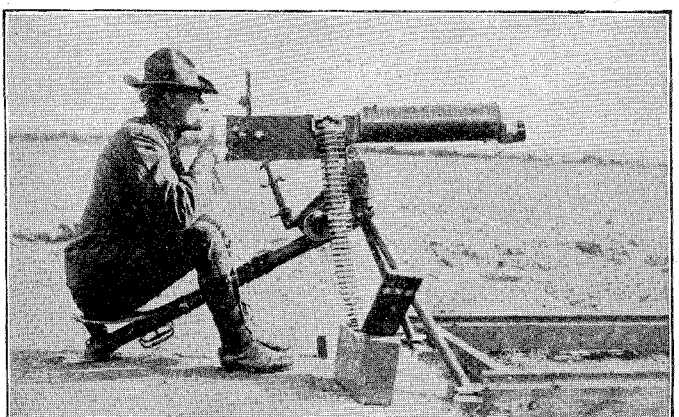

PLATE 41.

Trail in.

It is impossible for the gunner to maintain his line of sight while firing, but men must not be allowed to acquire the habit of throwing the body to the right or left or to lean back to the full extent of the arms. All these movements allow the gun to vibrate more freely than when held in the correct position.

INCORRECT POSITION.

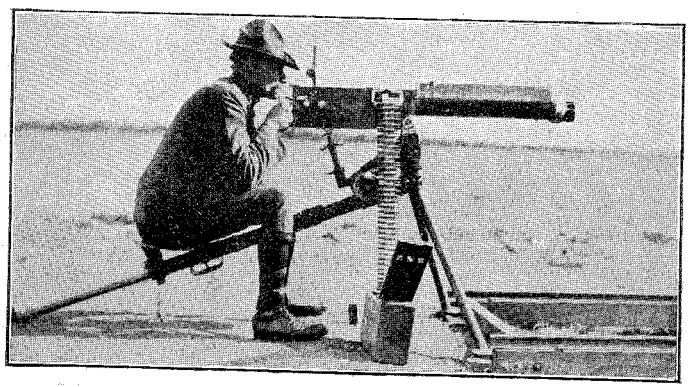

PLATE 42.

Trail out.

INCORRECT POSITION.

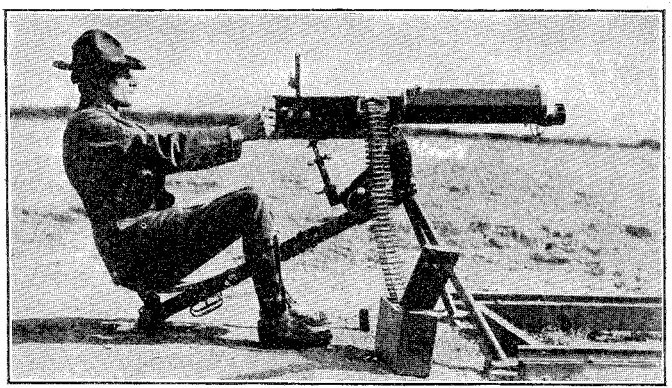

PLATE 43.

Trail in.

Eye too far from rear sight. Weight thrown so far to rear as to cause excessive jump (vibration) at muzzle. Gun not firmly held. No power to hold down on handles.

INCORRECT POSITION.

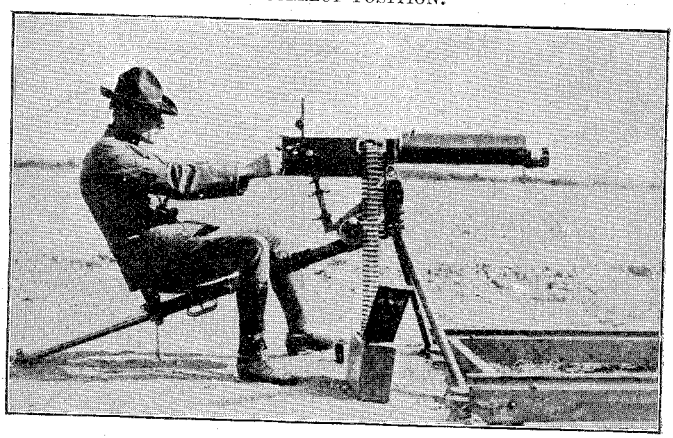

PLATE 44.

Trail out.

44. The instructor's illustration and explanation being completed, he requires the men undergoing instruction to take the firing positions, supervising and correcting until the position is perfect in every detail. With short intervals of rest, this is repeated until the position can be taken with accuracy and uniformity.

AIMING EXERCISES.

FIRST EXERCISE.

45. THE USE OF THE ELEVATING MECHANISM.—A target is prepared with several aiming points at different heights, on the following order:

(1) (2)

(3)

(4) (5)

PLATE 45.

The target is set up at 27⅞ yards and the various aiming points are numbered in such a manner that they can be distinguished easily from the position of the gun.

The instructor explains the proper method of moving the aim in vertical and horizontal directions, and that the object of this exercise is to familiarize the soldier so thoroughly with the manipulation of the weapon that false motions in changing aim are eliminated.

The instructor places himself in a position from which he can detect any errors of the movement of the line of aim, causes the man undergoing instruction to take the firing position, and then directs him to "Aim at No. 1 (2, 5, 4, etc.)."

In executing the command of the instructor there is no attempt at first at rapidity of movement. Care is taken that the changes made are not so great as to carry the line of aim beyond the aiming point and thus necessitate a further change.

When an ability to manipulate the weapon without hesitation or error has been attained then speed is sought and the exercise is continued until the desired degree of proficiency is reached.

SECOND EXERCISE.

46. VERIFYING THE USE OF THE ELEVATING GEAR.—The soldier being in the firing position and the line of aim being directed elsewhere than at the desired objective, the instructor directs "Aim at No. 5 (1, 2, 3, etc.)."

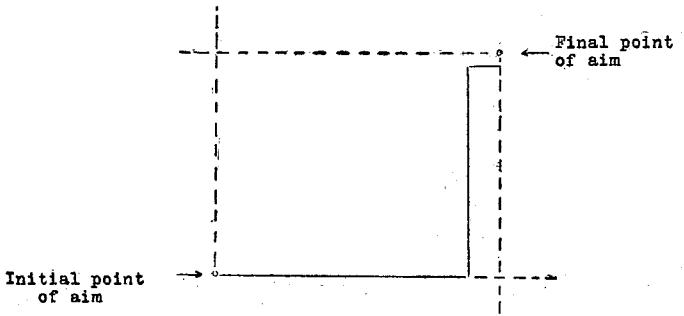

PLATE 46.

Correct travel of line of aim.

In carrying out the directions of the instructor the soldier causes the line of sight to approach his target by one large step in elevation and traverse, which brings the line of aim close to the final point of aim, and then executes a second small step to complete the correction, thus:

The instructor follows closely the movements of the soldier in obtaining his line of aim. If the line should be as shown in Plate No. 47 below, the incorrect method is pointed out to the soldier.

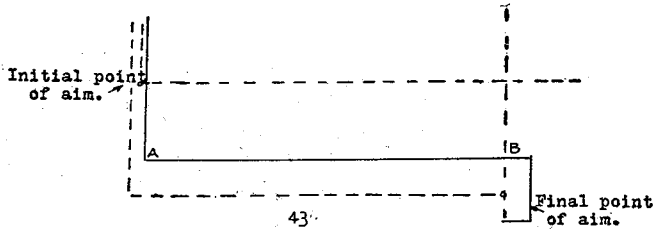

PLATE 47.

Incorrect travel of line of aim.

The soldier started in by elevating the piece instead of depressing it, indicating a lack of familiarity with the gear. When he arrived at the point "A," the muzzle was moved to the left before it was moved to the right. The travel was also continued to the point "B." It often will be easier, and perhaps necessary, when directing the piece on an objective that is below the initial point of aim, to bring the line of aim a little below the objective and then raise it to its proper position. To allow the line of aim to fall as low as the point "C," however, is unnecessary and may be accounted for by the fact that it was directed so far to the right of the objective that the latter was obscured by the sight cover or that the firer was not sufficiently practiced in the use of the gear to have it under perfect control. In each case the instructor determines the cause of the error by observation, and explains its nature and the method of correcting it to the soldier.

This exercise is continued until satisfactory results are obtained.

When the soldier can distribute his fire in a satisfactory manner on the straight horizontal line in either direction, the

arrangement of the figures is changed so as to represent straight diagonals and finally irregular lines.

When accuracy has been attained, speed is sought and the soldier is considered proficient when he can distribute his aim with accuracy on an irregular line and at a speed of about 5 seconds per aiming point.

The various classes of mounts are used in this as in the preceding exercise.

THIRD EXERCISE.

47. PRACTICE IN SEARCHING FIRE.—(Target MGB.) Searching fire is fire distributed in the direction of depth. It may be used for the purpose of distributing fire throughout a deep target or for the purpose of increasing the depth of beaten zone in order to compensate for probable errors in the estimation of the elevation or the range. Whatever its purpose, its execution is the same.

The unit of measure, by which the amount of searching is announced, is the mil. For this instruction, marks (heavy lines or pasters) are placed upon the target indicating intercepts of 2, 4, 6, and 8 mils.

When the mechanism is used to cause elevation or depression, it is sought first to cultivate the soldier's dexterity in judging with accuracy the various fractions of a turn of the elevating handwheel, one-eighth, one-quarter, etc., and consider these turns in terms of mils. In machine guns not fitted with the elevating mechanism, this data is determined in terms of the front sight or the aperture in the rear sight.

The soldier having determined the data necessary to effect the search of any ordered number of mils, the instructor directs that aim be taken on a target on which the mil intercepts are not marked. The order is then given "Target No. 1, search 4 mils up (or so many mils down)." The soldier aims at the target and calls "mark" as an indication to the instructor

that he believes the gun to be correctly pointed at the target. By means of the elevating gear or a movement of his shoulder in the case of a rifle not fitted with elevating gear he then elevates or depresses the piece until he believes it pointed at the proper angle of 2 mils above or below the target. The aim is then verified by the instructor.

This aiming at intervals of 2 mils is continued until the whole amount of the searching is completed. The instructor should see that a steady hold and correct change of elevation has been made every time the soldier calls "mark."

FOURTH EXERCISE.

48. PRACTICE IN DISTRIBUTED FIRE.—(Target MGB.) When the soldier has attained proficiency in the preceding exercise, practice is begun in distributed fire.

The target at first represents prone skirmishers in a straight horizontal line. This target is set up at $27\frac{7}{9}$ yards distance. The figures in the targets are reduced to scale, so that they have the same appearance as a line of the density of one man per yard at 300 yards.

The soldier is required to aim at each figure in succession from enemy left to enemy right and calls "mark" when he considers his aim at each to be correct. The instructor verifies the soldier's aim in each case with the aiming device.

The exercise is repeated, the aim moving from enemy right to enemy left.

The lateral interval between aiming points should be about $2\frac{1}{2}$ mils.

NOTE.—With the automatic machine rifle, model of 1909, a distribution of about $2\frac{1}{2}$ mils may be obtained thus:

1. Bring the normal sight to bear on an object.
2. Without moving the piece, shift the eye to right or left until the tip of the front sight approaches the corner of the rear sight triangle. The prolongation of this line will strike a point approximately 3 mils from the original aiming point.

FIFTH EXERCISE.

49. SEARCHING WITH DISTRIBUTION.—(Target MGB.) Searching fire is now combined with distributed fire. Targets are the same as for distributed fire without searching. The path of the point of aim is verified in the same manner as for distributed fire. The point of aim should not go above or below the control line more than the number of inches equivalent to the amount of searching in mils which was directed. As in distributed fire the horizontal interval between aiming points should be about 2½ mils.

SIXTH EXERCISE.

50. SEARCHING WITH DISTRIBUTION — DIAGONAL.—(Target MGA.) Aim is directed at the upper enemy right paster of an assigned section of target MGA. The instructor takes a position to verify the travel of the line of aim, the soldier directs the aim successively at the lower aiming point in the next row to the left, then diagonally upward, downward, etc., until the edge of the section is reached. The aim is then moved to the point vertically above (or below) and then directed successively at each point omitted, returning to the starting point.

The gunner calls "mark" as his aim is directed at each aiming point and the instructor notes whether or not the line of aim is following the path shown in plate 48.

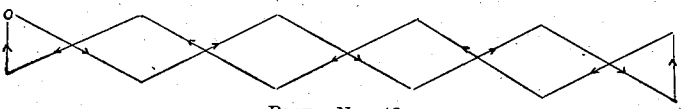

PLATE NO. 48.

Travel, line of aim. Searching with distribution, diagonal.

NOTE.—When using a tripod mount, due to mechanical difficulties and the advantage in approaching an aiming point from beneath, speed and accuracy will seldom be gained by manipulating the traversing and elevating gear simultaneously.

SEVENTH EXERCISE.

51. RELOADING.—Rate of fire is dependent to a certain extent upon the rapidity with which the piece is reloaded. Hence the importance of training in this particular.

This practice should include the case of the soldier firing and reloading without assistance and that of acting as assistant and reloading while another fires. The instructor illustrates the positions to be taken and the methods of reloading in each case.

The exercise is executed with dummy cartridges.

The gun is loaded with one dummy cartridge in the last recess of the cartridge container. The soldier directs his aim at a given point and calls "mark." The cartridge container is then replaced by another loaded with a single dummy cartridge in the first recess and the soldier again directs his aim at the same target calling "mark."

At first all attention is paid to details, to the precision and sequence of movements, speed being demanded only as dexterity is gained.

CHAPTER IV.

USE OF INSTRUMENTS.

52. Training in the use of instruments is a part of garrison work. The scheme of instruction in all instruments follows the same general idea. First, the instrument is studied as a piece of machinery, using the authorized handbook or some standard textbook as a guide to the theory of the instrument, its nomenclature, the mechanical principles on which it operates, methods of adjustment, and directions for its use. Second, practice in adjusting the instrument and in using it with a view to first obtaining the utmost precision of measurement and then attaining the greatest possible speed.

The following outline of training in the use of instruments is suggested: All members of a machine-gun organization should be thoroughly instructed in each instrument with which the organization is provided, and the men who are to habitually use a certain instrument should have a maximum amount of training in its use.

53. FIELD GLASSES.—Adjustment for interpupillary distance and for focus. Use in standing, sitting, and prone positions and with rests. Reading printed signs at maximum distances. Picking up designated objects whose general direction is indicated by the instructor. Counting indistinct and distant objects. Determining the character of distant and indistinct objects.

EXAMPLES.

1. Object for observation, a group of about 10 men in mixed uniforms at such a distance they can just be distinguished with the naked eye as men. *Problem:* Pick up the group with the glasses, note how many men are wearing hats, caps, fatigue clothes, O. D. shirts, etc. How many are standing, sitting, prone, etc.? Can you recognize any individuals by name?

2. Object for observation, a line of freight cars at such a distance that the lettering on the cars can not be read without glasses. *Problem:* Write down all the words and numbers that you can make out on each car. In recording this data draw a rectangle to represent each car and copy the words and numbers exactly as they appear on the car.

54. RANGE FINDERS.—Setting up and handling the instrument. Adjustments for focus, halving, and distance. Measurement of range to well-defined points. Measurements of indistinct objects. Use of instrument in vertical position. Range on moving targets.

EXAMPLES.

1. Five well-defined points, such as poles, corner of a building, railroad-crossing signs, etc., are chosen by the instructor.

Ranges should be between 500 and 2,000 yards. The soldier is required to make three (or five) measurements of the range to each of these points, closing the range scale slide each time while taking the measurement. He will then calculate the mean of his readings by adding the distances together and dividing by the number of measurements.

2. Stake out a straight route about 1,000 yards long on ground that is visible from the position of the range finder. The distant end of this route should be about 1,500 yards and the nearer end about 500 yards from the range finder. A soldier is directed to walk over this route at a uniform rate of speed. The soldier under instruction takes the range to the moving soldier whenever ordered to by the instructor. The instructor can check the accuracy of these measurements if he knows the range to each end of the route and notes the time at which the moving soldier starts, the time of each observation, and the time of reaching the end of the route.

55. MIL SCALE.—Measuring horizontal and vertical and inclined angles in mils. Use of the mil rule for obtaining any one of the quantities mils, width or range, when the other two are given. Auxiliary aiming point data. Combined sights.

Textbook, the handbook describing the particular type of mil scale used.

from the flagstaff.

EXAMPLES.

1. A telegraph pole in the distance, known to be 30 feet high, is found by measurement with the mil scale to subtend an angle of $22\frac{1}{2}$ mils. What is the range?

56. SIGHTS.—The study of tangent and telescopic sights as instruments will be confined to their theory, nomenclature, methods of adjustment and setting, and their care under field conditions.

57. PRISMATIC COMPASS.—Textbook, any work on topography. Obtaining magnetic declination. Precautions about iron in

vicinity. Measurement of bearings to distant points. Relocation from map by compass readings.

EXAMPLES.

1. Using the prismatic compass, determine the angle in mils subtended by the barracks of the machine gun company as seen from the flagstaff.

2. Here is a map showing that white church [pointing] and that railroad crossing [pointing]. Using the prismatic compass, determine our present position on the map.

58. CLINOMETER AND HAND LEVEL.—Textbook, any work on topography. Adjustments. Determining a level line. Measuring slopes. Measuring angles of site.

EXAMPLES.

1. Stake out, using the hand level, a level line around this hill, beginning at this point.

2. Determine the angle of site to the base of that tree, to that white rock, etc., using the clinometer for your measurements.

CHAPTER V.

THE DETERMINATION OF RANGES.

59. A maximum fire effect without an accurate determination of the range is impossible. A definite method in the determination of ranges is essential to accuracy.

Ranges may be determined, before fire is opened, by one of the following methods:

(*a*) Estimating distances on the ground by eye;

(*b*) Taking the range from a map of large scale;

(*c*) Obtaining it direct from infantry or artillery already engaged;

(*d*) Measuring the range directly on the ground;

(*e*) Estimating distance by sound;

(*f*) Ranging fire (par. 219);
(*g*) Range finders.

60. (*a*) ESTIMATING DISTANCES.—Skill in estimating distances can be attained and improved by training. To estimate distance by the eye with accuracy it is necessary to be familiar with the appearance, as to length, of a unit of measure which can be compared mentally with the distance which is to be estimated. The most convenient unit of length is 100 yards. To impress upon the soldier the extent of a stretch of 100 yards two posts 100 yards apart, with short stakes between to mark each 25 yards, should be placed near the barracks or on the drill ground, and the soldier required to pace off the marked distance several times, counting his steps. He will thus learn how many of his steps make 100 yards, and will become familiar with the appearance of the whole distance and of its fractional parts.

Next a distance of more than 100 yards will be shown him and he will be required to compare this distance with the 100-yard unit and to estimate it. Having made this estimate, he will be required to verify its accuracy by pacing the distance.

A few minutes each day should be spent in the practice, the soldier often being required to make his estimate by raising his rear-sight leaf and showing it to the instructor. After the first drills, the soldier should be required to pace the distance only when the estimate is unusually inaccurate.

61. The soldier should be taught that, in judging the distance from the enemy, his estimate may be corrected by a careful observation of the clearness with which details of dress, the movement of limbs, or of the files in a line may be seen. In order to derive the benefit of this method the soldier will be required to observe closely all the details noted above in single men or squads of men posted at varying distances, which will be measured and announced.

Although the standing and kneeling silhouettes used in field practice afford good objects upon which to estimate distances,

the instructor should make frequent use of living figures and natural objects, as this is the class of targets from which the soldier will be compelled to estimate his range in active service.

62. *Methods of estimating long distances by the eye.*—The following methods are found useful:

(*a*) The soldier may decide that the object can not be more than a certain distance away, nor less than a certain distance; his estimate must be kept within the closest possible limits and the mean of the two taken as the range.

(*b*) The soldier selects a point which he considers the middle point of the whole distance, estimates this half distance and doubles it, or he similarly divides the distance into a certain number of lengths which are familiar to him.

(*c*) The soldier estimates the distance along a parallel line, as a road on one side, having on it well-defined objects.

(*d*) The soldier takes the mean of several estimates made by different persons. This method is not applicable to instruction.

63. *Appearance of objects.*—How modified by varying conditions of light; difference of level, etc. During instruction the men should be taught the effect of varying conditions of light and terrain upon the apparent distance of an object.

Objects seem nearer—

(*a*) When the object is in a bright light.
(*b*) When the color of the objects contrasts sharply with the color of the background.
(*c*) When looking over water, snow, or a uniform surface like a wheat field.
(*d*) When looking from a height downward.
(*e*) In the clear atmosphere of high altitudes.

Objects seem more distant—

(*a*) When looking over a depression in the ground.
(*b*) When there is a poor light or fog.
(*c*) When only a small part of the object can be seen.
(*d*) When looking from low ground upward toward higher ground.

64. The manner in which the subject of estimating distances is taught depends in a large measure upon the local facilities as well as upon the experience and ingenuity of the instructor. For this reason no course of instruction is laid down.

The following exercises are given as a guide to instructors who should modify them at will to suit local conditions.

The course of training in estimating distances is divided into two distinct steps or stages:

First. Creating in the memory of the soldier an indelible picture of the appearance of the unit of measure from every possible viewpoint.

Second. Giving him practice in applying this unit of measure to all possible varieties of terrain and under all possible conditions of light and atmosphere.

FIRST STAGE.

65. *First exercise.*—A distance of 100 yards (the unit of measure) is measured accurately on level, open ground and conspicuous marks are placed at each extremity of the line. It is explained to the soldier that this is the unit by which he is to estimate distances and that the attainment of proficiency depends upon his becoming familiar with the appearance of this unit.

He is then required to view this distance from each extremity of the line, and also from different points that are neither on the line nor in prolongation of it. He is then required to pace the distance several times that he may remember the average number of his paces per 100 yards.

66. *Second exercise.*—The unit of measure is marked as in the first exercise. Considering one extremity of this line (the extremity at which the soldier is to stand) as the center of an imaginary circle of 100 yards radius, stakes are placed on the circumference of the circle at every 30° or each hour of the clock. The stake "B" (pl. 49) at the further extremity of the unit of measure is made quite conspicuous and is considered

as being at 12 oclock. The other stakes are carefully concealed in such manner that their location is not apparent from the center stake at "A." They are referred to by the usual clock designation. The arrangement of the stakes is modified to suit the conditions imposed by whatever ground happens to be available.

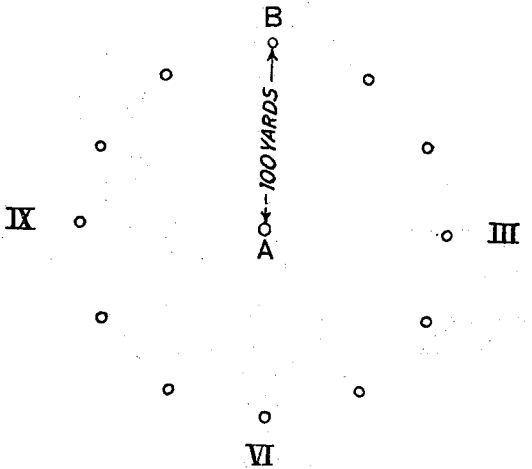

PLATE 49.

The instructor designates one or more men to assist him.

When the stakes are in place and the men (usually not more than a squad at a time) are assembled at the center, the instructor directs one of his assistants to stand on the line from

the center to the 1 o'clock or 11 o'clock stake and at a certain distance either short of or beyond the designated stake. He requires the men to turn their backs while the assistant is being posted.

The assistant being posted, the instructor causes the men to face toward the 12 o'clock stake. He then directs them to compare the distance to the assistant with the true unit of measure and to decide whether the former is greater or less than 100 yards.

He then calls upon one of the men to direct the assistant to move forward or back and halt at a point that he, the estimator, considers is exactly 100 yards from the center stake. A memorandum is kept showing the assistant's actual distance from the center stake, and the same procedure is repeated for each man in the squad, when the instructor causes the assistant to post himself accurately at 100 yards from the center stake and then notifies the men of the amount and direction of their errors.

Under these conditions the errors should be small, as the soldier constantly has before him the measured 100-yard unit, which is in such close proximity to the line on which he is estimating that comparisons are quite simple.

As soon as the men show proficiency in this first step, the instructor causes the assistant to move to the 2 o'clock or 10 o'clock stake, then to the 3 or 9 o'clock stake, etc., gradually working away from the visible measured unit in order to make comparisons more difficult.

67. *Third exercise.*—This is the same as the second exercise except that all marks showing the location of the further end of the measured unit are obliterated. When practicable, this exercise should not be held on exactly the same ground as was the second.

The basis of comparison is the man's *recollection* of the appearance of the unit of measure.

68. *Fourth exercise.*—From practice in the foregoing exercises, the men will have become familiar with the appearance of the unit of measure when standing at one of its extremities. It next becomes necessary to familiarize them with its appearance when they are at a point in prolongation of the line and at various distances from its nearer extremity.

Level open ground is used in this as in the foregoing exercises.

Stakes are arranged as prescribed in the second exercise, except that they are placed on the circumferences of *two* concentric circles (or as extensive arcs as the nature of the terrain will permit), one having a radius of 100 yards and the other a radius of 200 yards. The stakes on the smaller circumference or arc will be made plainly visible, those on the larger being carefully concealed except one which marks the further extremity of the unit of measure.

The procedure in this exercise is the same as in the second exercise, the men being required to place the assistant at a point which they consider 100 yards beyond the inner row of stakes, first in conjunction with a visible unit of measure and later basing their judgment on their recollection of its appearance.

This exercise is repeated at such longer ranges as the terrain affords up to 1,000 yards.

69. So far, all estimates have been made from the standing position. In combat the necessities of concealment and defilade will make the prone position the habitual one, hence the corresponding necessity of becoming adept at estimating distances in that position.

The foregoing exercises are therefore repeated, the soldier making all his estimates from the prone position.

Up to this point only open level ground has been used, this being the foundation or basis for all future progress in the estimation of distance.

It now remains to repeat these exercises under as great a variety of conditions as the terrain and the climate will afford.

The soldier should be made familiar with the appearance of the unit of measure on bright, sunny days and on overcast days; in rain, fog, or snow; on ground that is rising, falling, even, or undulating; over ground that is plowed, bare, grassy, or covered with brush; in fact, under every conceivable condition or combination of conditions that might surround a fire fight.

SECOND STAGE.

70. Up to this time it has been the endeavor to impress upon the soldier's memory the appearance of the unit of measure under all possible conditions.

In the second stage of instruction he is required to apply this knowledge in the determination of unknown distances.

71. *Fifth exercise.*—The instructor selects an observation point from which a wide arc of vision may be had.

He picks out some prominent landmark about 300 to 600 yards distant and points it out to the men, explaining that they are now to apply their knowledge of the appearance of the unit of measure in determining the range to this object.

He further explains that in order to make this estimate it is necessary to recall to the memory the appearance of the unit of measure and to apply this unit to the ground in the same manner that a ruler is applied in the measurement of short lengths.

He then cautions the men against the common fault of attempting to judge of the distance to an object by its appearance alone, although it is well, should time admit, to use the appearance of the object as a check against the unit-of-measure system.

He further explains to the men that in the use of the unit-of-measure system the objective is to be considered merely as indicating the *direction* of the line upon which the estimate is to be made and as the *limit* to which the estimate is to extend.

The instructor then adds such remarks as may apply to the special peculiarities of the ground that is to be measured and

explains that it is necessary for the soldier first to pick out some point in the direction of the objective that he considers to be 100 yards distant; then to pick out a second point 100 yards beyond the first; then a third point 100 yards beyond the second, and so on until the objective is reached.

The men are now directed to estimate the distance to the objective, to write their estimates on a piece of paper, and without communicating their decisions to each other to turn in the written estimates to the instructor.

72. Unless the instructor has had the true ranges measured before the exercise begins he should adopt some speedy and accurate method for their determination. If the time must be taken to measure the true range with a chain or tape after each estimate, the enforced inactivity of the majority of the men is apt to cause their interest to lag, with the result that much of the instructional value of the exercise is lost.

Speed is not sought in these first estimates. On the contrary, as much deliberation is allowed as may be required to insure results that are really estimates and not mere guesses.

When all the men have handed in their estimates, the instructor announces the true range and enters into such explanation as he may deem necessary as to the amount and direction of unusual errors.

Additional objectives are then selected and the same procedure repeated.

When the men begin to exhibit a reasonable degree of accuracy, then speed is sought and the practice continued from day to day until the desired standard of proficiency is attained.

In the selection of objectives it would be well at this stage of the training to include some that will resemble the targets that would be encountered in combat.

73. *Collective estimating.*—The training of an organization in the estimation of distance is not complete until the leaders (and those individuals who, in the exigencies of the campaign,

might be called upon to act as leaders) are able quickly to take advantage of the combined estimates of some or all of the individuals under their command.

It is of little moment what system is used, so long as it is simple and uniform in the organization.

The following system is suggested as meeting these requirements:

Let two good estimators in each squad estimate the distance and signal their estimates to their respective squad leaders. The squad leaders (mentally) average the two estimates that they receive and signal these averages to their respective platoon leaders. The platoon leaders (mentally) average the mean estimates that they receive from their squad leaders and then signal these averages to the company commander. The company commander then averages the two means that he receives from the platoon leaders and announces the result as the range to be used.

It will be noted that by the use of this system no single leader is called upon to obtain the mean of more than two quantities, a comparatively simple task in mental arithmetic. And yet, finally, the company receives the mean of many estimates as the range to be used.

In the training of leaders and prospective leaders in the subject of collective estimating, it is well to remember that it is the eye and not the ear that is to be trained, i. e., that the estimated ranges usually will be *signaled* to the leaders rather than communicated to them by word of mouth.

The preliminary exercises in this subject are nothing more than some form of mental gymnastics.

74. *A suggested exercise.*—The instructor assigns two men as assistants and furnishes each with a paper on which a series of assumed ranges are noted, thus:

To assistant—	
No. 1.	No. 2.
1..... 600	1..... 800
2..... 600	2..... 700
3..... 600	3..... 400
4..... 600	4..... 500
5..... 700	5..... 800
6..... 900	6..... 700
7..... 700	7..... 500
Etc.	Etc.

The two assistants, standing about 5 or 10 yards apart, face the instructor at a distance of about 25 yards. The leaders undergoing instruction are in line at convenient intervals facing the assistants at a distance of about 15 yards, thus:

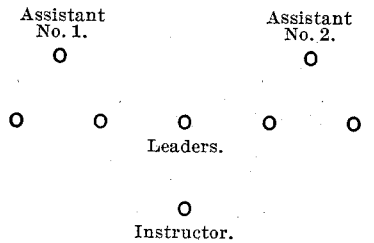

PLATE 50.

The instructor calls to the assistants, "Range No. 1." No. 1 assistant would then signal "600" while No. 2 assistant would signal "800." The leaders then determine the mean of these

two quantities and, facing about, signal their results to the instructor.

At first there should be an appreciable interval between the time that the range is signaled by assistant No. 1 and the time when it is signaled by No. 2. As progress is made, however, this interval of time gradually may be reduced until finally both assistants signal their ranges at the same time.

In similar manner, the instructor first demands absolute accuracy in the announcement of the mean ranges, speed being sought later, but never at the expense of accuracy.

75. Leaders may be considered proficient in this work when, in the prone position, they can receive two ranges by signal, determine the mean accurately, and transmit that mean by an intelligible signal in a reasonable time.

An organization may be considered proficient when, in the prone position, ranges are estimated by individuals in the firing line, transmitted by signal through squad and platoon leaders to the company commander, an accurate mean announced by him that shall not differ from the true range by more than 10 per cent, sights are set according to the range announced by the company commander, and all this in a reasonable time.

To carry such a system further, means could be devised to the end that each unit (squad and platoon) in the organization, should it happen to be acting alone, could use easily and quickly the average of the estimates of its six or eight most skillful estimators.

Doubtless there will be occasions, in the preliminary stages of an attack as well as during the preparation of defensive works, when there will be ample time to assemble the skillful estimators of a company and obtain the mean of their estimates without recourse to the channel of squad and platoon leaders. On such occasions, however, the necessity for estimating the distance probably will be lacking, for, as a general rule, instruments will be available for this purpose. In the preparation of defensive works, it even would be feasible to pace or actually

to measure the distance on the ground before contact with the enemy had been established.

76. (*b*) TAKING THE RANGE FROM A MAP.—At the effective ranges of the small-arms projectiles, it will rarely be practicable to scale the distances directly from the map. Machine-gun ranges usually are so short, in comparison to the scale of such maps as generally would be available to the company commander in the field, that it is most difficult to measure them with the required degree of accuracy. It should be remembered also that the minute details of the terrain, by which the position of the guns and that of the enemy might be identified, will usually not be found on a small-scale map, while on the other hand, experienced troops will avoid locating themselves in the vicinity of prominent landmarks such as might be shown on a map of this character.

In the rare instances when a company commander has a large-scale map available, the determination of ranges from it is merely a matter of reading the map.

77. (*c*) OBTAINING THE RANGE FROM TROOPS ALREADY ENGAGED.—This is merely a matter of inquiry on the part of the company commander of the nearest leader whom he finds on the firing line. This inquiry may be verbal or by the signals prescribed in the Drill Regulations.

78. (*d*) MEASURING THE RANGE DIRECTLY ON THE GROUND.—The distance on the ground may be measured by—

1. The use of a tape or chain;
2. The pacing of horse or man; or
3. The instruments of precision of the engineer.

It is obvious that none of these methods are practicable except on the defensive when ample time is available before the possibility of contact with the enemy.

Training in this, as in the use of maps for the determination of ranges, may be had in connection with the instruction in topography.

The use of the transit by organizations other than engineer troops would be so exceptional as to preclude the idea of instruction in the use of this instrument in machine-gun companies.

79. (*e*) ESTIMATING DISTANCE BY SOUND.—Sound travels at the rate of 1,100 feet, or 366 yards, per second. If a gun is fired at a distance, a certain time elapses before the sound is heard. If the number of seconds or parts of seconds between the flash and the report be carefully taken and multiplied by 366, the product will be approximately the distance in yards to the gun. This method will be of doubtful use on the battle field, owing to the difficulty of distinguishing the sound of the gun, whose flash is seen, from that of any other. It will probably be useful in determining the range to a hostile battery when it first opens fire.

80. (*f*) RANGE FINDERS.—Training in the use of range-finding instruments will depend upon the type of instrument that is supplied to the organizations. (See par. 54.)

81. RANGE ESTIMATORS.—The instruction in estimating distance having been completed, five or six enlisted men, selected by the company commander from the most accurate estimators, will be designated as "range estimators." These men will be given practice in estimating distances throughout the year. The practice will be on varied ground and at distances up to 2,000 yards.

CHAPTER VI.

RECOGNITION AND DESIGNATION OF SERVICE TARGETS.

RECOGNITION OF TARGETS.

82. Scouts or patrols preceding the guns when going into action, or those providing for the security of the guns on the march or in action, must be able quickly to see, recognize, and distinguish between hostile and friendly troops, and must also be able to locate objects of a military nature or significance within range of their vision.

Circumstances may demand that machine guns be held in positions of concealment, while but one or two scouts are kept on the outlook. These scouts must also be trained in the recognition of objectives.

It is also important that the men using the gun be able to locate quickly and recognize targets whose whereabouts is described to them briefly, but whose outlines are obscure and blend with the surrounding country.

Ability to observe an object depends on two qualifications of the individual:

First, his acuity of vision, which is constant for the individual and not susceptible of improvement by training.

Second, his power or faculty of perception. This power of perception can be increased by training.

Training in recognition of targets should, therefore, be designed with a view to increasing the powers of perception.

When the recruit first enters the military service objects of a military nature or significance are unfamiliar to him. It is necessary, therefore, that he be taught, first, *what* to look for, and then *how* to look for it.

EXERCISES IN RECOGNITION OF TARGETS.

83. *First exercise.*—It is the purpose of this exercise to teach the recruit what to look for and to demonstrate to him how quickly the eye is attracted by movement.

It is explained that, in combat, the enemy will use every endeavor to obtain concealment, and when seen at all, usually will be in the prone position. Perhaps it will occur that only the head and shoulders are seen above the parapet of a trench, or parts of the head and shoulder will appear from behind a tree or wall.

The instructor then conducts the men to the point selected for the exercise. This point should admit of a wide arc of vision and should permit of an uninterrupted view for a distance of from 100 to 200 yards.

Several assistants are posted beforehand at various short ranges and in various directions from the central point. They make use of no cover, but are in the prone position and are required to remain quite immobile or at least to make no conspicuous movements.

The instructor informs the men that one of his assistants is lying prone at a distance of less than ——— yards, that he is in the open and in the general direction of ——— (indicating by pointing the general direction of the first objective). He then directs them to look the ground over carefully and attempt to locate this man, and then calls them up in turn and causes them to point out his position. For this purpose, a rifle with sandbag and tripod may be used to advantage, or else a machine gun on a tripod mount, the recruit being required to sight the rifle or gun at what he believes to be the objective.

Should any of the men fail to locate the objective, the instructor signals to the assistant to raise his arm or to move from side to side. A very slight movement usually will betray his position.

This is repeated until all the objectives have been located.

84. *Second exercise.*—The purpose of this exercise, like the first, is to familiarize the men with the appearance of various forms of objectives.

The procedure is the same as in the first exercise, except that the assistants are concealed very slightly at first, the amount of concealment being increased as progress is made.

85. *Third exercise.*—The purpose of this exercise and the procedure is the same as the foregoing.

The assistants, however, are placed in groups of two or more men per group. The number of assistants per group, the range, and the amount of concealment are gradually increased.

In addition to locating the objectives, the men are required to state the number of figures in each group and to add any further details, such as peculiarities of dress or position, as the instructor may require.

86. *Fourth exercise.*—It is the purpose of this exercise to teach the men an effective method of searching a given area.

To search a given area thoroughly, the man's sight must not be permitted to wander aimlessly, but must be directed in such manner that every portion of the area is subjected to rigid scrutiny. To meet this demand, a system is necessary that will assure that no portion of the area is overlooked or slighted.

There are two systems or methods in general use and which have been found to give satisfactory results.

Both systems subdivide the area by a number of imaginary lines, in one case these lines being at right angles to the line of sight and in the other case being parallel to it. The division by lines parallel to the line of sight usually will be productive of the better results.

It should be explained to the recruit that it is of no special importance *what* system is used, but that it *is* important that *some* system be used that will give the required results.

Having completed the explanation of the exercises the instructor indicates certain boundaries in which various objectives of a military nature have been placed beforehand and directs the men to search this area and to describe all such objectives as they are able to locate.

As progress is made the area, the amount of cover used, the size and number of the objectives, and the ranges are gradually increased.

As a check on the men's imaginations the instructor occasionally should designate an area in which no objectives have been placed.

87. Up to this point only natural cover has been considered. It is also important for the soldier to become familiar with natural and cultural features and to note the changes that occur when these same objects have been adapted to military uses.

Usually a saving in time may be effected by having this practice in conjunction with that in field engineering.

In all this practice the men should be impressed with the difference between mere concealment and concealment of location and should be taught that the latter is always to be sought.

Exercise might consist of having the gun squads prepare various positions for defense and then have each squad attempt to locate the positions of the others from such points as they naturally would be viewed by the enemy.

It should be borne in mind, however, that in combat the usual target for machine guns will be the hostile infantry, and hence the bulk of this practice should be with a view to familiarizing all with the appearance of the various devices used by the infantry to secure concealment or defilade or both.

88. In all of these exercises the men are first permitted to search for objectives from the easiest vantage points, standing in full view in the open should they so desire. As proficiency is attained, however, the instructor demands a closer adherence to combat conditions, with the ultimate intention of having the search made in the prone position and from such cover as may be available.

TARGET DESIGNATION.

89. *Within the company* implies an ability on the part of the company commander to describe the objective or fronts for his platoons within the limits assigned to the company. It also implies an ability to cover the whole target of the company during a forward movement of part of the company.

Within the platoon implies an ability on the part of the platoon leaders to understand the company commander's designation of the target and to transmit that information to their platoons in such a manner as to insure an equal distribution of their fire within the front assigned them as objectives, not slighting the less visible parts.

In general, targets with reference to their designation will fall under the following heads:

(1) Those that stand out so plainly that the target is obvious.
(2) Those targets that are plainly visible but about which there might be some confusion.
(3) Those targets which are partially visible but which on account of backgrounds or other conditions are difficult to pick up.
(4) Those targets which can be seen only with field glasses.

90. METHODS OF DESIGNATION.—In the first case it is a simple matter, as follows:

System.	Example.
1. Announce range.	"Range 1,000."
2. If sights are to be set, allow time necessary.	
3. Announce objective.	"A troop of cavalry."

The distribution and width of the target are taken up later.

In the designation and description of the target it is essential that a system of angular measurement be adopted and that all be instructed in its use. The angular unit that has been adopted for this purpose is the mil. (See par. 55.)

In the second case the horizontal clock system may be used (with visible targets).

To avoid confusion it is necessary when using a clock system to preface the direction with the words, "Reference point" or "Target."

System.	Example.
1. Announce range. If sights are to be set, allow time necessary.	"Range 1,000."
2. Announce direction.	"Target at 2 o'clock."
3. Announce objective.	"A troop of cavalry dismounted.

PROCEDURE.

1. Gunners set sight at 1,000 yards.
2. All look along a line pointing toward 2 o'clock of a horizontal clock face whose center is at the firing point and the

direction of whose 12 o'clock mark is perpendicular to the firing line.

3. Look for objective at 1,000 yards on this 2 o'clock line.

91. In the third case the vertical clock system is used either singly or in combination with the horizontal (against small or indistinct targets).

System.	Example.
1. Announce range. If sights are to be set, allow time necessary.	"Range 1,000."
2. Announce the general direction of the reference point.	"Reference point to our right front" (or "at 2 o'clock").
3. Designate as a reference point the most prominent object in the zone indicated.	"A stone house with two chimneys."
4. Announce the position of the target with respect to the reference point.	"Target at 3 o'clock."
5. Announce objective.	"A hostile patrol of four men."

PROCEDURE.

1. Gunners set sight at 1,000 yards.

2. All men look to their right front (or along the 2 o'clock line horizontal clock).

3. The reference point (stone house) is found in the indicated direction.

4. A clock face (vertical) is imagined centered on the reference point, and the men look along the line leading from the clock center through 3 o'clock and

5. Find hostile patrol at 1,000 yards from the firing point.

It will often be necessary to use the mil scale, the rear sight or fingers to lay off the distance to the target from the reference

point and at the same time to indicate its lateral width and its subdivision into parts.

The term "one finger" is taken to mean 50 mils.

92. Care must be taken to distinguish between the enemy's right and our right. Such terms as "enemy right," "right of enemy's line" must be used when referring to the enemy and "our right"; "right of our line" when referring to our forces, and the terms must never be confused.

Reference points are not used when the target is plain and of such a nature as to be easily pointed out.

Orders should be as short as possible without losing in clearness. Hence to use a reference point when not called for is to add more to the order than necessary.

Reference points chosen should be definite and easily distinguished.

Data given from reference points must be complete.

The distance from the reference point to the right, left, or center of the enemy's line should be stated, as well as the width of the target that it is intended to cover. Do not sacrifice clearness to brevity.

93. The mil system may be used in switching targets. If, for instance, it is desired to change laterally to a new target, the prescribed signal for switching fire is made, "two fingers to the right," for example, and each gunner then changes his fire the designated distance to the right as has been signaled. The front covered by the fire of the unit remains the same width, but the center of the sheaf has been moved 100 mils to the right.

The designation of an aiming point is the same as the designation of a target of the visible class.

Precautions must be taken to prevent the gunner being confused by the difference between the actual range to the target and the sight setting announced in the fire order.

By dividing a given target, frontage, area, or sector into fractional parts and by assigning to each subdivision of his

unit one or more of these parts a commander is able to secure a proper distribution of fire. A correct application of the principles of target designation is the means employed to secure this distribution. It is unusual to assign less than two guns to any given sector or objective.

CHAPTER VII.

KNOWN DISTANCE PRACTICE.

GENERAL.

94. *Definition.*—Known distance practice consists of firing ball cartridges at machine-gun targets MGA, MGB, MGC, and MGD at a distance of $27\frac{7}{9}$ yards.

95. *The object of known distance practice* is to give the soldier prior to combat firing a certain amount of training with service ammunition against targets of such a nature that his errors may be readily detected and pointed out to him. It should be kept constantly in mind that the final measure of fire in batttle is the number of enemies disabled in a unit of time, and every effort should be directed toward bringing the soldier's marksmanship up to a high state of proficiency as measured by this standard.

96. *General.*—1. The soldier is practiced in reloading, both when the new strip or belt is placed in the gun or the magazine is placed on the gun (Lewis), by his assistant, and when the reloading is done by the firer. By this practice any derangement of the aim caused by the operation of loading should be overcome.

2. The soldier is then taught to "hold," i. e., when directing his fire at a single aiming point to confine the resulting shot group within limits found by experiment to be possible for men well trained in the use of the machine gun.

3. He is next taught the principles of and given practice in "fixed fire." Fixed fire is that fire directed at an objective of such size that it may be covered effectively by a single cone, i. e., a single aiming point is used. By this practice the soldier is taught to place the center of impact of his shot group at the center of the target.

4. The fourth step in known distance practice consists in teaching the soldier the principles of and giving him practice in firing at objectives of such size and shape that the fire must be distributed laterally, in depth, or in combination of these methods, in order that an even distribution of impact may be obtained throughout the entire area.

97. *Individual.*—The general scheme for firing is as follows:

Known distance.	Instruction practices	1. Reloading on target MGA. 2. Holding on target MGA. 3. Fixed fire on target MGA. 4. Distributed fire on target MGB. 5. Searching fire on target MGB. 6. Searching with distribution on target MGB. 7. Searching with distribution on target MGC. 8. Searching with distribution on target MGD.
	Record.	1. Searching with distribution on target MGD.

INSTRUCTION PRACTICE.

98. *Reloading.*—(Target MGA.) Proficiency having been acquired in the details involved in the process of reloading, a strip, belt, or magazine, containing two cartridges in the last spaces, is placed in the gun. Aim is carefully directed at a designated aiming point, the two shots fired and another cartridge container containing two cartridges in the first spaces loaded and fired without unnecessary delay.

The positions of the hits on the target will indicate the extent the soldier's aim and position has been affected by the operation of reloading.

This exercise will be held—

First. With loading done by an assistant.

Second. With loading done by firer.

The interval between firings should not exceed five seconds when loading without assistance and three seconds when an assistant loads.

99. *Holding.*—(Target MGA.) The practice in holding is a verification, with ball cartridges, of the soldier's ability to take the firing position properly and to maintain it with uniformity while firing.

The soldier being in the firing position, the piece loaded, the instructor directs the soldier to fire a string of five shots at a designated aiming point. To avoid a waste of ammunition at the beginning of the practice, the instructor directs that every sixth cartridge space be empty.

The soldier having fired his string of five shots, the target is drawn back to the firing point, and the shot group is examined. The entire group (exclusive of "strays") should be contained within the circumference of an ellipse with a horizontal diameter of 3.5 inches and a vertical diameter of 2.5 inches. With the tripod mount the shape of the group is modified somewhat—the vertical diameter of the ellipse is the same but the horizontal diameter is 2 inches.

A convenient gauge for this purpose is made by bending a piece of wire in the shape of the ellipse and twisting the ends together to form a handle. By applying this wire ring to the face of the target, it can be determined at a glance whether or not the shot group is within the required limits.

Should the soldier's first group of five shots not be within the gauge, he is required to repeat the practice, the instructor observing carefully for faults in his position and instructing the soldier how to correct those faults.

A satisfactory group of five shots having been made, the soldier is next required to fire two strings (of five shots each) in succession. All 10 shots must now be grouped within the

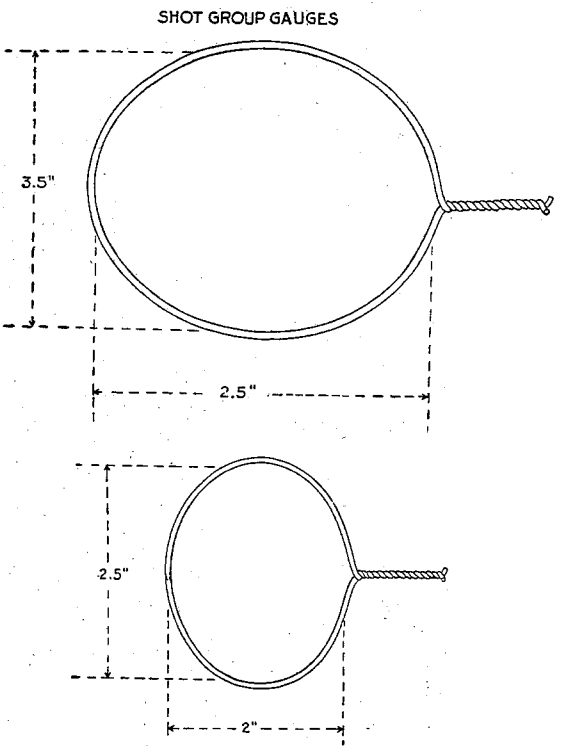

PLATE NO. 51.

gauge. The instructor observes the firer, notes and corrects faults as before. As progress is made, the soldier is required to fire three, four, and finally five strings (of five shots each) in succession and to place all the shots of the combined group in each case within the limits marked by the gauge.

The soldier is next required to fire two strings of 15 shots each and finally a string of 30 shots. The groups must lie within the gauge as before.

A too rigid insistence on the entire group being within the limits of the gauge is not desirable. A well-trained instructor will know when wide shots are due to faulty holding and when they are merely strays.

When the groups show by their size that the soldier's fire is becoming dependable, he should keep a record of the center of impact of each group that he fires. This record should show the sight setting used, the theoretical height of the center of impact above the point of aim for that particular sight setting, the actual distance of the center of impact above the point of aim, and the difference between the actual and theoretical ordinates expressed in mils. The mean of all these differences will give the soldier a fairly good idea of what his "equation" is with that particular gun and should remain quite constant for all ranges.

100. A convenient scale to use for the purpose indicated in the preceding paragraph is shown in plate 52. On this scale 1 mil intercept is equal to 1 inch, and the ordinates in inches from the lower end of the scale are given in paragraph 102 for United States Ammunition and for British Mark VII Ammunition.

The position of the zero on the scale is determined as follows: To the height in inches of the front sight above the axis of the bore add the distance in inches that the bullet falls vertically between muzzle and target. These values for drop of bullet are 0.173 inch for United States ammunition and 0.226 inch for British Mark VII ammunition. Then add 0.8 inch for jump of

the gun. The position of the zero for various guns is given in paragraph 103.

From this firing and the use of the scale in connection with it the soldier should learn exactly what sight setting to use on that particular gun in order that the center of impact will lie on a given ordinate. When he has this data he will be able, by use of the same sight settings, to place his cone of fire exactly at any ordered range when he comes to field firing, providing the muzzle velocity of the gun remains constant. Data for each barrel for each gun showing the elevation required on the sight in order to hit the 500-yard ordinate when the aiming point appropriate to the type of gun is used must be carefully preserved in the organization for use in connection with technique of fire.

101. To obtain this data concerning the 500-yard ordinate the following system may be used in connection with the work of instruction under this paragraph.

Paste an aiming point 1 inch high and 10 inches long at some convenient point on the target. Aim will be taken at the bottom edge of this aiming point. The sight should be raised or lowered after each trial firing until the center of impact for groups of three or more shots is as shown in the following table:

Lewis gun, center of impact 0.9 inch above bottom of A. P.

Benêt-Mercié rifle, center of impact 2.1 inch above bottom of A. P.

Vickers gun, center of impact on bottom edge of A. P.

Maxim gun, center of impact 0.3 of an inch below bottom of A. P.

Make a record of the sight setting required to get this effect. If several men fire the same gun, each man should get this data for the barrel that he uses, and the mean of their results should be the sight setting recorded for that barrel of that gun.

102. *Ordinates at 27⅞ yards.*

Yards.	United States ammunition.	British Model VII.
	Inches.	*Inches.*
100	0.547	0.000
200	1.357	.789
300	2.197	1.699
400	3.267	2.917
500	4.497	4.338
600	5.817	6.000
700	7.457	7.972
800	9.257	10.244
900	11.357	12.893
1,000	13.877	15.949
1,100	16.637	19.449
1,200	19.737	23.402
1,300	23.157	27.879
1,400	26.917	32.716
1,500	30.907	38.571
1,600	35.337	44.894

103. *Position of zero on scale.*

Gun.	Inches from lower end of scale.
Maxim	4.83
Vickers	4.50
Benet-Mercié	2.40
Lewis	3.40

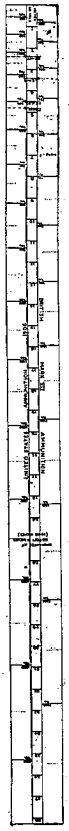

PLATE 52.

Scale of machine-gun ordinates at 1,000 inches or 27⅞ yards from the muzzle of the gun.

104. FIXED FIRE.—(Target MGA.) The purpose of this practice is to insure such a precise knowledge of the gun on the part of the soldier that when the instructor orders firing with "Range 400 (or so many) yards," said firing will result in the production of a cone whose mean trajectory *is* 400 (or so many) yards.

As the essence of this practice is a knowledge of the amount of change in sight reading from the normal and of how to apply this change in actually setting the sight, it is obvious that much of the practice may be confined to work in merely setting the sight, the firing of ball cartridges being limited to a few groups for the purpose of verifying or demonstrating the correctness or incorrectness of the soldier's work.

105. DISTRIBUTED FIRE.—(Target MGB.) The object of this practice is to secure an even distribution of fire throughout the entire width of a linear target.

Except that ball cartridges are used, the practice is similar to that given in paragraph 44.

At first the soldier fires but a single shot at each aiming point, and not more than about 10 aiming points are used. The resulting shot group should show a distribution that would approximate one hit to each 3 inches of front covered on the target, and no shot should be more than about 2 inches above or below the space containing the center of impact.

By totaling and recording the number of hits in each horizontal and in each vertical ruled space on the target, the instructor may readily determine whether the distribution is even and whether or not the center of impact is at the correct height.

The soldier will next distribute his hits at intervals of about 2½ mils by utilizing the means determined in preliminary training.

When proficiency in the even distribution of single shots has been attained, the soldier will fire strings of about three shots at each of 10 aiming points. In this practice 30 shots will be fired in short bursts at a front represented by 10 targets.

Finally the feature of reloading is introduced and it is sought to develop a rate of fire that shall not fall below 150 shots per minute, including reloading.

The vertical distribution of the shot group, in the various horizontal ruled spaces on the target above and below the center of impact, should show an average percentage of hits approximately as follows:

	Per cent.
Fourth space above the center of impact	2
Third space above the center of impact	5
Second space above the center of impact	12
First space above the center of impact	18
Space containing the center of impact	26
First space below the center of impact	18
Second space below the center of impact	12
Third space below the center of impact	5
Fourth space below the center of impact	2

The soldier's progress is considered satisfactory when, with five shots per aiming point, he can strike 60 per cent of the rectangles in the horizontal space in which the center of impact should be placed.

106. SEARCHING FIRE.—(Target MGB.) The object of this firing is to give the soldier practice in securing an even distribution of fire in the direction of depth and in certain specified amounts.

The general method of executing searching fire conforms to that for the execution of distributed fire. The aiming points are placed at vertical intervals of 2 mils and aim is taken at each aiming point in turn, beginning at the top or bottom one as the instructor may direct.

The soldier at first fires but one shot at each aiming point, and not more than about 10 aiming points are used. The resultant shot group should be contained in a rectangle about $2\frac{1}{2}$ inches wide and about 2 inches longer than the line of aiming points.

The soldier will next attempt to distribute his hits in a vertical line, starting up or down from a single aiming point, so that the single shots will be placed with a vertical interval of

about 2 mils. The elevating mechanism in guns so equipped will be used for obtaining this vertical interval.

When the soldier can place single shots at the searching interval of 2 mils, he will fire bursts of about three shots with the 2-mil vertical interval between bursts. The instructor orders, "Search down (or Search up) so many mils from such aiming point," giving at the same time the amount per burst.

Finally, the feature of reloading is introduced, and it is sought to develop a rate of fire of at least 150, including reloading.

The study of the shot group by the instructor follows the lines set forth in the preceding paragraph.

107. SEARCHING WITH DISTRIBUTION.—(Targets MGB and MGC.) Target MGB: This firing is merely distributed fire, in which the firing at each aiming point is a searching by a given number of mils.

Target MGC: This target is designed to represent a column marching on a hillside. The firing may be under the assumption that the range is known exactly and that the head of the column is 600 yards distant and the tail 700 yards distant. The gunner makes allowance for the difference in range therefor, and the center of impact of the resulting group should be about 3 inches above the point of aim at the head of the column and about 4½ inches above the point of aim at the tail of the column.

The practice is varied by considering that the range has been estimated with a probable error of a certain percentage and searching fire ordered in addition to the allowance for difference in range.

108. PRELIMINARY PRACTICE ON TARGET MGD.—Target MGD is the record target. The preliminary practice on this target will consist of one firing under the conditions of "Record practice" as laid down in paragraph 110, except that the soldier may call "Time out" at any time and verify the results of his firing. Ample use of this opportunity should be made so that the soldier may be certain that his sight elevations are such that his

shot groups are hitting the scoring spaces. The "time out" will be determined by the announcement "Ready" by the firer.

Table of sight settings to be used with target MGD.

Gun.	Group 1.	Group 2.	Group 3.	Group 4.
Maxim	700	575	1050	800
Vickers	675	550	1050	775
Benet	525	400	975	675
Lewis	600	500	925	700

Aim is taken at bottom edge of aiming points. These values will vary slightly for individual guns. The foregoing table is calculated to bring the centers of impact in centers of scoring spaces.

109. Immediately after the conclusion of known distance instruction practice the soldier will fire the known distance record test.

The two courses will not be fired by one man on the same day.

CHAPTER VIII.

RECORD PRACTICE.

110. The qualification course on the known distance range will consist of one firing (300 rounds) under the following rules and conditions:

1. *Range.*—27 7/9 yards (1,000 inches).
2. *Target.*—MGD.
3. *Firing.*—As demanded by objective.
4. *Ammunition.*—300 cartridges per man. This to be loaded, by the individual who is to fire it, in strips, belts, or magazines according to the type of gun used.

5. *Mount.*—The mount issued as the regular equipment will be used.

6. *Equipment.*—The firer will be equipped with a gunner's pouch, tool box, or other accessories necessary to the operation of the gun.

7. *Sight.*—The leaf sight will be used and will be set at the appropriate elevation.

8. All firing will be "automatic."

9. *Time.*—The soldier will be allowed a minimum of two minutes and a maximum of seven and one-half minutes for firing the 300 rounds, exclusive of time taken out for jams. Time will be kept at the firing point by two timekeepers with stop watches, and the mean of the time of the two watches will constitute the time of firing. The time will commence at the firing of the first shot and end at the firing of the three hundredth shot. The soldier should study carefully the method of obtaining the percentage for classification, and base his firing method on the general principle of attaining the highest possible rate of fire consistent with accuracy.

10. *Loading.*—During firing, by an assistant.

11. *Jams.*—When jams occur time is taken out until the gun has been made to function. The candidate is then allowed to continue the firing in the time remaining to his credit.

12. *Score.*—The score is the total number of points made by the firer in a given time.

The percentage for rating is obtained by the formula $\frac{240S}{T}$ where S is the number of scoring spaces struck and T is the time in seconds required for the firing.

13. *Procedure.*—The firer being in the firing position with the gun loaded, set at automatic, aimed, and having signified his readiness to fire, the command is given "Fire at will." The firer will determine for himself the order of firing at the different aiming points and the number of shots to be directed at each. Fire will cease at the whistle signal. The firing and scoring will be done under the direct personal supervision of a commis-

sioned officer, and the scores will be kept in his personal possession until made of final record.

14. *Reports and records.*—See paragraphs 131, 289, and 291.

CHAPTER IX.

DETERMINATION OF SIGHT SETTING.

111. The firing at the short-range targets gives the zero of each gun under the assumption that the muzzle velocity of the bullets fired from the gun is that for which the table of ordinates was calculated. But this may not be true for a comparatively new barrel and certainly will not be true for a badly worn barrel.

In order to determine the true sight settings to be used in actual field firing, the following test will take place immediately after the known distance record practice (par. 110).

Range, 500 yards, target "B." Choose a day when shooting conditions are satisfactory. Provide about 30 rounds of service ammunition per barrel to be tested. Fire single shots with the gun, changing the sight setting and windage until three shots in succession are in the bull's-eye. Then fire two bursts of about 3 shots each and note their position with reference to the bull's-eye. Bursts are usually higher than single shots. If the estimated centers of impact of the bursts are low or high, change sight setting and repeat until the center of impact is about at the height of the bull's-eye. If ammunition is available, verify by a burst of 10 shots.

Note that both the horizontal and vertical dispersion for machine guns at 500 yards varies from 5 to 10 feet and that all 10 of a burst of 10 shots may not hit the 6 by 6 feet target. This is immaterial so long as the general shape and position of the group is such that the center of impact may be assumed to be at the approximate height of the center of the target.

A comparison of the sight setting actually used to hit a target 500 yards distant and the sight setting used to hit the 500-yard trajectory at a range of 27 yards (par. 102), gives the correct sight setting to be applied to this particular barrel for actual field firing at any range. For this purpose, refer to the table "Sight setting, United States ammunition" (par. 112).

112. *Table of sight settings, United States ammunition.*

[Range in yards.]

	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300
300	----	----	100	200	300	450	550	700	800	900	1,025	1,140	1,249
	----	----	150	250	375	500	625	775	875	975	1,100	1,210	1,310
	----	----	200	300	450	575	700	825	925	1,050	1,175	1,280	1,380
	----	----	225	350	510	640	760	875	985	1,110	1,225	1,340	1,440
	----	100	250	400	575	700	825	925	1,050	1,175	1,275	1,390	1,490
400	----	100	200	300	400	525	650	750	850	950	1,075	1,175	1,275
	----	125	250	350	460	585	710	810	910	1,025	1,140	1,240	1,340
	----	150	300	400	525	650	775	875	975	1,100	1,200	1,300	1,400
	----	175	325	450	575	710	825	940	1,040	1,150	1,250	1,350	1,450
	100	200	350	500	625	775	875	1,000	1,100	1,200	1,300	1,410	1,510
500	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300
	125	225	325	450	550	650	750	850	960	1,060	1,160	1,270	1,370
	150	250	350	500	600	700	800	900	1,025	1,125	1,225	1,330	1,430
	175	275	400	550	650	750	850	960	1,075	1,180	1,280	1,390	1,490
	200	300	450	600	700	800	900	1,025	1,125	1,250	1,350	1,450	1,550
600	250	350	400	500	600	700	775	850	950	1,050	1,150	1,240	1,340
	275	375	450	550	650	750	815	900	1,010	1,100	1,210	1,300	1,400
	300	400	500	600	700	800	850	950	1,075	1,150	1,275	1,360	1,460
	325	425	525	640	740	840	910	1,010	1,125	1,210	1,325	1,420	1,520
	350	450	550	675	775	875	975	1,075	1,175	1,275	1,375	1,475	1,575
700	400	500	550	625	700	775	850	950	1,025	1,125	1,200	1,290	1,390
	425	525	575	660	750	810	900	1,000	1,075	1,175	1,260	1,350	1,450
	450	550	600	700	800	850	950	1,050	1,125	1,225	1,325	1,410	1,500
	475	560	625	740	825	900	1,000	1,100	1,175	1,275	1,375	1,460	1,560
	500	575	650	775	850	950	1,050	1,150	1,225	1,325	1,425	1,510	1,610

112. *Table of sight settings, United States ammunition*—Contd.

[Range in yards.]

	1,400	1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500
300...	1,350	1,450	1,550	1,650	1,760	1,860	1,960	2,060	2,160	2,260	2,370	2,475
	1,410	1,520	1,625	1,725	1,835	1,935	2,035	2,135	2,235	2,335	2,440	2,540
	1,480	1,590	1,700	1,800	1,910	2,010	2,110	2,210	2,310	2,410	2,510	2,610
	1,540	1,650	1,760	1,870	1,970	2,080	2,180	2,280	2,385	2,585	2,600	2,700
	1,600	1,720	1,830	1,940	2,040	2,150	2,250	2,350	2,460	2,675	2,690	2,800
400...	1,375	1,475	1,575	1,675	1,775	1,880	1,980	2,080	2,180	2,280	2,380	2,485
	1,440	1,545	1,645	1,750	1,850	1,955	2,055	2,155	2,255	2,355	2,455	2,555
	1,500	1,610	1,720	1,820	1,925	2,030	2,130	2,230	2,330	2,430	2,530	2,630
	1,560	1,680	1,780	1,890	1,990	2,100	2,200	2,300	2,410	2,510	2,620	2,720
	1,625	1,750	1,850	1,960	2,060	2,160	2,260	2,360	2,475	2,590	2,700	2,810
500...	1,400	1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500
	1,470	1,570	1,670	1,770	1,875	1,975	2,075	2,175	2,275	2,375	2,475	2,575
	1,530	1,640	1,740	1,840	1,950	2,050	2,150	2,250	2,350	2,450	2,550	2,650
	1,590	1,700	1,810	1,910	2,010	2,110	2,210	2,320	2,425	2,530	2,635	2,740
	1,650	1,760	1,875	1,980	2,080	2,180	2,280	2,390	2,500	2,610	2,720	2,825
600...	1,430	1,530	1,630	1,730	1,830	1,925	2,020	2,120	2,220	2,320	2,420	2,515
	1,500	1,600	1,710	1,810	1,910	2,000	2,095	2,195	2,295	2,395	2,490	2,590
	1,560	1,660	1,775	1,875	1,975	2,070	2,170	2,270	2,370	2,470	2,560	2,660
	1,620	1,725	1,830	1,930	2,030	2,135	2,235	2,335	2,440	2,545	2,645	2,750
	1,675	1,790	1,900	2,000	2,100	2,200	2,300	2,400	2,510	2,620	2,730	2,840
700...	1,475	1,575	1,660	1,760	1,860	1,960	2,050	2,150	2,240	2,340	2,430	2,525
	1,540	1,630	1,730	1,830	1,930	2,030	2,120	2,220	2,315	2,415	2,505	2,600
	1,600	1,700	1,800	1,900	2,000	2,100	2,190	2,290	2,390	2,490	2,580	2,680
	1,660	1,760	1,860	1,960	2,060	2,160	2,260	2,360	2,460	2,560	2,660	2,765
	1,710	1,825	1,925	2,025	2,125	2,225	2,325	2,425	2,530	2,630	2,740	2,850

113. The numbers 300, 400, 500, 600, and 700 at the left indicate the sight elevations used in order to get the center of impact on the *500*-yard trajectory of the short-range target. The five lines of sight settings following each of the above numbers are for trajectories with muzzle velocities varying from 2,700 f. s. to 2,300 f. s.

An example will show how to use this table. A certain barrel required a sight setting of 600 yards at the short range to get the center of impact on the 500-yard ordinate of the short-range target. An elevation of 650 yards had to be used at the 500-yard range in order to get the center of impact on the bull's-eye of the "B" target.

Consult the table with the number 600 at the left and in the column headed "Range in yards 500" find the number 650. This is in the second line of the 600 group. This second line beginning 275 and ending 2,590 then gives the proper sight settings for this barrel for all ranges from 100 to 2,500 yards. For instance, at a range of 1,200 yards we would use the sight setting 1,300.

It will be seen from the construction of this table that, knowing the sight setting to be used to get the center of impact on the *500*-yard trajectory of the short-range target and the correct sight setting for hitting a target at *any* one range, we can get the correct sight settings for use with this barrel at all ranges from this table. We merely enter the table in the column corresponding to the true range of the target and, in the five lines following the short-range elevation, find the nearest number to the sight setting found to be correct for the true range. The line in which the number is found is the line of proper sight setting for the barrel. *Example:* A gun required 400 yards' sight elevation at the short range to get on the 500-yard trajectory. Ranging fire at a target 1,000 yards distant required a sight elevation of 1,150 to get in the target. The proper sight elevations to use with this gun are therefore found in the fourth line of the group having the number 400 to the left, because on this line is found the number 1,150 in the 1,000-yard column. With this barrel a setting of 1,680 will be used for firing at 1,500 yards.

It is best, however, to use a single range of from 400 to 600 yards to determine the sight setting since the center of impact is more easily determined at the shorter ranges, and the firing can be done on ordinary rectangular targets.

This determination of the proper sight setting for each barrel should be made before commencing such field training as requires actual firing. After each 5,000 rounds, or oftener if the barrel is beginning to shoot low, a single carefully conducted ranging test at from 400 to 600 yards should again be fired and a new set of sight settings chosen if found necessary.

The table of sight settings may be interpolated either for short-range sight values or for the full-range sight value, but this procedure will be unnecessary, as a rule, since an attempt to set a sight for a value such as 635 or 1,555 is a waste of time.

The gunner should carry a card with the sight settings to be used for each barrel of his gun for each range. This is much preferable to an attempt to memorize these tabular values, particularly as they will change from time to time as the gun wears.

CHAPTER X.

INSTRUCTION FIELD FIRING.

GENERAL.

114. The organization having finished the record known distance practice and determined the correct sight setting for its guns (par. 111), practical instruction in the technical application of fire against field targets (Instruction Field firing) is taken up. This includes:

1. Indirect fire (Chap. XI), embracing adjustment by map from reports of observers, by compass and clinometer, by aiming point and clinometer; adjustment without map, by compass and clinometer, by aiming stakes.
2. Overhead fire. (Chap. XII.)
3. Night firing. (Chap. XIII.)
4. Adjustment of fire on visible target (not masked). Choice of means—battle sight, single elevation, combined sights, searching. Ranging. Auxiliary aiming points or lines.

5. Fire for effect on straight and irregular lines both normal and oblique to the line of fire. Choice of aiming points. Methods of distribution required in order to obtain various desired results. Designation, adjustment, wind corrections, rate, and volume to be incidental.

6. Fire for effect on columns. Head on, flank oblique, on hillside. Designation, adjustment, wind corrections, rate, and volume to be incidental.

7. Fire for effect on gun positions. Targets to represent machine guns or field pieces and to be concealed but not defiladed. Adjustment from landscape sketch or range card. Designation, wind corrections, rate, and volume to be incidental.

8. Fire for effect on moving targets—parallel, oblique, and perpendicular to the line of fire. Designation, adjustment, wind corrections, rate, and volume to be incidental.

9. Fire for effect for the purpose of rendering a certain area, bridges, etc., untenable. When fire is opened, suitable targets will be used to represent an attempted crossing of this area by the enemy.

115. The soldier, having made 65 per cent or over in the record known distance firing, will fire the record field-firing course (par. 136) over at least once before taking the qualification test. This firing will, if practicable, be fired over ground other than that to be used for the record problem.

This practice immediately follows the instruction outlined in paragraph 114.

CHAPTER XI.

INDIRECT FIRE.

116. Indirect fire is that class of fire in which the proper direction and elevation are given to the gun without the use of the tangent sight, or, when the tangent sight is used, by directing the line of aim at some object other than the objective.

No special instruments are provided for the machine gun for this purpose, and such angular measurements as are necessary

must be obtained with the compass, clinometer, and mil scale. The computation of the firing data from these measurements, taken in connection with the range, is greatly facilitated by the use of a slide rule.

The tactical utility of indirect fire is not a subject for discussion in this chapter which deals merely with certain improvised methods that have been found successful.

117. Indirect fire may be divided into two general classes:

(*a*) Indirect fire without a map.

(*b*) Indirect fire with a map.

In each of these two classes of fire, the problems to be solved are:

(1) What direction in azimuth to give the gun.

(2) What elevation to give the gun.

There are several ways in which each of these problems may be solved. The particular combination of methods used in the solution of both problems will depend upon the terrain. In certain cases it may be possible to use any of the methods for determining either azimuth or elevation, while in other cases some of the methods may prove impracticable.

INDIRECT FIRE WITHOUT A MAP.

118. Indirect fire without a map demands that an observer must be able to see the target and that he must be in communication with the crew at the gun.

AZIMUTH.

119. The proper direction in azimuth is given to the gun by so laying it that the axis of the bore forms the correct horizontal angle with a line whose direction is known to the fire controller at the guns.

This line of known direction may be the magnetic meridian through the gun position, the line from the gun to an aiming

point, or the line from the gun to a point, in the plane of site, that has been established on the near side of the mask. In this third case (drift and windage disregarded) the angle between the bore and the known line would be zero.

One of the simplest methods of laying by magnetic meridian is by the ground map method. As an example, let the observer be at O (see Pl. 53), the target at T, the gun at G, and the mask at M.

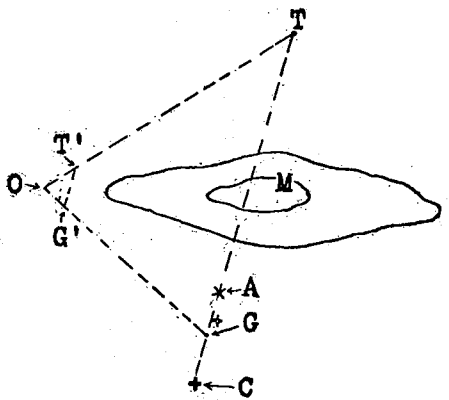

PLATE 53.

The observer at O finds the ranges OT and OG and then, to some convenient scale—say 1 foot=100 yards—he establishes the point T′ on the ground in the line OT and having the distance OT′ equivalent to OT on the reduced scale. In a similar manner the point G′ is established. The observer now goes to the point G′ and with a compass finds the bearing of the point

T'. The lines G' T' and GT being parallel, this bearing is that of the target from the gun.

The observer at O now communicates this bearing to the crew at the gun and they lay the gun for direction as follows:

A compass is set up at the gun position, care being taken to remove the gun and all other iron equipment to a distance of at least 25 yards in order that there may be no abnormal deflection of the compass needle. The compass is now revolved until it registers the bearing sent by the observer. The sights of the compass are now used to line in an assistant who places a stake, stone, or other aiming target at some convenient point in front of the gun position as at A. Should it prove inexpedient to remove the gun and equipment from the position G, the compass may be set up at some convenient point in rear of the gun and then moved to the right or left until a point C is found at which the bearing of G is the same as that sent by the observer. The point A is then established as before.

The point A having been established, the gun will be given its proper direction in azimuth when the sight is set at zero windage and the line of aim directed at A.

This method may be varied to suit local conditions:

For example, the ground map may be made at the gun position instead of at the observer's post, etc.

When a natural aiming point is used, one must be selected whose deflection from the plane of fire is not greater than the arc of the windage scale.

There are two general types of problems to be solved in determining the amount of deflection to be used with a natural aiming point. These two types are:

(*a*) When the observer is so close to the gun that there is no appreciable difference in this deflection as seen from his post and as seen from the gun position, and

(*b*) When the observer is at such a distance from the gun that the angle subtended by target and aiming point at his post

differs materially from the angle subtended by these same two points at the gun position.

In the first case the observer merely measures the horizontal angle between the target and the aiming point (a mil scale being the most convenient instrument for this purpose). Having obtained this angle, he converts it into points of windage and directs the gunner to set his sight accordingly. In converting mils to points, the following formula may be used:

$$\text{Points}=\frac{9\times\text{mils}}{10}$$

In the second case, the problem can be solved in a simple manner by the construction of a ground map.

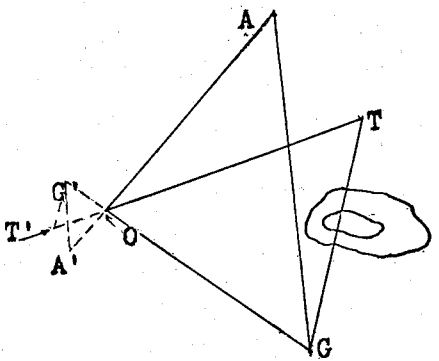

PLATE 54.

Referring to the figure, let G be the gun, T the target, A the aiming point, and O the observer.

The observer finds the ranges OA, OT, and OG. He then constructs his ground map to any convenient scale. This may be done without measuring any angles by placing the point A′ in prolongation of AO, T′ in prolongation of TO, and G′ in prolongation of GO. The distance OA′, OT′, and OG′ would be proportional to OA, OT, and OG. It will be seen that the angle T′ G′ A′ is equal to the angle T G A, and hence the observer goes to G′ and measures the angle subtended by T′ and A′. Having measured this angle, he converts it into points of windage and directs his gunner to set his sight accordingly.

The third method of giving the gun its proper direction in azimuth is by the establishment of an artificial aiming point on the near side of the mask.

The establishment of this aiming point may be accomplished in three general ways:

(*a*) By making a ground map.

(*b*) By having two observers go to the mask and line each other in on the gun and target.

(*c*) By having an observer line in the aiming point from high ground in rear of the gun from which he can see both the gun and the target.

The ground map method is similar to that already discussed under the head of the compass.

Referring to plate 55, let G be the gun, T the target, and O the observer. The observer measures the ranges OT and OG and the angle T O G. Then going to the gun position he establishes a point O′ in the line OG, the distance O′ G representing OG to the scale selected for the ground map. He then establishes the point T′ in such manner that the angle T′ O′ G shall be equal to the angle T O G and the distance T′ O′ proportional to TO. The point T′ then will be in the plane of fire and hence may be used as an aiming point with zero deflection.

In the absence of an angle measuring instrument of greater accuracy than the mil scale, this method can not be depended

upon for very precise results when the angle T O G is much greater than 200 to 300 mils.

The method of alignment by two observers at the mask is as follows:

The gun position having been selected, the two observers advance to the mask, establish themselves on the line joining the gun and target, and drive stakes to indicate these two points in the line. By means of these two points, this line

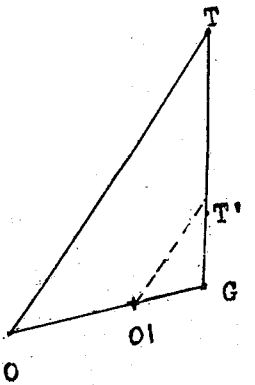

PLATE 55.

is prolonged toward the gun and a third stake placed in the line and at some convenient distance (say, 25 yards) in front of the gun. A fourth stake is placed in the line about 50 yards from the gun.

To give the gun its proper direction in azimuth, it is placed in position in prolongation of the line established by the stakes and the line of aim directed at the nearest stake.

These aiming stakes also may be established by an observer in rear of the gun when high ground is available from which a view may be had of both gun and target.

This method of determining the azimuth by the direct alignment of aiming posts is quick and accurate and is the method to be preferred when local conditions will permit its use.

ELEVATION.

120. To give the gun its proper elevation one must first determine what that elevation is and then apply that elevation to the gun.

Determining the elevation.—To determine the elevation required it is necessary to know—

The range, and

The angle of sight.

The range may be found by the ground-map method. For example (see figures in discussion of ground-map methods under "Azimuth" ante), the measurement of the distance G T′ or G′ T′ to scale will give the range.

When the observer is directly in front of the gun (for example, at the mask), he would find the distance to the target and to the gun. The sum of these distances would be the range. When the observer is directly in rear of the gun, he finds the range to be the difference between the distances to the gun and to the target.

To find the angle of sight when the target is masked, it is necessary to know the range and also the difference in elevation, in feet or yards, between the gun and the target.

These factors are determined from the post of the observer as follows:

Referring to plate 56, let G be the gun, O the observer, T the target, and the line HH′ the horizontal through the observer's post.

The observer measures the ranges OT and OG with a range finder and the angles T O H and G O H′ with a clinometer. An example will best illustrate the further procedure.

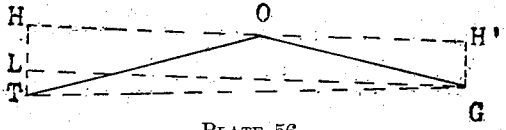

PLATE 56.

Let OG=500 yards, OT=1,200 yards, G O H′= 12 mils, and T O H=21 mils. Let it be assumed also that the range has been found (from a ground map or otherwise) to be 1,500 yards.

By the use of the mil formula $W=\frac{RM}{1000}$ it is found that H′ G= $\frac{500\times15}{1000}$=6 yards and that H T=$\frac{1200\times21}{1000}$=25.2 yards.

The difference between these amounts is 25.2—6=19.2, i. e., the target is 19.2 yards below the gun, this amount being represented in the figure by the distance L T.

This difference in level between gun and target having been found, the angle of sight (L G T) is found by using the mil formula $M=\frac{1000W}{R}$.

Hence angle L G T=$\frac{1000\times19.2}{1500}$=12.8 mils.

Having the range and the angle of site given, the elevation to be given the gun becomes the algebraic sum of the angle of departure and the angle of site, the angle of site being positive (+) when the target is higher than the gun and negative (—) when the target is lower than the gun.

The angles of departure (in mils) for the various ranges (in yards) are given in the following:

Range table.

Range.	Angle of departure.	Range.	Angle of departure.	Range.	Angle of departure.
100	0.7	1,100	16.8	2,100	62.3
200	1.5	1,200	19.9	2,200	69.2
300	2.4	1,300	23.3	2,300	76.1
400	3.4	1,400	27.0	2,400	83.5
500	4.6	1,500	31.1	2,500	91.4
600	6.0	1,600	35.5	2,600	99.8
700	7.6	1,700	40.2	2,700	108.6
800	9.4	1,800	45.3	2,800	118.1
900	11.6	1,900	50.7	2,900	128.2
1,000	14.0	2,000	56.5	3,000	138.9

For example, assuming the range to be 1,000 yards and the angle of site to be +10 mils, then the required elevation would be 14 (from table) +10=24 mils. Had the angle of sight been —10 mils, then the required elevation would be 14—10=4 mils.

Applying the elevation to the gun.—Having determined the required elevation, the next problem is to apply this elevation to the gun. This may be done in any one of the following ways:

(*a*) By the use of a quadrant;

(*b*) By the use of a level; or

(*c*) By the use of an aiming point placed accurately in the line of site.

In any case it is assumed that the gun has first been given its proper direction in azimuth before the elevation is applied.

When a quadrant is used, the instrument is merely adjusted to the required elevation, placed on the gun, and the gun then elevated until the level bubble of the quadrant is centered. The gun then has the correct elevation.

To avoid the inconvenience and loss of time incident to verifying the elevation with the quadrant during the firing, it is usual, after the gun has thus been given its proper elevation, to clamp it fast, and then by manipulation of the rear sight and without changing the direction of the bore to direct the line of aim on some suitable aiming point. The correct elevation is maintained thereafter by keeping the line of aim directed at this aiming point. If a suitable natural aiming point is not to be found, an artificial one, such as a stake or stone, may be placed at a convenient point in front of the gun.

To use a level for the purpose of giving the gun its proper elevation, an aiming post is placed at some convenient distance (say, 25 yards) in front of the gun and in the plane of fire.

The level is now placed on the gun and the gun elevated or depressed until it is level.

The rear sight is set at zero and an aiming point is placed on the aiming post at the height at which it is cut by the line of aim.

An example will best illustrate the further procedure. Assume the range to be 1,000 yards and the angle of sight to be +13 mils. The required elevation is, therefore, +27 mils. Consulting the range table, it is seen that an elevation of 27 mils corresponds to a range of 1,400 yards. The rear sight, therefore, is set at 1,400 yards, the line of aim directed at the aiming point, and the gun will then have its proper elevation.

To give the gun its proper elevation by the use of an aiming point placed accurately in the line of sight, it is assumed that an aiming post has been established in the plane of fire for the purpose of giving the gun its proper direction in azimuth.

A clinometer is now set at the angle of sight and, from the gun position, its line of sight directed at the aiming post. Where this line of sight cuts the aiming post, an aiming point is established. The rear sight is now set at the true range, the line of aim directed at the aiming point, and the gun will then be given its proper elevation.

There remains to be considered the methods used in giving the gun its proper elevation by the use of a natural aiming point. There are, in general, two cases for consideration:

(*a*) When the vertical angle between target and aiming point can be measured directly from a point approximately at the gun position; and

(*b*) When this vertical angle can not be so measured.

In the first case the problem is easiest solved with a mil scale or with a sight scale. These methods are described in the Musketry Manual and in the pamphlets describing the mil scale and field glass.

In the absence of any of these instruments, however, the problem may be solved with approximate accuracy by the use of the range table. For example, assume the range to be 1,000 yards and the vertical angle between target and aiming point to be 13 mils—the target being above the aiming point. When aim is taken at the aiming point, the elevation to be used would be 13 mils more than 1,000 yards. As the elevation for 1,000 yards is 14 mils (see range table), then the total elevation required would be 14+13=27 mils. From the range table it is seen that 27 mils corresponds to a range of 1,400 yards. Hence the gun is given its proper elevation when the sight is set at 1,400 yards and aim taken at the aiming point.

Had the target been below the aiming point instead of above it, then the elevation required would have been 14—13=1 mil, which would correspond to a sight setting of a little more than 1,000 yards.

When the vertical angle between target and aiming point can not be measured directly, it is found indirectly as follows:

By the methods heretofore described, the observer finds the angle of sight from gun to target and the angle of sight from gun to aiming point. The difference between these two angles is the vertical angle required. This vertical angle having been found, the determination of the sight setting is the same as when the angle is measured directly.

INDIRECT FIRE WITH A MAP.

121. Much of the indirect fire of trench warfare is done with a map, and hence proficiency in this class of fire is to be sought.

The first thing to be done in map firing is to locate accurately one's own position on the map and also that of the target. As this is merely a matter of map reading, mention will be made only of the method of "squares" now largely in use. A discussion of this system will be found in the pamphlet of May, 1917, on Maps and Artillery Boards, War Department Document No. 587.

Having located the gun and target on the map, it is necessary to determine—

(*a*) The direction of the target;
(*b*) The range; and
(*c*) The angle of sight.

The direction is found by using a protractor to determine the compass bearing of the target, the protractor being oriented to the true north, magnetic north or grid north, according to circumstances. The protractor also may be used to measure the angle to some suitable natural aiming point.

The range is found by scaling it directly from the map. The angle of sight is found thus:

First refer to the contours and determine the difference in level (in feet or yards) between the gun and the target. Then scale the range from the map. Now, having the range and this difference in level, the angle of sight is found by using the mil formula $M=\frac{1,000W}{R}$, care being taken to express the difference in level (W) and the range (R) in the same unit of measure as feet, yards, meters, etc.

As an example, assume the range to be 1,500 yards and that the gun is on the 1,040 foot contour and that the target lies half way between the 1,050 and 1,060 foot contours. The level of the target, therefore, would be 1,055 feet and the difference

in level between gun and target would be 15 feet or 5 yards. Then applying the formula,

$$\text{angle of sight} = \frac{1{,}000 \times 5}{1{,}500} = 3\tfrac{1}{3} \text{ mils.}$$

Having the direction, the range and the angle of sight, the gun is laid by the most convenient of the methods already described for firing without a map.

After the technique of the solution of the single-map problem has been learned, leaders should be practiced in the registration of given map sectors and in opening fire quickly on any given point within that sector.

THE CLEARANCE OF THE MASK.

122. To determine whether or not the mask will be cleared by a given cone of fire, the following procedure is adopted: The gun is placed in position, given its proper direction and elevation, and then clamped fast. Without moving the barrel, the tangent sight is now set at the range *to the mask*. If the line of aim is found to clear the top of the mask by not less than the amounts shown in the following table, then the 100 per cent cone will clear the mask. If the line of aim is found to be directed exactly *at* the top of the mask, then only the upper half of the cone will clear the mask. If the line of aim is found to be directed below the top of the mask by not less than the amounts shown in the table, then the mask will intercept the entire cone of fire.

Table of mask clearances.

Range to mask.	Clearance, in mils.	Range to mask.	Clearance, in mils.	Range to mask.	Clearance, in mils.
100	2 6	1,100	2.8	2,100	5.6
200	2.6	1,200	2.9	2,200	6.3
300	2.6	1,300	3.0	2,300	7.0
400	2.6	1,400	3.2	2,400	7.9
500	2.6	1,500	3.4	2,500	9.1
600	2.6	1,600	3.7	2,600	10.5
700	2.6	1,700	4.0	2,700	12.2
800	2.6	1,800	4.3	2,800	14.2
900	2.6	1,900	4.7	2,900	16.3
1,000	2.7	2,000	5.1	3,000	18.7

123. Should it be desired to solve the problem of mask clearance without putting the gun in position, it may be done thus: Find the quadrant elevation required to hit the target and the quadrant elevation required to hit the top of the mask. If the target elevation exceeds the mask elevation by not less than the amounts shown in the table, then the mask will be cleared. If the two elevations are equal, then only the upper half of the cone will clear the mask. If the mask elevation exceeds the target elevation by not less than the amounts shown in the table, then the mask will intercept the entire cone of fire.

CHAPTER XII.

OVERHEAD FIRE.

124. Overhead fire is fire delivered over the heads of one's own troops. It may be either direct or indirect.

The tactical application of overhead fire is not a subject for discussion in this chapter, which will deal only with its technical phases.

The technical problem presented to the machine gunner, when the tactical situation demands overhead fire, is whether or not one's own troops will be safe.

125. Experience proves that, even with care, the errors in the determination of firing data combined with those of sight setting and aiming may amount in the aggregate to what would be equivalent to a 15 per cent underestimate of the range.

Assuming that this maximum error may be made, it is necessary to provide a further factor of safety, and this is done by demanding that, with this maximum error, the lowest shot in the sheaf shall clear the troops by not less than 10 feet and not less than 5 mils.

Referring to plate 57, let G be the gun, T the target, UUU the upper limit of the sheaf, MMM the mean trajectory, LLL

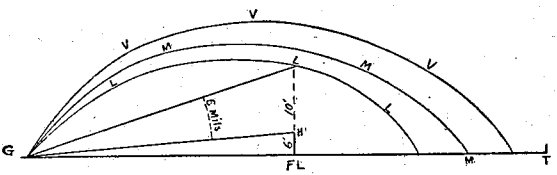

PLATE 57.

the lower limit of the sheaf, FL the feet of a man standing at the firing line, and H the head of the same man.

Now, assuming the error in laying to have resulted in the center of impact falling short of the target by the distance MT, which is 15 per cent of the range, then overhead fire would be unsafe so long as the distance LH was less than 10 feet or the angle LGH less than 5 mils.

126. To determine this in any concrete case, the range table given in Chapter XI is used in conjunction with the following:

Table of safety angles.

Distance to troops.	Safety angle.	Distance to troops.	Safety angle.	Distance to troops.	Safety angle.
Yards.	*Mils.*	*Yards.*	*Mils.*	*Yards.*	*Mils.*
75	102.4	800	27.7	1,000	65.5
100	77.3	900	30.5	1,700	73.0
200	41.6	1,000	33.7	1,800	80.8
300	30.8	1,100	37.6	1,900	89.6
400	26.3	1,200	42.2	2,000	98.9
500	24.3	1,300	47.2	2,100	109.2
600	23.9	1,400	52.7	2,200	120.3
700	25.5	1,500	58.8		

The question of troop safety can be determined in the same manner as that of the clerance of masks. The gun being laid and clamped in position, the tangent sight is set at the range to the troops. If the line of aim is found to clear the highest point of defilade (the point FL in the above example) by not less than the amounts shown in the table of safety angles, then it is safe to fire.

127. If the troops are hidden by a mask or if for any reason it is desired to solve the problem of troop safety without putting the gun in position, it can be done thus: Find the quadrant elevation required to hit the target and the quadrant elevation required to hit the troops. Then in order that the fire may be considered safe, the target elevation must exceed the troop elevation by not less than the amounts shown in the table.

128. The following precautionary measures are taken when overhead fire is attempted:

(1) A worn barrel is never used.

(2) It is necessary to find or make a solid foundation for the tripod or carriage.
(3) All firing data must be carefully checked.
(4) When clinometers are used, their accuracy must be verified before firing.
(5) A positive mechanical stop is used to prevent the depression of the muzzle below the limits of safety.
(6) Troops are notified before firing over them.
(7) Corrections for atmospheric conditions, especially wind, are important.

CHAPTER XIII.

NIGHT FIRING.

129. Occasions will frequently require that machine-gun fire at night be brought to bear on targets such as bridges, defiles, fords, rivers, or some obstacle in front of the position, wire entanglements, etc. This is accomplished by laying the gun in daylight and by the use of auxiliary aiming points.

It is essential that all machine-gun men be thoroughly familiar with the methods involved; therefore, all machine-gun organizations will have annually at least one night firing exercise using ball ammunition.

The firing data and all necessary arrangements for firing may be made before dark, but the actual firing will not take place earlier than two hours after sunset nor later than two hours before sunrise.

One of the following methods is suggested:

(*a*) The illuminated face of a "night firing box."

(*b*) A stake silhouetted in front of a night firing box, or by means of a stake faced with luminous paint.

Before nightfall the gun is placed in position. If a light gun, the muzzle rests in a notch cut in the top of a stake driven firmly into the ground, or with a heavy type of gun the position

of the tripod legs is marked by stakes. An auxiliary aiming point is provided by placing a night firing box or stake 12½ yards from the muzzle rest stake or muzzle of heavy gun at the night firing position and in line with the target. The gun is then accurately aligned on the target. By adjusting the rear sight slide and windage screw, the line of sight is brought to bear upon the aiming point without changing the direction of the bore. The reading of the rear sight in elevation and windage is recorded.

When once located the position of the night firing box is marked by driving stakes at the back and sides; this done the box may be removed and replaced when needed.

For night firing the sight is set as recorded, the gun muzzle rested in the notch of the muzzle rest or legs of tripod put in marked positions, and the line of sight brought to bear upon the aiming point by means of the elevating and traversing gear. Fire for effect may then be opened at once.

When circumstances place target and aiming point at approximately the same elevation, the aiming point will be set a trifle to one side of the line of fire, and the necessary adjustment made in the line of sight by means of the windage screw. The night firing box is constructed so as to be invisible from the front and flanks. The auxiliary aiming point must never be placed so near the line of fire that a bullet may strike the box and expose the illumination to hostile view.

130. DESCRIPTION OF NIGHT FIRING BOX.—This consists of a box one face of which is covered with transparent material marked as shown in plate 60. At 12½ yards from the eye, the interval betwen the horizontal lines subtends 2 mils, and the intercept between the vertical lines 4 mils.

Illumination is provided by an electric flash light, candle, lantern, etc., placed within the box. The illumined face is 8 inches square.

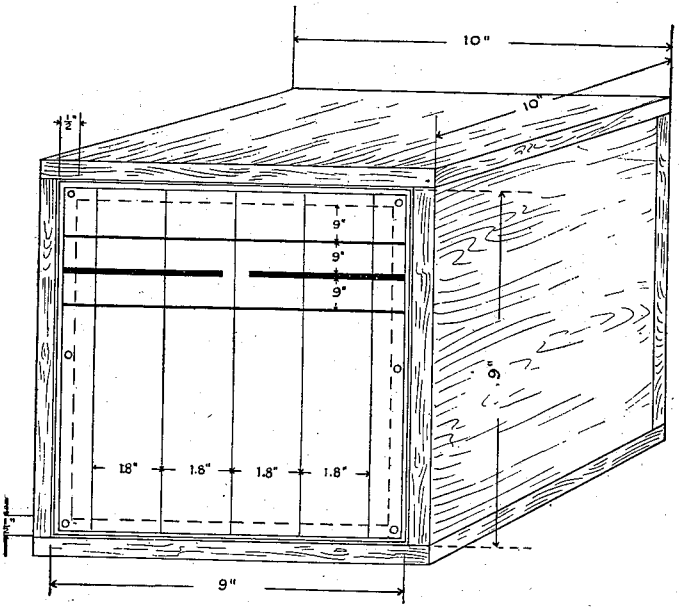

PLATE 58.

CHAPTER XIV.

INDIVIDUAL QUALIFICATION TESTS FOR MEMBERS OF MACHINE-GUN ORGANIZATIONS.

131. The examinations will be conducted by boards appointed, in regiments, by the regimental commander. The boards for examination of special units will be appointed by the commanding officer of the unit to which the organization is attached. The board will consist of three officers, one only of whom will be on duty with the organization undergoing examination. The examination will take place as soon as practicable after the completion of the instruction field firing (Chap. X).

Only those officers and enlisted men whose names appear on the report of individual known distance practice (par. 291) as having made 65 per cent or over in the individual known distance practice (par. 110) will be examined by the board.

Subjects:	Value.
A. Matériel	50
B. Determination of ranges	10
C. Sight setting and recognition of targets	5
D. Individual known distance practice	15
E. Individual field firing	20

Any candidate who falls below 65 per cent in any subject will not be permitted to proceed further with the test.

Classification.

	Minimum general average.	Minimum in each subject.
	Per cent.	*Per cent.*
Expert rifleman, machine gun	85	75
Sharpshooter, machine gun	80	70
Marksman	75	65

132. A. MATÉRIEL—VALUE 50.—The examination will be comprehensive and test the candidate's familiarity with the use and care of the matériel with which the machine-gun organization is equipped:

(A) THE MACHINE GUN.

The candidate will be required:	Value.
1. To completely dismount the machine gun, including (1) barrel group; (2) receiver group; (3) working parts or firing mechanism, and (4) the mount	2
2. To give name and explain the functions of all parts, their sequence of movement in operation, and their adjustment, including the important parts of the rear and front sights	8
3. To assemble gun and mount	2
4. To completely dismount and assemble the machine gun, as enumerated under 1 above, blindfolded	8
5. To give and explain points to be specially attended to in preparation for firing, during firing, and after firing, and to explain care, cleaning, and oiling of the gun	6
6. To name and give use of contents of gunner's pouch, tool or spare parts box, and accessories	2
7. To name parts, and give use and adjustment of loading tools	4

(B) JAMS OR FAILURE TO FUNCTION.

The examining board will state or give five conditions which prevent or impede functioning of the gun. The candidate will describe the cause of the condition and will demonstrate the means of remedying the same	18
Total	50

NOTE.—Machine guns will be considered completely dismounted when certain paragraphs of official pamphlets have been complied with.

Maxim: Paragraphs 1 to 10, inclusive, pages 26, 27, and 28, with the exception that paragraph 3, page 27, should be changed to require the disassembling of the lock. Page 33, packing, "For the rear bearing." "For the front end." (Ordnance Department Handbook of the Maxim Automatic Machine Gun, cal. .30, Model 1904, revised to July 5, 1916.)

Vickers: Paragraphs 1 to 10, inclusive, pages 28, 29, and 30. Page 30, packing, "For the rear bearing" and "For the front end." (Ordnance Department Handbook of the Vickers Machine Gun, Model 1915, dated Mar. 19, 1917.)

Benet-Mercié: Paragraphs 1 to 17, inclusive, pages 30, 31, and 32, second paragraph, page 38. (Ordnance Department Handbook of Automatic Machine Rifle, cal. .30, Model 1909, revised to July 31, 1916.)

Lewis: Dismounting, general, page 27, as given. Buttstock group, page 28, not dismounted. Receiver group, page 29; rear sight will not be removed from feed cover. Mainspring group, page 30, as given. Guard group, pages 30–31, not dismounted. Bolt complete, page 31, as given. Operating rod, page 32, not dismounted. Barrel group, pages 32–33, the barrel and gas chamber band will not be dismounted from the radiator. (Handbook Savage Arms Co., Lewis Automatic Machine Rifle, Model 1916.)

NOTE.—The following table is given only as a guide for examining boards in the tests for knowledge of the matériel under "A." This table gives a fair average time in which replacements should be made by well-instructed men and must not be construed under any circumstance as having any value in the test or increasing the mark attained by any man for performing any given operation in less time than that given in the table.

The weight to be given any candidate should be based on—

1. An apparent knowledge of the sequence of movements necessary to remove or replace any given part; or

2. The avoidance of unnecessary movements in removing or replacing any part; or

3. The dexterity with which he performs any operation; or

4. The use of proper tools for making replacements; or

5. The accuracy and time in which he determines the cause of a stoppage.

These tests will commence with the gun completely assembled and properly adjusted ready to fire.

In dismounting the proper group must first be removed and then the designated parts dismounted.

In assembling the test is completed when the gun is adjusted and ready to fire.

Maxim or Vickers Guns.

Parts, given in detail.	Dismount.		Assemble.	
	Minutes.	Seconds.	Minutes.	Seconds.
1. Barrel group	2	0	4	0
(*a*) Recoil plates r and l.				
(*b*) Crank.				
(*c*) Barrel.				
Firing mechanism		30		
(*a*) Lock.				
(*b*) Trigger bar.				
2. Working parts		30	1	
(*a*) Spring box.				
(*b*) Recoil spring.				
(*c*) Fuse and links.				
3. Feed box		5		5
4. Nozzle and barrel disk		10		10
5. Handle block.				
(*a*) Trigger.				
6. To replace asbestos packing			15	
(*a*) Front			5	
(*b*) Rear			10	

LEWIS MACHINE GUN.

NOTE.—The barrel group will not be dismounted in any manner involving a time element. There is great danger of cross-threading the delicate union between the gas cylinder and gas chamber, the chamber and gas band. The rear end of the gas cylinder is easily injured where it fits into the rear locking piece. An attempt to force the barrel into a reversed gas band might cause irreparable damage to the gas band, barrel, and radiator.

Table showing in detail groups and parts to be dismounted and assembled.

Parts, given in detail.	Dismount.		Assemble.	
	Minutes.	Seconds.	Minutes.	Seconds.
1. Constituent groups	1	0	2	0
(*a*) Buttstock group.				
(*b*) Receiver group.				
(*c*) Mainspring group.				
(*d*) Guard group.				
(*e*) Bolt and rod group.				
(*f*) Barrel group.				
2. The receiver group	2	0	3	0
I. Feed cover.				
(*a*) Magazine pawls spring.				
(*b*) Stop pawl.				
(*c*) Rebound pawl.				
(*d*) Cartridge guide pin.				
(*e*) Cartridge guide.				
(*f*) Cartridge guide spring.				
II. Feed operating arm.				
(*a*) Feed pawl.				
(*b*) Feed pawl spring.				
III. Ejector cover.				
IV. Ejector.				

Table showing in detail groups and parts, etc.—Continued.

Parts, given in detail.	Dismount.		Assemble.	
	Minutes.	Seconds.	Minutes.	Seconds.
3. Working parts groups	2	30	2	30
I. Operating rod.				
II. Bolt.				
(*a*) Feed operating stud.				
(*b*) Both extractors.				
III. Gear casing.				
(*a*) Collet pin.				
(*b*) Gear.				
(*c*) Mainspring in casing.				
(*d*) Collet.				
AUTOMATIC MACHINE RIFLE, MODEL 1909 (BENET MERCIÉ).				
Barrel group	1	38	2	0
(*a*) Regulator.				
Receiver group	4	40	8	56
(*a*) Ejector.				
(*b*) Ejector spring.				
(*c*) Ejector cap.				
(*d*) Cartridge stop.				
(*e*) Cartridge stop spring.				
(*f*) Cartridge stop holder.				
(*g*) Cover plate.				
(*h*) Cover plate washer.				
(*i*) Cover plate screw.				
(*j*) Feed piece.				
(*k*) Feed piece spring.				
(*l*) Fermature nut.				
(*m*) Locking nut.				
Firing mechanism group	0	58	1	44
(*a*) Actuator.				
(*b*) Actuator spring.				
(*c*) Breech block.				
(*d*) Firing pin.				
(*e*) Extractor.				
(*f*) Extractor spring.				

133. B. DETERMINATION OF RANGE—VALUE 10.

	Credits.
(*a*) Range-finder adjustment	0.5
(*b*) Range finding	3
(*c*) Mil scale	4
(*d*) Estimation of distance	2.5
Total	10.0

The candidate will be tested on terrain away from class A range. The self-contained base-range finder and musketry rule, model 1916, will be used.

(*a*) ADJUSTMENT OF RANGE FINDER.—Halving and distance. (As prescribed in handbook for the particular instrument with which organization is equipped.) For which a value of 0.25 will be given for each of the halving and distance adjustments, a total value of 0.5.

(*b*) RANGE FINDING.—Three trials with self-contained base range finder at ranges from 600 to 1,800 yards, using well-defined objects as targets, aiming points, or registration marks.

The range finder will be in adjustment, set up, put in gear, and focussed, but will be out of direction at the beginning of each trial.

The object to which the range is to be found having been identified by the candidate, the examiner commands, for example:

1. Object, that (name of object, as tree, house, target, etc.).
2. Measure the range.

At the last word of the last command the candidate measures the range, and announces, for example, 950. He then steps clear of the instrument.

No credits are given if the range announced is not within 5 per cent of the correct range as determined by the board with the instrument used.

If the range has been correctly measured and announced with the limits prescribed, credits are given for each as follows:

	Within 3 per cent of range.			Within 5 per cent of range.		
Time in seconds, exactly or less than	15	25	30	15	25	30
Credits	1	.9	.8	.75	.7	.65

(c) MIL SCALE.—The candidate will be provided by the board with a suitable mil scale, or may use his own instrument if he prefers.

Four tests will be given:

1. The determination of the deflection between a reference point and an announced target.

Error in mils.	0	1	2	3	4	5	6	7	8	9	10 or more.
Credits	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0

2. The determination of a prescribed front expressed to the candidate in mils.

3. The determination of the range to an objective from 800 to 1,500 yards distant. This objective to be established by the board and to subtend a front of between 150 and 250 mils.

Error in range	5 per cent or less.	6 per cent	7 per cent	8 per cent	9 per cent	10 per cent or greater.
Credits	1	0.8	0.6	0.4	0.2	0

4. The determination of a sight setting appropriate for use with a given target and auxiliary aiming point.

(*d*) ESTIMATE OF RANGE.—The candidate will be taken to ground away from the class A range and be given five trials, three from a standing position and two from a prone position. The objectives will be arranged at distances varying from 200 to 1,200 yards and will be physical objects, standing or prone men, grouped or single, appropriate to the distance.

No credits will be given in the following cases:

1. If the error in the estimated distance is greater than 15 per cent.

2. If the time taken in announcing the estimate is more than 25 seconds.

Credits for each trial will be given as follows:

	Within 10 per cent of range.			Within 15 per cent of range.		
Time in seconds, exactly or less than	15	20	25	15	20	25
Credits	0.5	0.3	0.2	0.2	0.15	0.1

134. C. SIGHT SETTING AND RECOGNITION OF TARGETS—VALUE 5.—The candidate will be so posted behind cover that the target figures are invisible. The location of the target will then be described to him by the board—using the clockface and mil system—announcing the true range and an arbitrary windage. If the terrain does not include reference points sufficiently distinct, the board will cause the same to be established.

At the command "ready" the candidate will step to a position from which the target may be seen; "find" the target; set his sights as ordered and adjust his machine gun on the designated target.

No credits will be given in the following cases:

1. When the gun is not pointed at the correct target.

2. When the sight is not set at the announced elevation and with the windage ordered.

135. D. INDIVIDUAL KNOWN DISTANCE PRACTICE.—The percentage adopted by the board is that entered on the record of individual known distance record firing and qualification test by the company commander under paragraph 289A.

136. E. INDIVIDUAL FIELD-FIRING TEST.—To be so arranged that it may be fired on a class A range at stations where a class B range is not available.

At least five groups of targets will be used. (These may radiate from a common firing point.) The targets will be on a beam, and only the group to be fired at will be visible.

Men awaiting test will remain in a position from which the targets can not be observed.

1. *Range.*—Between 500 and 1,200 yards.

2. *Target.*—A group of eight prone figures so spaced as to cover a front of 10 yards (or $48\frac{2}{7}$ inches between centers).

3. *Firing.*—At discretion of candidate.

4. *Ammunition.*—60 cartridges per man. This to be loaded by the individual who is to fire it in two clips, belts, or magazines containing 30 rounds each.

5. *Mount.*—As issued.

6. *Equipment.*—The firer will be equipped with a gunner's pouch, tool box, or other accessories necessary to operation of the gun.

7. *Sight.*—Leaf or battle, as determined by firer.

8. All firing will be "automatic."

9. *Time.*—Time, two minutes, taken from the arrival at the firing point with the gun. The signal for ceasing fire will be communicated by whistle.

10. *Loading.*—By an assistant.

11. *Jams.*—When jams occur time is taken out until the gun has been made to function. The candidate is then allowed to continue the firing in the time remaining to his credit.

12. *Score for fire effect.*—Each figure hit will count as follows:

500 yards	2.14	900 yards	2.33
600 yards	2.19	1,000 yards	2.41
700 yards	2.23	1,100 yards	2.5
800 yards	2.28	1,200 yards	2.62

13. *Coaching.*—None allowed after the candidate has identified his target.

14. *Cover.*—A sandbag revetment not less than 8 feet in length and 3 feet in height, with loopholes not to exceed 100 square inches in area.

15. *Assistant.*—The candidate will be furnished an assistant who may assist in advancing the gun, ammunition, and accessories to the firing position and setting up the gun. He will further assist in loading, regulating gas pressure, and reduction of jams.

His duties will be limited strictly to those described above.

16. *Procedure.*—When directed by the board the candidate, leaving his assistant at least 30 yards to the rear, will advance to the artificial cover provided and be shown his targets for identification. No determination of ranges will be permitted at this time.

He will then advance the gun by hand to the firing position, go into action, determine the range by any means he may desire, and open fire for effect.

At the whistle signal for ceasing fire, or on firing the 60 cartridges allowed, he will retire 20 yards.

17. *Credits.*—The board will determine credits for the test on the following basis:

	Value.
1. Advancing under cover and going into action (celerity and use of cover considered)	1
2. Use of cover while firing	1
3. Retiring under cover from action (celerity and use of cover considered)	1
4. Effect of fire (figures hit)	17
Total	20

PART III.

COMBAT FIRING.

CHAPTER I.

FIRE PROBLEMS.

137. The solution of a tactical problem may involve a consideration of many incidental problems, including questions of supply, maneuver, transportation, policy, psychology, infantry fire, machine-gun fire, artillery fire, etc.

The subject of fire action (infantry, machine guns, or artillery), is taught by means of fire problems.

A tactical problem may or may not include a fire problem as an incident to its solution. A fire problem, however, is always a part of a tactical problem, fire power being a physical means to a tactical end.

Therefore the tactical methods adopted in the solution of a fire problem should receive full consideration in judging the problem as a whole.

138. Fire problems are of two general types: First, those designed to give commanding officers (battalion, regimental, brigade, and division) a knowledge of and practice in the utilization of the fire power at their command for the accomplishment of given tactical missions; second, those designed to give practice to subordinate commanders and their organizations in applying their technical skill in the use of their fire power in the accomplishment of their missions.

139. These two types of problems are quite different in their subject matter. The commanding officer considers the firearms in the hands of his troops merely as so many tools with which to do a certain piece of work. His problem concerns the placing of his troops in such position that they may develop fire power commensurate with the assigned task. The question is therefore a tactical one, the solution of which requires, not only tactical ability but a technical knowledge of the limitations and capabilities of the material in the hands of his troops.

140. At the outset of a campaign, the machine-gun commander might be depended upon for advice as to these technical details, but the casualties occurring in field operations of any magnitude are more than apt to result in the command of machine-gun organizations pertaining to regimental and smaller units falling to men of immature judgment. Disaster might well result at such a time, if the commanding officer's judgment was based upon his unguided *opinion* rather than upon sound knowledge of the *facts* of applied technique.

141. Tactical ability and facility in command is developed by means of tactical walks and rides, terrain exercises, war games, and maneuvers. With a view to training of officers for command, commanding officers of posts and regiments are responsible that all officers acquire not only a thorough familiarity with the tactical limitations and capabilities and uses of the machine gun but a thorough knowledge of machine-gun matériel, technical methods of fire, etc. To this end the available machine-gun organizations should serve as a school for instructing other officers of the command.

142. The training of machine-gun commanders involves both technique and tactics.

In a tactical way he must be able, when called upon to do so, to offer sound advice to his commanding officer as to the employment of his machine-gun organization in the prospective combat. Also there will be times when failure of communication will place the machine-gun commander out of touch with

his commanding officer. In such a case the responsibility for correct tactical decisions rests upon the machine-gun commander.

143. In a technical way, the machine-gun commander's problem is somewhat as follows:

Based entirely upon the directions received from his commanding officer, or upon these directions supplemented by such tactical discretion as is allowed him, he arrives at the conclusion that the tactical requirements of the situation demand that he—

1. Occupy a given position,
2. With a given number of guns, and
3. Fire upon a given target
4. For a definite purpose
5. At a given time, and
6. For a given length of time.

His technical problem then becomes—

1. How to reach the position;
2. How to occupy the position;
3. How to secure the safety of his transport;
4. How to keep his guns supplied with ammunition for the task before them;
5. How to replace casualties;
6. How to keep in communication with his commanding officer, with the subdivisions of his unit, and with neighboring troops; and
7. How to make his fire effective.

The development of a tactical situation may require the solution of a series of such technical problems.

144. Whether designed for the training of officers or of machine-gun units, a course of fire problems should include as many of the probable phases of combat as possible.

Thus, such a course would include the use of machine guns in—

The service of security.
Attack.

Defense.
Withdrawal.
Delaying actions.
Attack and defense of convoys.
Siege operations.
Trench warfare, etc.

A course in fire problems should also be made progressive. At first such problems would involve a single tactical principle and simple technique, while toward the end of the course the problems are so framed as to be a severe tax upon the tactical skill and technical ingenuity of the participants.

In addition to the methods employed in the training of officers (map problems, tactical walks, etc.), field firing exercises are used in the training of machine-gun units.

145. THE CONSTRUCTION OF FIRE PROBLEMS.—Depending upon their purpose, fire problems may be divided into two general classes as stated above:

(*a*) Those designed for the training of officers in general.

(*b*) Those designed for the training of machine-gun commanders.

146. Problems designed for training of officers in general are usually without troops, or, if troops are used, then the use of ball cartridges is exceptional.

The usual problem of the commanding officer is to express the accomplishment of his mission in terms of fire effect, to determine what troops are required to produce that fire effect, and then to issue an order that will carry his decision into effect. In a word, his problem is to translate tactics into technique.

The statements of such problems should be as simple and concise as consistent with clearness. The solution of the problem may require any one or more of the following: The estimate of the situation, the decision, the orders.

It is seen that the commanding officer's problem (assuming a decision to fight) as well as that of the commander of a sub-

ordinate unit higher than the company is one largely of deployment and the assignment of objectives or sectors.

147. MACHINE-GUN COMMANDER'S PROBLEMS.—The individual training of the machine-gun commander in the application of fire is by means of fire problems similar to those employed in the training of other officers—i. e., map problems, terrain exercises, tactical rides and walks, etc.

In the training of the machine-gun commander in the actual handling of his unit under simulated combat conditions the fire problem takes the form of a field firing exercise.

A field firing exercise is a fire problem solved by troops on the ground, the enemy (or such portion as concerns the troops participating) being represented by targets, and the troops being supplied with ball ammunition to be used (or not) under the direction of their leader.

148. Tactical problems which do not include fire problems may be presented in the guise of field firing exercises—i. e., the enemy being represented by field targets and the troops being supplied with ball cartridges. Such problems are for the purpose not only of testing the leader's judgment in the application of fire, but also of impressing upon the participants that a problem combining a belt full of ammunition and a visible enemy does not always require fire action for its correct solution.

149. The field-firing exercise limits the action of the leader to a much greater extent than do other forms of fire problems. These limitations are necessary, first, because it usually will prove impossible to manipulate the targets in such a manner as to present a logical situation to meet all of the many possible solutions of the problem, and, second, because precautions for safety usually demand that the direction of the fire be confined within the limits of a certain definite arc.

As a consequence of these limitations the field firing exercise usually is confined to the representation of a single phase or episode of an engagement. Such episode might be covering an

assault, resisting an assault, resisting a counterattack, covering a withdrawal, covering an outpost position at night, etc.

Like other tactical problems, the field firing exercise is constructed with a view to imparting a lesson in tactics. An extended series of these exercises would be so framed as to include the application of all possible phases of technique to the accomplishment of tactical missions.

In order to preserve the realities of war, the problem, when practicable, should be laid on ground that is unfamiliar to the participants.

150. The targets representing the enemy must present a logical appearance. Their position, arrangement, and movement should be such as might be expected from well-trained troops under the conditions of the exercise.

As far as the mechanism of the target range will permit, there should not be left to the imagination any visible action of the enemy that can actually be represented by manipulation of targets.

Representing, by targets, the troops with which it is assumed the organization is acting adds interest and reality to the exercise.

151. In presenting all possible phases of combat, there will be problems that must be solved with a limited ammunition supply. In such cases the actual amount of ammunition supposed to be available is given in the statement of the exercise. As a rule, it is better to have the troops take the field with the ammunition they would naturally carry. The expenditure of this ammunition is regulated by the umpire, who causes the firing to cease when he considers that the volume of fire has been sufficient for the purposes of the exercises.

There are practical difficulties, however, that prevent a strict adherence to this principle. The majority of machine-gun problems will require for their solution only a small part of all the ammunition that is carried in the field equipment. Ammunition deteriorates more rapidly after it has been removed from the

original cases. Thus, to avoid having large quantities of loose ammunition on hand after the completion of any firing, the amount of ammunition actually carried in any exercise usually would not be more than about 30 per cent in excess of the amount which the umpire decides should be expended.

In informing the organization commander of the amount of ammunition to bring to the range, the umpire would state, in effect, "For this exercise it is assumed that your ammunition chests are full (or that the supply has been reduced to 2,500 rounds per gun). Of this assumed supply you will carry only 900 rounds per gun loaded in belts (strips or magazines)."

152. The umpire should estimate the amount of time required for an organization to complete an exercise. Organizations that follow should be ordered to report on the range at such an hour as to require the minimum loss of time in waiting their turn.

An exercise loses much of its instructional value if the participants have any advance information as to number, location, arrangement, or movement of targets, or, in fact, if they have any knowledge of the exercise conveyed to them in any manner prior to their taking part in it. Particular care is necessary in order to prevent this advance information reaching troops that are waiting their turn to fire.

153. The form of the written statement of a field-firing exercise differs in some particulars from that of other tactical problems.

In the ordinary tactical problem the leader is presented with a statement of the situation and, based upon that situation, there is required, perhaps, his estimate of the situation, his decision, his orders, the execution of those orders by his subordinates, etc. This is the complete statement of the problem.

154. In the field-firing exercise, the leader is confronted with similar situations and requirements, but there is a second part to this statement which the leader does not see before his solution of the problem is complete.

This second part of the statement is for the information of the umpire and the range officer.

In it are included statements covering as many of the following points as are essential:

1. The object of the exercise. The tactical and technical lessons it should impart. Stress is laid upon the mission and what must or may be done to accomplish it.

2. The procedure is given in considerable detail. This would include such further information as is given the troops and also a description of the manner in which the targets are to be manipulated in order to represent the action of the enemy.

3. A statement as to the number, kind, location, and arrangement of targets is given. This would include also a statement of what shelter is required for markers and the number of men required as a pit detail to manipulate the targets.

4. A complete statement as to the system of communication required between pits and firing points and elsewhere about the range. The number of agents of communication (signalists, buzzer or telephone operators, messengers, etc.).

5. A statement as to the necessary precautions for safety, roads and routes on which traffic must be stopped, number of range guards required to perform this duty, as well as their posts or beats.

6. A sketch showing location and arrangement of targets, position of firing points, dangerous area, posts of range guards, etc.

155. In writing problems that are to be carried out on a range where a permanent range officer is in charge, the details as to agents of communication, range guards, pit details, etc., may be omitted, the attention to these details being part of the range officer's duty.

156. In the solution of problems pertaining to brigades and divisions it usually is assumed that the student is the brigade or division machine-gun officer.

The requirements might be as follows:

1. The commanding officer asks your advice as to the use of the machine guns in this case. How would you advise him?

2. State briefly your reasons for this advise or make a detailed estimate of the situation.

3. What orders are necessary to carry this decision into effect?

4. Your commander has outlined his plan of action to you and directs that you write the portion of the order pertaining to the machine guns.

5. What action will you take in order to carry out the order issued under 4?

6. In a case requiring verbal orders, give them orally and then prepare a brief written statement embodying your estimate of the situation and your decision.

Similar problems may be used involving the employment of machine-gun units by regimental, battalion, and company commanders of infantry and cavalry.

157. In field-firing exercises, it is usual to have only the machine-gun units participate.

The necessity for arranging the targets to meet certain preconceived conditions usually demand that the machine-gun unit be acting under certain definite orders that are embodied in the statement of the problem. It will sometimes be possible, however, to call on the machine-gun commander to issue the order to his unit in the name of his commander and then to require him to carry out that order.

158. A complete set of combat problems for machine guns should include the following:

1. *Rencontre problems.*—A machine-gun organization is presumed to be part of an advance guard on the move and with guns packed. A meeting with the enemy is presumed to occur and the advance guard commander gives the machine-gun commander a mission to hold a certain point or to support the advance guard in its attack on the enemy or to assist in some other

way in the action. The ranges are usually under 500 yards and rarely over 800 yards. Time is a most important element in the correct solution of this class of problems.

2. *Problems in supporting an attack.*—The machine-gun commander is given a mission to support an attack from a point on the flank or to guard a flank during an attack or to assist by firing over the advancing line from a height. The ranges may be between 600 and 1,200 yards, with an advance of the machine-gun organization in some cases to 500 yards or less. Time is usually ample for the preliminary preparation, but prompt opening of fire at the proper time is important.

3. *Problems in defense.*—The machine guns may have a position at a supporting point and open fire at the time and at the objective named by the commander of the supporting point. In another case, the machine-gun organization may be in reserve, under cover, and be rushed up to a position to fire on some target at an opportune time. The ranges are usually under 600 yards, since the fire of machine guns in this case is properly withheld until the enemy begins his charge. Fire on targets representing cavalry charging from the front or flank comes under this head. Time is usually sufficient for preliminary preparation, but prompt opening of fire is necessary.

4. *Problems in trench warfare.*—Single guns are covered by intrenchments against fire from the front and have, for a mission, the stopping of the enemy's charge by flank fire over the area immediately in front of the wire entanglements. The ranges are from 150 to 50 yards against rapidly moving targets. Quick action is required.

5. *Rear-guard and delaying-action problems.*—The idea in these cases being to force the enemy to deploy as soon as he comes in sight, the firing will be at targets representing large formed bodies of the enemy at long ranges, say 1,200 to 1,800 yards or more. Time is often a consideration but is, in general, a relatively unimportant factor unless there are unnecessary delays in opening fire.

6. *Problems in firing on masked targets.*—In this case the target is not visible from the guns but is masked by some natural features. If, however, the target can be seen by observers at one or more positions on the flank or flanks or from higher ground to the rear of the guns, then the fire of machine guns can be made effective. Firing of this character may be held at ranges of from 800 to 1,800 yards or more. A reasonable time for the more complicated preparation for fire must be allowed.

7. *Problems where the guns are masked.*—In this case the organization must use a method of indirect fire modeled after that of the field artillery. The tactical situation might require this type of fire when the machine guns are within effective range of hostile artillery. The range to the targets may be anywhere from 400 to 1,800 yards or more. As in problems under case 6 a reasonable time for preparation must be allowed.

8. *Problems in night firing.*—These may be of two kinds. In the first the target is illuminated by searchlight or other means. In the second case the guns are set up by daylight covering a bridge or road, the mission being to stop the advance by night of an enemy over the road or bridge. The ranges in either case will rarely exceed 600 yards and prompt opening of fire is demanded.

9. *Problems in firing at aeroplanes.*—Kites of special forms, towed by automobiles, will serve as targets. The results of such firing should be very carefully analyzed, and it should be made perfectly clear to all that the greater speed and flying height of real aeroplanes will require altogether different and much greater corrections in sight elevations and point of aim in front of the machine. Ranges of the kites will usually be from 300 to 800 yards, the kites actually flying at heights of 300 to 400 yards. All time elements are vital.

159. Problems under 1, 2, 3, 7, and 8 can be handled on "A" ranges as actual combat problems with ball cartridges. It will often be possible on the larger "A" ranges to handle firing problems under 4, 5, and 6, but problems under 9 can not be fired

on "A" ranges on account of the elevation which must be given to the guns and the resulting distribution of the bullets over a wide area.

It is, of course, desirable to use "B" ranges for all combat firing on account of the increase in interest inspired by new terrain and the nearer approach to service conditions possible on such ranges, but combat firing can always be held and held with much value to all concerned, even if an "A" range has to be utilized for the firing.

CHAPTER II.

DRILL EXERCISES.

160. It is essential that the mechanism of combat problems be thoroughly understood before any are attempted with ball ammunition, and this can always be done by adequate preliminary combat-drill exercises on any available terrain.

In this preliminary work especial attention should be paid to target designation, fire orders, taking up positions, questions of cover for guns, men, and transportation, and details of the technique of preparation for and adjustment of fire. It is presumed that the members of the organization have been trained in their individual duties before combat firing is attempted.

161. The target for these exercises may be either represented, outlined, or assumed. When represented or outlined, either men or silhouettes may be used for the purpose. The limits of the objectives are indicated by flags and may include the entire line or only a portion of it.

162. The unit (company, platoon, or squad) is halted at some point from which it is not possible to obtain a view of the target. The instructor calls the leader forward to a point from which the target is visible and at the same time causes the

flags to be displayed at the target. He points out the target to the leader and informs him that the flags mark the flanks of his objective. The instructor further informs the leader that these flags will be removed before his unit is permitted to come within view of the target and that therefore the flanks of the objective must be fixed in the mind by reference to natural landmarks. When the leader informs the instructor that he has the target definitely located with reference to natural landmarks, the latter causes the flags to be removed.

163. The leader is now directed to complete his reconnaissance of the position, to occupy it with his unit, and to issue his fire order—all this under the assumption that his mission requires this target to be taken under fire. The instructor may add further conditions to the problem, such as, for example, that the fire must be opened without delay; that the position is or is not under hostile fire; that the enemy's air scouts have probably marked his position and identified his machine-gun unit as such; that the enemy is known to have artillery observers at X—, from which point this position is readily discernible, etc.

164. The leader makes such further reconnaissance as he deems necessary and then brings his unit to the position. The unit, in this exercise, consists only of those individuals who constitute the machinery of command that brings the will of the leader to the gunner; i. e., platoon leaders, squad leaders, gunners, range takers, guides, agents, etc.

In a word, the gun squads, except the leaders and gunners, are not used.

165. The leader then issues his fire order in a manner that would be feasible under the assumed conditions of the problem.

Each subordinate leader in turn issues his fire order in a similar manner.

When the fire orders have been issued, each leader and gunner (by the use of the aiming tripod; see par. 166) indicates what he believes to be the limits of the objective or of the fraction of the objective upon which he has been ordered to direct

his fire. Each also makes a written memorandum as to the elevation to be used, this elevation being the one he would use in compliance with his orders as he understood them.

This being done, the instructor causes the flags again to be displayed at the target, verifies the sighting of the aiming tripods, checks the elevations used with the true range to the objective, and then gives a critique on the execution of the exercise.

166. The aiming tripod is made as follows: Referring to plate 62, figure 1–A, the base AB and the arms DE and FC are made of hardwood. They are each about ½ inch square in cross section and about 10 inches in length.

At its center the base is made fast to the tripod (any camera or sketching tripod is satisfactory for this purpose) by a bolt and wing nut at C. This joint is made loose enough to permit of the base being turned in a horizontal plane without undue muscular exertion, but there must still be sufficient friction at this point to prevent the base being turned on the tripod by the action of a strong wind.

In like manner the arms are fastened to the ends of the base at A and B, the pivot of the arms being about half an inch off center to permit of the device being folded as shown in plate 62, figure 1–B.

The pointers, HD, IE, JF, and KG, may be made of any available pieces of thin sheet metal—zinc, copper, brass, tin, etc. The shape and size of these pointers, as cut from the flat metal sheet, are as shown in plate 62, figure 1–C. This piece is then bent in the shape shown in figure 1–D, plate 62.

These pointers are riveted to the ends of the arms in such manner as to permit of their being placed in an upright position for use, plate 62, figure 1–A, or folded down for packing or transportation, plate 62, figure 1–B.

In use, the tripod is set up with the base approximately perpendicular to the line of fire. When the leader or gunner has received his fire order, he decides upon what he believes to be

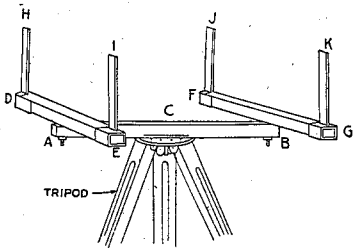

Fig. 1a.

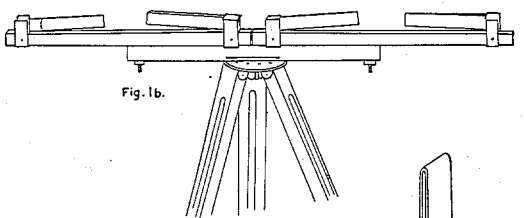

Fig. 1b.

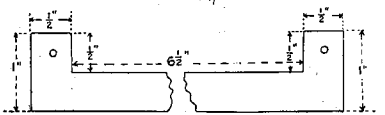

Fig. 1c.

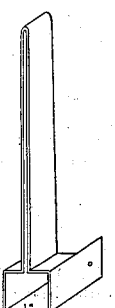

Fig. 1d.

PLATE 59.

the location of his target and then, using the pointers as front and rear sights, directs the arm DE at the point which marks the right flank of his particular fraction of the objective, while the arm FG is similarly directed at the left flank.

In judging the execution of any particular exercise the instructor takes into account the probable material effect of the fire, assuming it to have been carried out in strict compliance with the fire order.

Errors in the determination of the range are first considered, and the probable reduction in accuracy may be found by reference to the following table:

167. *Table showing theoretical effect of errors in the determination of the range.*

Estimate.	Errors in yards.																
	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
400	100	99	91	83	73	51	40	35	28	20	14	10	6	4	2	1	1
500	100	97	88	77	59	44	31	20	13	8	4	3	1	0	0	0	
600	100	94	83	68	48	32	19	10	5	3	1	0	0				
650	100	93	80	63	40	23	13	6	3	1	0						
700	100	92	77	58	36	19	10	4	2	0							
750	100	91	74	54	30	13	7	3	1								
800	100	90	70	48	25	11	5	2	0								
850	100	89	67	41	20	8	3	1									
900	100	88	64	36	16	6	2	0									
950	100	87	61	32	13	4	1										
1,000	100	87	59	29	11	3	1										
1,025	100	86	57	28	10	3	1										
1,050	100	86	55	27	10	2	1										
1,075	100	86	54	26	9	2	0										
1,100	100	85	54	24	8	2											
1,125	100	85	52	23	7	2											
1,150	100	84	51	21	7	1											
1,175	100	84	50	20	7	1											
1,200	100	83	49	19	6	1											
1,225	100	83	47	18	5	1											
1,250	100	82	46	17	5	1											
1,275	100	82	45	16	4	1											
1,300	100	81	43	15	4	1											
1,325	100	80	42	14	3	0											
1,350	100	80	40	13	3												
1,375	100	79	39	12	2												
1,400	100	78	37	11	2												
1,425	100	77	36	10	2												
1,450	100	76	34	9	1												
1,475	100	75	33	8	1												
1,500	100	74	31	7	1												

The figures in the body of the table show, in theory, the probable number of hits that would be obtained for any given estimate of the range and for any given error in that estimate. This is on the assumption that 100 hits will be obtained when there is no error in the determination of the range.

For example, assume a true range of 950 yards to have been determined as 1,000. The error is 50 yards. What is the effect of this error?

In the column headed "Estimate" find the amount corresponding to the estimated range (1,000). Follow this line to the right until entering the column corresponding to the error (50). Here will be found the figure 59. This figure 59 indicates that for every 100 hits that would have been obtained with the correct range but 59 hits would have been obtained with this particular error.

168. It is not sufficient for the instructor to state merely that the range is in error by a certain amount. He must observe the manner in which the range was determined; decide whether this method would have been practicable under the assumed conditions; point out the possible or probable causes of error; show how these errors may be eliminated or at least reduced in amount; and state whether the error is or is not excessive.

The instructor next turns his attention to the manner in which the target has been designated and to the precision of direction and control resulting from this designation.

169. The instructor's conclusions as to the correctness or incorrectness of the designation are based on his own observation of the manner in which the leader and his subordinates issue their fire orders. The precision of fire attained by the order is shown by the aiming tripod.

Referring to plate 63, let XY be the line of targets and A and B be the flags marking the flanks of the particular fraction of that line at which fire is to be directed. Let G represent the position of the gunner or leader, and the line Ga and Gb repre-

sent the two lines of aim as shown by the arms of the aiming tripod.

Case A shows that the designation and the understanding of said designation were perfect, the arms of the aiming tripod pointing with precision at the flanks of the target.

Cases B and C show that the designation or the understanding of it (the instructor determines by observation whether the error lies with the leader or the subordinate) is lacking in precision to such an extent as to reduce the effect of the fire by one-half; in case B because twice the allotted front is covered and hence the assigned target receives but half of the volume of fire that should have been directed upon it; in case C but half of the target is covered with fire.

In case D no credit whatever can be allowed for designation, as there is no portion of the target covered with fire.

By showing how the effect of fire is reduced by the combined errors in range and designation, the instructor may give a forcible demonstration of the fact that the best marksmanship is of no avail if acting under the direction of a faulty fire order.

Take case B for example, and assume that the true range of 800 yards was estimated at 900 yards. From the table in paragraph 167 it is found that this error will reduce the hits from 100 to 16. As only half of the fire is directed at the target this 16 hits would also be reduced by one-half. Hence good marksmen, who are capable of making 100 hits on this target, if properly directed, make only 8 hits because of the errors of their leaders.

This exercise may be varied in several ways.

One variation would be to point out the target to the leader and then require him to occupy a position several hundred yards nearer the objective and there issue his fire order.

A second variation would be similar to the first except that the new position would be well off to one flank as well as to the front.

Both of these might be varied by having the subordinate leaders shown the target at the first position and then, when the

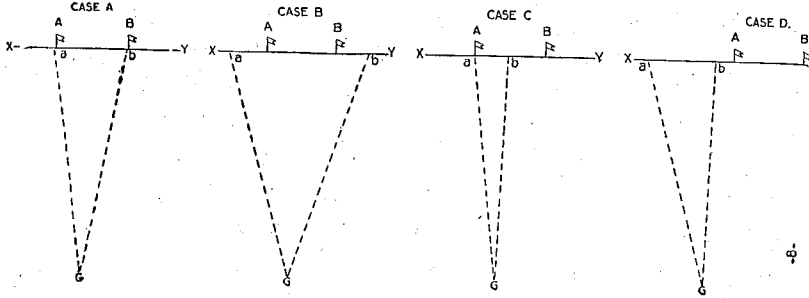

PLATE 60.

CASE A.—Designation perfect. Entire target covered and no more.

CASE B.—Designation reduced to one-half in value. The front covered is twice that of the assigned objective.

CASE C.—Designation reduced to one-half in value. The front covered is only half that of the assigned objective.

CASE D.—Designation reduced to 0 in value. No portion of the objective covered.

second position was reached, to require that the aiming tripods be sighted and firing data be communicated by signal alone—this under the assumption that the unit has come under a hostile fire from the target which makes it impossible to hear the voice.

Though it would be unusual for a superior commander to use a map for the purpose of assigning an objective to so small a unit as a company, it is still possible to conceive of situations in which such a procedure might be necessary. For this reason a further variation of this exercise is suggested in which the instructor uses a map for the purpose of informing the leader as to his firing position and his target. The leader occupies the position with his unit and issues his fire order without reference to the map.

170. Drill exercises of this general character will serve for preparation for rencontre problems, problems in supporting an attack, problems in defense and in rear guard and delaying actions.

Preparation for combat problems in trench warfare, night firing, and firing at aeroplanes is largely a question of technique. The targets, when they appear, will be perfectly self-evident, and their fleeting nature will require fire to be opened with a maximum of speed and a minimum of orders.

Note, however, that direct fire *at* aeroplanes will have *no result whatever* and that the data for sight setting and point of aim ahead of the flier must be worked out for the gunners before fire can be opened with any prospect of success.

Where the guns or target or both are masked, the firing should, as a rule, be done by company, and the preparatory training for it will be wholly technical, as far as the gun squads and platoons are concerned. The captain alone is responsible for the tactical decisions, for the preparation of firing data to be given to the gunners for observation of the effect of the fire and the resulting change in his fire data. The guns have an arbitrary aiming point and an arbitrary elevation and deflection, the target itself being invisible to the gunners.

CHAPTER III.

THE CONDUCT OF FIELD-FIRING EXERCISES.

171. RANGE OFFICIALS.—All field-firing exercises for machine-gun units are held under the general supervision of the commanding officer.

To assist him in these duties the commanding officer may detail the following range officials:

A director of machine-gun practice;
An umpire or umpires;
A range officer; and
A recorder.

In small commands it will be possible to combine the functions of director and umpire in the person of a single officer.

In large commands, several umpires may be required.

When practicable the director should be senior to all other range officials, and both the director and the umpire should be senior to any officer participating in the execution of the exercise.

The duties of officers are given under the subject of Range Regulations (pars. 275–279).

172. In the conduct of field-firing exercises the umpire should take care to present the situation with as much semblance of reality as is possible. Only such information is given to the troop leader as he naturally would have under the assumed conditions. Care should be taken, on the other hand, to avoid the withholding of any information that naturally would have come to the knowledge of the troops in the course of the action.

It may be advantageous to have an assistant umpire observe the conduct of the troops from the viewpoint of the enemy, the result of his observations to be included in the critique.

In the earlier stages of training the value of the instruction may be enhanced by stopping the exercise and commenting upon

errors at the time they are made. In like manner an umpire may correct a wild estimate of the range in order that the instructional value of the exercise in other respects may not be lost.

It is only in the earlier stages of training, however, that such procedure is admissible. At this time the exercises are solely for the purpose of instruction. It is only during the later stages of training that they partake of the nature of tests and, when this point is reached, the umpire interferes as little as possible during the progress of the exercise, the leader being allowed to solve the problem in his own way, and being required to abide by his own mistakes and those of his subordinates.

173. THE BASIS OF JUDGMENT.—In order to pass intelligent judgment upon the solution of a fire problem, there must be standards with which the performance in question may be compared.

The decision of the umpire as to the amount of credit to attach to any given solution of a technical problem must follow as a logical result of the answer to his self-directed query "Had these hypothetical conditions been real, is it probable or improbable that the solution I have just witnessed would have accomplished the mission?" More definite guidance is unnecessary for the trained umpire, nor would it in any manner make up for the deficiencies of an untrained one.

Without doubt there are many shades of proficiency or deficiency between unqualified success and flat failure. These must be taken into account by the umpire. For example, he might state in his critique, "It seems entirely probable that your mission would have been accomplished, but your method of attack would have been unnecessarily costly. You directed fire on the enemy at a rate which was but little greater than that which they were directing upon you. Considering troops of equal morale, your higher rate of fire doubtless would have obtained fire superiority in the end, but at the expense of much time, much ammunition, and many casualties."

174. In judging of the solution of a tactical problem which includes the firing of ball cartridges, the umpire must take care to differentiate between failures which result from a non-observance of tactical principles and those which result from a lack of technical knowledge or skill, and he should indicate them thus in his critique. In like manner he should call attention to these two factors when contributing to success.

The umpire's guide as to the tactical employment of the machine gun is that part of the text of the Field Service Regulations, the Drill Regulations of the infantry and cavalry arms, and the Machine Gun Drill Regulations which deals with the tactical employment of this weapon.

175. In judging of the technical knowledge and skill of the participants, the umpire has two phases to consider. First, that which deals with the commanding officer's part in the solution of the problem, and, second, that which deals with the machine-gun commander's part in the problem.

In judging of the commanding officer's share in the solution of the problem, the umpire considers—

1. Was the mission such that the decision to use these particular guns, as an agency for its accomplishment, an admissible procedure? If not, what other troops or arms were available that were better suited to the purpose?

2. Were a sufficient number of guns used for the accomplishment of the mission? If not, was it due to an error in judgment on the part of the commander or to the conditions imposed by the problem? If due to an error in judgment, is that error due to the conditions of the problem or is it due to lack of training?

3. To what extent did the commanding officer's share in the solution of this problem contribute to success or failure?

In considering the machine-gun commander's share in the solution of the problem, the umpire employs, as a standard of comparison, the results that might be expected from a well-trained organization having at its disposal the same number of

guns that were made available in this problem by the order of the commanding officer.

Thus, an umpire's decision might take the following form:

"The mission was not accomplished because of the failure of the commanding officer to assign a sufficient number of machine guns to this task (or because he assigned machine guns to a task properly belonging to riflemen, or because he assigned to the light gun a task that could only be accomplished by heavy guns). The actual results obtained by the guns, however, were in excess of what might be expected from a well-trained organization acting under similar circumstances."

Or, in another case:

"The mission was accomplished, but about twice as many guns as necessary were assigned to the task. The actual results obtained by the guns, however, were far below what might be expected from a well-trained organization acting under similar conditions."

The material effect of fire is shown by the number and the distribution of hits upon the recording area of the target. To judge of its psychological or tactical effect, the umpire must take into account the length of time required to obtain a given material effect.

176. The judgment of the effect of fire as an agency for the accomplishment of a given mission will depend upon the nature of the problem. In the employment of machine guns for repulsing an assault, for example, the criterion would be the number of casualties produced during the enemy's charge. In covering an assault, on the other hand, the measure of efficiency is, first, the rate of impact of the fire directed upon the enemy's trenches, and, second, when the sheaf has been raised in order to avoid casualties among our own troops, the percentage of casualties among enemy reinforcements moving forward to the fire trench.

Judgment of the number of casualties produced is secured with the aid of the two following tables:

Umpire's reference table.

PRONE FIGURES.

Range (yards).	Time (minutes).															
	¼	½	¾	1	1½	2	2½	3	3½	4	5	6	10	15	20	25	30
200.....	42 *39*	66 *63*	80 *78*	89 *87*	96 *95*	99 *99*	99 *99*	100 *100*	....	....	....	....	....	....	....	....	....
300.....	30 *30*	52 *51*	66 *65*	77 *76*	89 *88*	94 *94*	98 *98*	99 *99*	99 *99*	99 *99*	100 *100*	....	....	....	....	....	....
400.....	23 *23*	41 *41*	55 *55*	66 *66*	80 *80*	88 *88*	93 *93*	96 *96*	98 *98*	99 *99*	99 *99*	100 *100*	....	....	....	....	....
500.....	19 *16*	34 *29*	46 *40*	57 *50*	71 *65*	81 *75*	88 *82*	92 *87*	95 *91*	97 *94*	99 *98*	99 *99*	100 *100*	....	....	....	....
600.....	15	28	38	48	62	73	80	86	90	92	95	98	100	....	....	....	....
700.....	12	22	31	40	53	63	72	78	83	87	92	95	99	100	....	....	....
800.....	9	17	25	32	44	54	62	68	74	79	85	90	98	99	100	....	....
900.....	7	13	19	25	35	44	51	58	64	68	76	82	94	99	99	100	....
1,000...	5	10	15	19	27	35	41	47	54	57	66	72	88	96	99	99	100

Umpire's reference table—Continued.

KNEELING FIGURES.

Range (yards).	Time (minutes).												
	¼	½	¾	1	1½	2	2½	3	3½	4	5	6	10	15
200	60	84	93	98	99	100	....	....	....	....	....	....	....	....
	59	*83*	*93*	*98*	*99*	*100*								
300	48	73	86	93	99	99	100	....	....	....	....	....	....	....
	47	*72*	*85*	*92*	*98*	*99*	*100*							
400	39	63	77	86	95	99	99	99	100	....	....	....	....	....
	36	*59*	*74*	*84*	*93*	*98*	*99*	*99*	*100*					
500	32	54	69	79	90	96	98	99	99	100	....	....	....	....
	24	*41*	*55*	*66*	*80*	*88*	*93*	*96*	*98*	*99*	*99*	*100*		
600	26	46	60	70	84	91	95	99	99	99	100	....	....	....
700	21	38	51	61	76	85	91	94	97	98	99	99	100	....
800	17	30	42	52	66	77	84	89	92	95	98	99	100	....
900	13	24	34	42	56	67	75	81	85	89	94	97	99	100
1,000	10	18	26	33	46	56	64	71	76	80	87	91	99	100

NOTE.—Amounts in body of table indicate the percentages of figures that should be struck. Those in italic indicate "battle sight."

177. *Machine-gun umpire's table.*

Range (yards).	Equivalent fire power in terms of riflement.
200	15
400	13
600	22
800	29
1,000	40

Though based upon mathematical calculation, the standard expressed in these tables must be quite flexible in its application. The figures in the tables are merely averages obtained from the firing of many hundreds of cartridges and hence represent nothing more than the *probable* material effect to be expected provided the cone of fire under consideration is similar to the average cone. Furthermore, these figures are based on the assumption that the center of impact lies exactly at the center of the target and that the distribution is perfect. Plainly this is a theoretical ideal which rarely if ever will be attained in practice. Thus, should the actual result be a little less or even a little more than that specified in the table this would indicate neither deficiency nor a remarkable proficiency, but merely that the actual result was a somewhat close approximation to the probable average.

If the tables are used merely as a guide, they will be used correctly. They will be used incorrectly if the figures in the table be taken as indicating a sharp line of demarcation between proficiency and deficiency.

178. The machine-gun umpire's table is based on the assumption that the rate of fire of the machine gun is 100 shots per minute. Should the actual or correct rate be other than 100, then the figures in the second column would vary directly as the rate, i. e., if the rate were 200 shots per minute, then the figures in the second column would be doubled; if 250 shots per minute, then they would be multiplied by $2\frac{1}{2}$, etc.

179. These two tables, the umpire's reference table and the machine-gun umpire's table, are used in conjunction in the following manner. An example will best illustrate their use.

Assume a machine gun to have been firing at a plainly visible target composed of 100 kneeling figures occupying a front of 100 yards. The target is 300 yards distant and the firing lasted for one minute. Fifty figures were struck. Was this fire satisfactory or not?

First, consult the umpire's reference table. What is sought is the number of riflemen who, in firing at this target for one minute, probably would have struck 50 per cent of the figures in the target—the percentage struck by the machine gun. On the line of the 300-yard range and in the $\frac{1}{4}$-minute column is found the amount 48, which is a close enough approximation to 50 for the purpose of this comparison. This 48 indicates that 100 riflemen firing at these 100 figures probably would strike 48 per cent of them in one-fourth of a minute.

The figure sought is now found by the proportion—

The actual duration of the fire in minutes	1
is to	:
The time required for a number of riflemen, equal to the number of figures in the target, to produce the same result as the gun	$\frac{1}{4}$
as	::
A number of riflemen equal to the number of figures in the target	100
is to	:
The number of riflemen sought	25

That is to say, 25 riflemen, firing at this target for 1 minute, probably would strike about 50 figures, or the gun has shown a fire power equivalent to 25 rifles.

To determine the credit to attach to this performance, the machine-gun umpire's table is consulted. The umpire decides that the rate of fire should have been 150 shots per minute and hence, from the table, it is seen that the gun should show a theoretical value of about 24 rifles. The umpire would decide quite correctly that this firing indicated proficiency in technical skill.

In this same example, had there been 2 guns firing, then they would have shown a value of 12½ rifles each, while 4 guns would have been worth 6¼ rifles each, assuming, of course, that the firing in each case resulted in 50 figures being struck. A judgment of "lacking in technical skill" might or might not be correct in the case of the two guns with a value of 12½ rifles each, but probably would be justified in the case of the four guns with a value of 6¼ rifles each.

180. In judging of the casualties that would be produced among troops moving through a given beaten zone—as, for example, the sheaf of fire directed in rear of a fire trench to prevent the forward movement of reinforcements, the umpire may assume that any target moving through the beaten zone at a uniform speed will receive half as many hits as it would have received had it remained stationary for the same length of time at the center of impact. For example, assume a beaten zone 100 yards in depth and that a target passes through that zone at a uniform speed in 20 seconds. Then that target will receive half as many hits as it would have received had that same sheaf been directed upon it with perfect adjustment for 20 seconds.

181. The judgment as to rates of impact is based on the following:

To obtain, on a single yard of front, a rate of impact of 1 hit per minute, the following rates of fire must be maintained. Perfect adjustment is assumed.

Range.	Kind of target.				
	Head.	Prone.	Kneeling.	Standing.	Horse.
200	14.90	3.15	2.45	2.95	1.41
400	22.50	5.31	3.20	3.18	1.42
600	30.30	7.12	4.02	3.64	1.51
800	40.60	9.36	5.03	4.33	1.68
1,000	51.00	11.93	6.36	5.27	1.95

For any given rate of fire the rate of impact will vary inversely as the size of the target. Thus, with the kneeling targets at 400 yards and a rate of fire of 3.2, the rate of impact would be one-half if the target were 2 yards wide, and one-fourth if the target were 4 yards wide.

To maintain a given rate of impact the rate of fire must vary directly as the size of the target. Thus, to maintain a rate of impact of 1 on a target composed of prone figures on a front of 100 yards and at a range of 600 yards the rate of fire must be 712. On the same front head targets at 400 yards would require a rate of fire of 2,250, and mounted figures at 1,000 yards a rate of fire of 195 in order to maintain the rate of impact at 1.

For any given target the rate of impact will vary directly as the rate of fire. If it is desired to double the rate of impact, then the rate of fire must be doubled, etc. Thus, considering that it was desired to maintain a rate of impact of 10 on standing targets at 800 yards, then the required rate of fire would be 43.3 for each yard of front occupied by the objective, e. g., if the target had a frontage of 10 yards, then the required rate of fire would be 433; if it occupied a front of 100 yards, the required rate of fire would 4,330, etc.

182. The percentage of casualties depends upon the volume of impact as shown in the following table. In this table the column H (hits) gives the volume of impact—the average num-

ber of hits per unit of front; and the column D (distribution) indicates the percentage of units of front that should be struck with an evenly distributed fire.

It will be noted that when the volume of impact reaches 3 the percentage of casualties is 95 per cent, and that a further increase of 100 per cent in the volume of impact (increasing it to 6) results in an increase of only about 5 per cent in casualties.

H.	D.	H.	D.	H.	D.	H.	D.
0.01	1.0	0.31	26.7	0.61	45.7	0.91	59.8
0.02	2.0	0.32	27.4	0.62	46.2	0.92	60.2
0.03	3.0	0.33	28.1	0.63	46.7	0.93	60.6
0.04	3.9	0.34	28.8	0.64	47.2	0.94	60.9
0.05	4.9	0.35	29.5	0.65	47.8	0.95	61.3
0.06	5.8	0.36	30.2	0.66	48.3	0.96	61.7
0.07	6.8	0.37	30.9	0.67	48.9	0.97	62.1
0.08	7.7	0.38	31.6	0.68	49.4	0.98	62.5
0.09	8.6	0.39	32.3	0.69	49.8	0.99	62.8
0.10	9.5	0.40	32.9	0.70	50.3	1.00	63.2
0.11	10.6	0.41	33.6	0.71	50.8	1.02	63.9
0.12	11.3	0.42	34.3	0.72	51.3	1.04	64.7
0.13	12.2	0.43	34.9	0.73	51.8	1.06	65.4
0.14	13.1	0.44	35.6	0.74	52.3	1.08	66.0
0.15	13.9	0.45	36.2	0.75	52.8	1.10	66.7
0.16	14.8	0.46	36.9	0.76	53.2	1.12	67.4
0.17	15.6	0.47	37.5	0.77	53.7	1.14	68.0
0.18	16.5	0.48	38.1	0.78	54.2	1.16	68.6
0.19	17.3	0.49	38.7	0.79	54.6	1.18	69.3
0.20	18.1	0.50	39.4	0.80	55.0	1.20	69.9
0.21	18.9	0.51	40.0	0.81	55.5	1.22	70.5
0.22	19.7	0.52	40.5	0.82	56.0	1.24	71.1
0.23	20.5	0.53	41.1	0.83	56.4	1.26	71.6
0.24	21.3	0.54	41.7	0.84	56.8	1.28	72.2
0.25	22.1	0.55	42.3	0.85	57.3	1.30	72.7
0.26	22.9	0.56	42.9	0.86	57.7	1.32	73.3
0.27	23.7	0.57	43.4	0.87	58.1	1.34	73.8
0.28	24.4	0.58	44.0	0.88	58.5	1.36	74.3
0.29	25.2	0.59	44.6	0.89	58.9	1.38	74.8
0.30	26.0	0.60	45.1	0.90	59.3	1.40	75.3

H.	D.	H.	D.	H.	D.	H.	D.
1.42	75.8	1 82	83.8	2.55	92.2	4.50	99.0
1.44	76.3	1.84	84.1	2.60	92.6	5.00	99.3
1.46	76.8	1.86	84.4				
1.48	77.2	1.88	84.7	2.65	92.9	5.50	99.5
1.50	77.7	1.90	85.0	2.70	93.3	6.00	99.8
1.52	78.1	1.92	85.3				
1.54	78.6	1.94	85.6	2.75	93.6		
1.56	79.0	1.96	85.9	2.80	93.9		
1.58	79.4	1.98	86.2	2.85	94.2		
1.60	79.8	2.00	86.5	2.90	94.5		
1.62	80.2	2.05	87.1				
1.64	80.6	2.10	87.7	2.95	94.8		
1.66	81.0	2.15	88.4	3.00	95.0		
1.68	81.4	2.20	88.9				
1.70	81.7	2.25	89.5	3.25	96.4		
1.72	82.1	2.30	90.0	3.50	97.8		
1.74	82.4	2.35	90.4				
1.76	82.8	2.40	90.9	3.75	98.3		
1.78	83.1	2.45	91.4	4.00	98.7		
1.80	83.5	2.50	91.8				

If every figure in the target is hit H times on the average, then from the table, D per cent of the figures will be hit.

It may be assumed, therefore, that, in theory at least, a volume of impact of 3 will meet the maximum requirements in the production of casualties. This theory is confirmed by actual experience in combat.

CHAPTER IV.

THE CRITIQUE OF FIELD-FIRING EXERCISES.

183. The critique is a statement by the umpire in which he compares in detail a given solution of a problem with a solution that might be expected from a thoroughly trained organization acting under similar conditions.

The basis of all good instruction is intelligent, tactful, and constructive criticism. This should be the aim of the critique.

The illustration of principles and their intelligent criticism depends solely upon the ingenuity and alertness of the umpire, who must make the exercises conform to local conditions. Otherwise a field firing exercise degenerates into mere practice in technique and its tactical significance is lost.

The umpire should bear in mind that, aside from the practical application of abstract principles to concrete cases, the instructional value of a field firing exercise lies wholly in the critique.

184. Much depends upon the personality of the umpire, for it often will be his duty to call attention to errors and faults that may be due to lack of judgment, lack of knowledge, or lack of skill, and all this must be done without giving offense to his hearers.

185. The critique should seek to bring to the mind a conception of what the situation would be were it real instead of merely assumed.

186. Failures properly to apply tactical principles often are due to misconceptions as regards modern combat, and it is these misconceptions that the critique should seek to eradicate.

The umpire should not only comment upon faulty procedure but should seek also to bestow commendation for a proper application of principles whenever the nature of the case seems to warrant it.

It should not convey the impression that there is *one* particular method of executing the exercise which is *the* correct method. This is only too apt to lead to the adoption of fixed forms, and this tending to destroy initiative should be studiously avoided.

187. The critique is best given on the ground immediately after the conclusion of the exercise. When required for record, a synopsis only is written.

In the critique an umpire should be careful to differentiate between statements of opinion and statements of fact, principle, or experience.

The following are some of the points on which an umpire might comment:

Was the mission accomplished?
If so, what were the causes contributory to success?
If not, was failure due to any of the following causes:
The assignment of machine guns to a task that called for other weapons;
Premature opening of fire or too long a delay in so doing;
Failure to conceal the identity of the guns during the advance to the firing position;
Inadequate fortification or concealment;
Inadequate or faulty reconnaissance;
Ambiguous or wrong target designation;
Faulty determination of ranges;
Poor adjustment of fire;
Poor observation of fire;
Laxity in fire direction and control;
Ambiguous or incomplete fire orders;
Lack of fire discipline;
Poor marksmanship;
Malfunction of guns through ignorance of poorly trained gun crews;
Rate of fire too slow to produce required rate of impact or too fast for accuracy;
Poor distribution;
Insufficient safety angle, the fire resulting in casualties among our own troops, etc.?

CHAPTER V.

COMBAT PRACTICE—RECORD.

188. After having had such preliminary training in the solution of fire problems as the time available and ammunition permits, the organization will be given a record combat problem—such problem to involve as many of the essential features

of fire training as the range facilities will admit. An annual ammunition allowance of 500 rounds per gun is authorized for this problem.

A very careful record will be kept of this exercise and a proper report made to the division commander under paragraph 293. The organization will not be given a rating on this problem, and it is not to be considered as a test, but is more for the purpose of furnishing to higher commanders information regarding methods and means used in the solution of such problems. However, in case any performance appears to be excellent it should be noted, as should any other pertinent points that are worthy of record.

PART IV.

THE THEORY OF FIRE.

CHAPTER I.

THE BALLISTIC QUALITIES OF MACHINE GUNS.

189. The ballistic qualities of machine guns are, for all practical purposes, the same as those of the infantry rifle.

The ballistic data pertaining to the service ammunition is found in the Ordnance pamphlet (No. 1923) describing the United States magazine rifle, and includes a description of the various types of cartridges issued; tables showing corrections for variations in initial velocity, temperature, and barometric pressure; the maximum range, powder pressure, energy of recoil, accuracy (deviation only), penetration, and point blank danger space; a table of fire (angles of elevation and departure, angles of fall, time of flight, etc.); a table of ordinates; a table of dangerous spaces; a table of horizontal deviations; and tables of corrections for given velocities and directions of wind.

190. POWERS AND LIMITATIONS.—The powers and limitations of machine guns may be divided into two general classes—physical and psychological.

The machine gun is both physically and psychologically, potentially more powerful than a number of rifles producing an equal volume of fire, but the limitations upon the fire of machine guns are greater than those of a number of rifles capable of producing the same fire effect.

A. POWERS.

191. A. PHYSICAL.—(1) *The sheaf produced by the fire of machine guns is more compact than that of an equal volume of rifle fire.*

This is principally due to the fact that the "holding" of the firearm is done by the mount and not by the firer, thus eliminating many of the personal errors of the latter, such as flinching, faulty trigger squeeze, unsteady hold, etc.

The size of the sheaf of the automatic machine rifle depends to a great extent upon the skill of the gunner. It has been made (in practice on the target range) and with well-trained gunners as small as one-quarter of that of "average rifle shots." But all so-called machine rifles that are fired from the shoulder are subject to the same human influences as the rifle. These influences are reflected in an increased dispersion on the battle field.

The effects of the nervous emotions of the gunner when firing with his gun on a standard machine-gun mount, sled, or tripod are not transmitted to the gun. Therefore the battle dispersion of this type of gun is little if any greater than its peace dispersion.

It is quite obvious that with proper adjustment of this smaller sheaf the fire should be more accurate than that of riflemen, i. e., there should be a greater number of hits for any given expenditure of ammunition.

This compact sheaf, and the ease with which the fire of several guns may be concentrated upon a single point, makes the machine gun particularly adapted for use in covering certain definite restricted areas, such as bridges, roads, approaches, obstacles, landings, defiles, etc.

192. (2) *The fire power of the machine gun has been variously estimated as being equal to that of from 30 to 60 riflemen.*

Considering an accurate and properly distributed fire, the basis of comparison between machine guns and riflemen is the

rate of fire. The rate of fire of the machine gun depends on the type of gun and on the skill of the gun crew, the lowest rate being obtained by untrained or semitrained men with an automatic machine rifle, this rate being from 0 to 40 shots per minute per gun, and the highest rate being obtained by expert gun crews with a belt-loaded gun of the Maxim type, this rate running from 500 to 700 shots per minute per gun.

193. The rate is not influenced to any marked degree by variations in the range. The character of the objective, however, has a decided influence upon it. With a broad, deep target, such as troops in mass formation, fire may be directed at a single aiming point and be practically continuous, whereas at a linear target whose elements are separated by wide intervals fire must be by short bursts, with a change of aiming point for each burst.

For purposes of comparison with rifle fire it may be said, then, that for any given target the rate of fire of the machine gun is practically constant irrespective of the range, while that of riflemen decreases as the range increases, i. e., they fire 10 shots per minute at the shorter ranges and 5 shots per minute at the longer ones. Assuming, then, that the average rate of fire of the machine gun runs from 20 to 600 shots per gun per minute, it follows that to produce an equal rate of fire it would take 2 to 60 riflemen at the shorter ranges and from 4 to 120 riflemen at the longer ranges for each machine gun employed.

This concentration of fire power in the hands of a single man makes the machine gun a desirable weapon to use as a substitute for riflemen in cases where the front is so restricted as to prevent sufficient riflemen being deployed to produce the required rate of fire. Such cases would be in salients, reentrants, and defiles.

With the power of from 30 to 60 rifles in the hand of a single individual, fire control and fire direction are quite simple as compared with the difficult problem of infantry. The movement of the sheaf is also much more responsive to the will of the leader, and the piece may be loaded and laid to cover a

given area, either by day or night, and then, by keeping but a single man on the alert, may be held indefinitely as a reserve force to be applied instantly when the necessity arises by the mere pressure of a finger. To accomplish a like result from 30 to 60 riflemen must be kept constantly on the alert, and even then under the conditions of night firing their fire would not be as dependable as that of the gun.

194. (3) *A loss of machine-gun personnel does not necessarily mean a loss of fire power, for, with the gun in position and well supplied with ammunition, fire may continue undiminished so long as there remains a single man capable of operating the piece.*

The vulnerability of the personnel may be said, in general terms, to be the same as that of infantry, but with every casualty the infantry lose fire power unless the losses in the firing line are replaced by supports, whereas a machine-gun unit may suffer losses that would stagger an Infantry organization and yet continue in the fight with undiminished fire power.

The vulnerability of a machine-gun crew may be compared to that of a like number of riflemen; nevertheless the target presented to the enemy is so small that even while fire is in progress it will prove difficult to locate, provided there is proper concealment, and when located it will demand a great expenditure of ammunition in order to silence it. This latter condition is especially true of guns provided with shields.

195. (4) *The mobility of the machine gun is that of the Infantry or Cavalry with which it operates.*

The machine gun, with its pack transportation, can maneuver or march with Infantry or Cavalry, and on entering the zone of hostile fire it can be carried by its personnel over any terrain accessible to Infantry.

The utility of the machine gun from the viewpoint of mobility depends not so much upon the ease with which it can be carried by its pack or wheeled transport as upon the facility with which it can be moved from place to place by its dismounted

personnel when operating within the zone of hostile fire. For the latter is a prime essential, while the former is merely a question of selecting that type of transportation suitable for making progress over the country to be traversed and then adapting that type to carry the special machine-gun equipment.

Thus the mobility of machine guns presents two phases—their mobility in combat and their mobility on the march or in maneuver.

Mobility in combat depends primarily upon the type of mount and combat equipment used with the gun, as practically all machine guns have been reduced below 30 pounds in weight.

Mounts and other combat equipment are divided roughly into two classes—those that must be carried and those that may be dragged. Of the former are the muzzle rest and tripod types of mount, and of the latter the sledge of the Germans and the low-wheeled mount of the Russians.

196. The mobility of the machine gun on the march or in maneuver should be suitable to the task it has to perform. With guns that are to act as strictly regimental auxiliaries, the problem is well solved by pack transportation, as all that is demanded of the guns is merely to keep pace with the regiment. With the guns that are attached to higher units than the regiment, animal draft or motor transportation would seem to be essential.

197. B. PSYCHOLOGICAL.—The psychological or moral power of the machine gun lies in its prestige as a deadly weapon, the sound of its fire, its ability to produce many casualties in a short space of time, and in the fact that its force may be withheld until the crisis of the action and then applied unexpectedly or as a surprise.

B. LIMITATIONS.

198. A. PHYSICAL.—(1) The compact cone of the machine gun demands precise adjustment, and it can be directed at but a single point at a time.

The fire of a machine gun, though equal to that of many riflemen, is capable of being directed at but a single point at a

time, whereas that of a number of rifles producing an equal volume may be concentrated to cover a single point or may be distributed so as to cover simultaneously every point in a given area. In this connection there is also the danger, with poorly trained men, that in the excitement of combat an undue amount of fire will be directed at a single point when the tactical situation demands an even distribution of fire to cover an extended line or area.

The compactness of the machine-gun sheaf demands an extreme nicety of adjustment of fire in order that material results may be obtained commensurate with the expenditure of ammunition. With this peculiar weapon correct adjustment means not only accurate range finding, but also an intimate knowledge of the individuality or the "equation" of each particular gun. These difficulties of adjustment, as well as those of observation of fire at long ranges, preclude the probability of effective fire by machine guns at ranges exceeding 1,200 to 1,500 yards. This does not mean that these guns are never to be used beyond these ranges. There are instances where these guns have been used with great effect at ranges as great as 2,500 yards, but the conditions were particularly advantageous both as to the size and immobility of the target and as to facility of observation—visibility of target and of impact.

199. (2) Machine guns are not suited for continuous participation in a prolonged fire fight.

This comes not only from the fact that they will be promptly overwhelmed by hostile fire when once they disclose their position, but also from the fact that frequent pauses must be made in the firing in order that the mechanism of the pieces may be cooled and oiled, and that jams may be reduced.

The position of the gun may be disclosed by the peculiar sound of automatic firing and, with water-cooled guns, by the escape of steam. Once located, the guns at once become the target for all hostile artillery and infantry capable of firing upon them. For this reason it is not only essential that there be concealment

and defilade for the guns, but also that usually they be located elsewhere than in the infantry firing line.

By having the guns away from the infantry line fire directed on the former will be withdrawn from the latter, and thus will prove an additional aid to the advance of the infantry soldier.

The escaping steam of water-cooled guns must be condensed.

200. (3) Machine guns are more vulnerable in many ways than Infantry or Cavalry.

The mechanism of the machine gun is delicate and may be disabled by a single well-placed hostile bullet. In the difficulties of supply that are incident to any campaign there is apt to be a scarcity of cleaning and lubricating material that will do much toward increasing the frequency and seriousness of jams. The guns may even become disabled from this cause alone.

The difficulties of ammunition supply in the attack render it improbable that any particular machine-gun unit would be able to meet the exigencies of but a single crisis in the action without a renewal of its ammunition supply.

201. The machine-gun organization with its animal transport is particularly vulnerable and helpless on the march. Its security at such times must be provided for by detachments of Infantry or Cavalry.

202. (4) The mobility of a machine-gun organization is readily destroyed by casualties.

The mobility of a machine-gun organization on the march or in maneuver depends on the condition of its means of transportation. If these means become disabled, the weight of the equipment is so great that the personnel can not carry it and keep pace with the troops with which the guns are marching.

The mobility of the gun in combat depends upon the ability of the personnel to move the equipment and the ammunition supply. Obviously, casualties first reduce the ammunition supply and finally render the equipment immobile.

203. B. PSYCHOLOGICAL.—Psychologically, the machine gun is lacking in the threat of personal encounter with an armed enemy.

There is no threat or apprehension of personal combat with the bayonet, as the power of the machine gun lies in fire action alone.

There is nothing so harmless as a disabled machine gun.

C. SUMMARY.

204.

Powers.	*Limitations.*
Smaller sheaf fire more accurate than Infantry and more easily controlled. The ballistic properties are the same as those of the rifle.	Small sheaf demands precise adjustment of fire and can be directed at but one point at a time.
Each gun represents an instantly available reserve of fire power equal to from 30 to 60 rifles. This permits fire to be delivered from a restricted front at a high rate.	Can not be used continuously in a prolonged fire fight. Ten to fifteen minutes' continuous firing is about the limit of its opportunity or capability at any time.
With ammunition at hand, the fire power is undiminished so long as there remains a man unwounded who can operate the gun.	The mechanism of the piece is delicate and is readily disabled by hostile fire or by a lack of a suitable supply of cleaning and lubricating material.
Its mobility is such that it can operate over any terrain accessible to Infantry or to Cavalry.	Heavy losses of personnel destroy mobility in battle; those of pack animals, mobility in march or maneuver.
The moral power of the gun lies in its prestige, in the sound of its fire, in its surprise action, and in its ability to produce many casualties in a short space of time.	The gun is limited to fire action. There is lacking the threat of the bayonet. A disabled gun is at once an encouragement to the enemy and a discouragement to our own troops.

CHAPTER II.

RATES AND VOLUMES AND THEIR RELATION TO EFFECTIVENESS.

205. *Cyclic rate* is a term used to express the speed at which a gun delivers its fire while operating without interruption. This cyclic rate is expressed in terms of "shots per minute," though for the sake of brevity the words "shots per minute" often are omitted. For example, should an automatic rifle fire a strip of 30 cartridges in 3 seconds, and this without pause or interruption of any kind, then it is said to develop a cyclic rate of 600.

The cyclic rate is not altered because of malfunctions or because of voluntary pauses made by the gunner—only that firing being considered which is continuous and without interruption. Thus, suppose 10 shots were fired in 1 second and the piece then stopped firing because of a jam, the cyclic rate remains 600.

The cyclic rate differs for different types of guns, and in some types it is possible to control this rate within rather narrow limits by certain modifications in the adjustment of the mechanism.

For any given adjustment of the mechanism of a particular type of gun, the cyclic rate may be reduced by such causes as the accumulation of fouling from continued firing, lack of lubrication, faulty cleaning, the use of heavy lubricants or the freezing of the lubricant in cold weather, etc.

206. *The rate of fire* of a single gun is the average number of shots fired per minute during the time between the first and the last shot of any particular firing. In speaking of the rate of fire of an organization (company or platoon), it is usual to differentiate between the "gun rate," which is the *mean* of the rates of all the guns, and the "company (or platoon) rate," which is the *sum* of the rates of all the guns.

For the sake of brevity, rate of fire usually is expressed in numerals alone, e. g., "the rate of fire is 200" means "the rate of fire is 200 shots per gun per minute."

The rate of fire that is adaptable to tactical uses usually is somewhat less than the cyclic rate, this being due to the necessity for pauses in the fire for the purpose of correcting the aim, changing the aiming point, reloading, reducing jams, oiling the mechanism, cooling the barrels, etc.

This usable rate differs for different types of guns and mounts. The usable rate of fire of a belt-loaded, water-cooled gun on a mechanically controlled carriage may be as high as 500 or more shots per minute, while with a strip-loaded, air-cooled gun on a carriage without mechanical control the rate may not exceed 150 to 200 shots per minute.

The rate of fire is dependent also upon the kind of fire used. The rate of fire of a single gun directed at a single point may be much greater than that which is interrupted after each 5 or 10 shots to effect a change of aim.

207. *Rate of fire* includes all pauses in the firing whether voluntary (as pauses to make a change of aiming points or to reload) or involuntary (as pauses because of malfunction or breakage of the mechanism). In this particular it differs from the cyclic rate in which such pauses are not included.

208. *Volume of fire* is the total number of shots directed at a given target during any particular firing at that target.

This term is sometimes used erroneously instead of "rate of fire" and "rate of impact." For example, a "volume" of 2,000 shots may be directed at an objective by firing at the rate of 2,000 shots per minute for one minute. The same "volume" is obtained by firing at the rate of 20 shots per minute for 100 minutes (1 hour and 40 minutes).

Hence

Volume of fire=Rate of fire × Duration of fire.

$$\text{Rate of fire (average for single guns)} = \frac{\text{Volume of fire}}{\text{Duration of fire} \times \text{No. of guns firing}}$$

$$\text{Rate of fire (for an organization)} = \frac{\text{Volume of fire}}{\text{Duration of fire}}$$

209. *The rate of impact* is the number of *effective shots* per minute per unit front of a given target.

The definition of "effective shots" is taken from the Infantry Drill Regulations which states:

"In combat shots which graze the enemy's trench or position and thus reduce the effectiveness of his fire have the approximate value of hits; such shots only, or actual hits, contribute toward fire superiority."

The "unit front" of a target is taken as 1 yard.

In peace-time firing against silhouette targets no measure is afforded of the number of "shots which graze the enemy's trench or position" except the number of actual hits on the targets.

As the center of impact approaches the center of the target, the number of hits increase. The number of "shots which graze" or what might be termed "near hits" also will increase. Thus, the number of actual hits serves as a very satisfactory measure of the number of effective shots.

Thus, the measure of the rate of impact is taken as the number of *hits* per yard per minute. For brevity the words "hits per yard per minute" often may be omitted.

For fire of a given rate and at given range and with no variation in accuracy the rate of impact will vary inversely as the width of the target. If the target be of such depth as to require longitudinal as well as lateral distribution of fire to cover it effectively, it will vary inversely as the area of the target, the unit of depth being taken as the zone that is covered effectively by a single elevation. For example, in four minutes firing 800 effective shots are placed on a target 100 yards wide. The rate of impact therefore is 2. Had the target been but 50 yards wide, then it could have been covered twice in four minutes and the rate of impact would have been 4. Had the target been 200 yards wide and of such depth as to require two elevations, then the rate of impact would have been one-fourth of that on the original target, i. e., one-half.

210. *Volume of impact* is the average number of effective shots per unit front of target obtained during any particular firing, i. e., it is the total number of effective shots divided by the number of units of front.

As in the case of the rate of impact, the measure of the number of effective shots is the number of actual hits.

Assuming an equal distribution of fire, then upon volume of impact depends the number of casualties that are produced in the ranks of the enemy. Thus, with a volume of impact of 1—an average of 1 hit per unit of front—then it is probable that about 63 per cent of the units of front will be struck. With volumes of impact of 2, 3, 4, 5, and 6, the probable percentage of units of front that will be struck are 86, 95, 98.7, 99.3, and 99.8.

It must be understood that this is based on the assumption that the distribution of fire continues throughout the *entire target area.*

It appears, therefore, that when the volume of impact exceeds 2 the additional casualties that may be produced are not commensurate with the additional expenditure of ammunition. The conclusion that the volume of fire should be no greater than is necessary to produce a volume of impact of 2 seems logical.

This conclusion is correct only under the following conditions:

(*a*) That the target is a body of men and is not merely a position or area.

(*b*) That the target is in the open, without defilade, and that its degree of vulnerability is constant and equal throughout its entire area.

(*c*) That the casualties in the target are not replaced by reinforcements.

When it is a question of rendering a certain area untenable, or of keeping a given body of the enemy confined to their defilade; then it is rate of impact rather than volume of impact that is the predominant factor. In such a case volume of impact would be merely a result of the required rate of impact and

the length of time during which it must continue to accomplish a given tactical end. Thus, effective shots falling on each yard of the enemy's front at the rate of 1 per minute might not be sufficient even to disturb his aim, whereas were these shots increased to 60 per minute it might force him to retire to the cover of his trenches and not even attempt to return the fire. Of course such a fire would produce no casualties when the enemy had been forced to cover, but still it would be effective in that it gave fire superiority.

211. DISTRIBUTION FACTOR.—If continuous fire is maintained at a single aiming point, the rate of fire will be greater than if the fire is divided between two or more aiming points where it is necessary to cease firing while shifting and relaying the gun. The distribution factor is therefore defined as the ratio between the rate of fire and the cyclic rate. It is expressed as a decimal. For example, the cyclic rate for a certain gun is 500; the actual number of shots fired in a minute during distributed fire is 125. The distribution factor is therefore $125 \div 500 = .25$. It is evident that a distribution factor of 1 is only possible when the gun fires at its cyclic rate, and that a value of the distribution factor of less than 1 is due to pauses in firing. The distribution factor should be kept as large as possible. This can be done in three ways: (*a*) Keeping the number of aiming points as low as consistent with the tactical misssion; (*b*) taking the least possible time for shifting fire from one aiming point to another; and (*c*) reducing loading pauses and stoppages to a minimum.

With skilled gunners it is possible to execute distribution either in width or depth (but not in both at the same time) while firing continuously and thus to maintain a distribution factor of 1.

This method of fire increases the dispersion, and the ratio of this increase is greater for light type guns than for the heavy ones.

Therefore, as the range increases, as the height of the target decreases, and as the skill of the gunner decreases, so will the

effectiveness of this class of fire decrease as compared with fire which is directed in bursts at several aiming points in succession.

Hence, for targets of a given height there is a certain range beyond which it is more profitable to fire in bursts at successive aiming points, and below which a continuous fire will be the more profitable procedure. This dividing range is greater with skilled gunners and with mechanically controlled gun carriages, and it is less with unskilled gunners and with automatic rifles fired from the shoulder.

Example: The cyclic rate of a certain gun is 600 shots per minute. The gunner is required to lay on 10 aiming points and fire 15 shots at each. He will have to shift his aim nine times and he requires four seconds for each shift. Loading is assumed to be done during pauses for relaying. The total time of firing the required 150 shots is, then, 15 seconds for the actual firing plus four times nine or 36 seconds for the shifting of aim, making 51 seconds in all. Now, at the cyclic rate 510 shots would be fired in 51 seconds. The distribution factor is then $150 \div 510 = .294$.

If the gunner's skill is such that he requires but two seconds to shift his aim, the resultant distribution factor will be obtained as follows:

15 seconds for firing + 18 seconds for shifting = 33 seconds. Fire at cyclic rate in 33 seconds = 330.

$$\text{Distribution factor} = \frac{150}{330} = .454.$$

If the number of aiming points is reduced to 5, the amount per aiming point increased to 30, and the gunner's shifting time per aiming point remains as four seconds, gives:

Fifteen seconds for firing + 16 seconds for shifting = 31 seconds.

Fire at cyclic rate in 31 seconds = 310 rounds.

$$\text{Distribution factor} = \frac{150}{310} = .483.$$

212. *Amount of fire* is a term used to express the number of shots per burst that are or should be directed at each aiming point used in covering the width or area of a given target.

The amount of fire, i. e., the number of shots to be directed upon any single aiming point, is dependent upon the range, the nature of the target, and the tactical situation.

Should the situation be such that a certain amount of execution was demanded throughout the entire front of the objective as quickly as possible, then the amount of fire would be relatively small, whereas were it such that the certainty of hits were a more important factor than the time element, then the amount of fire would be relatively great. Obviously, too, the greater the range and the smaller the target, the greater will be the amount of ammunition required to produce a given result.

The figures in the body of the following table show, in rough approximation, the theoretical number of shots required per unit of front in order that there shall be a probability that 80 per cent of those units of front will be struck. The table is based on the assumption that the adjustment is precise and that the targets are in single dense lines.

Should a greater or less effect be desired, then the number of shots should be increased or decreased accordingly. Twice the number of shots given in the table would make it probable that 95 per cent of the units of front would be struck, while one-half and one-fourth of the amounts in the table would reduce the effect to 55 per cent and 33 per cent, respectively.

Should it be necessary to distribute the fire in the direction of depth, then the amounts in the table should be increased by an equal amount for each two mils of searching ordered. With combined sights, the amounts given in the table should be used for each sight reading.

While it is not to be expected that these figures will be memorized, nevertheless they should serve as a guide from which there should be no radical departure in practice.

Range (yards).	Kind of target.				
	Head.	Prone.	Kneeling.	Standing.	Mounted.
200	15	5	5	4	3
400	25	8	6	5	3
600	35	11	7	6	3
800	45	14	8	7	4
1,000	55	18	10	8	4

213. EFFECTIVENESS OF FIRE.—The true measure of the effectiveness of fire is the degree to which it keeps the enemy from directing an accurate fire upon our own troops. Thus, in its final analysis, the measure of the effectiveness of fire is a moral or psychological one.

The immediate cause which produces this moral effect is the killing or disabling of the individuals in the enemy's firing line. It also may be produced by the enemy's apprehension of being killed or disabled, so thus a fire may be effective without producing any casualties in the enemy's ranks. In other words, his fear of being struck by a hostile bullet keeps the enemy down in his trenches without firing, or else prompts him to sacrifice accuracy of fire for the security of his shelter.

For example, when a body of troops at A delivers such an effective fire on troops at B that they can not or do not return the fire, and thus the troops at A are enabled to advance on B without suffering casualties that would cause them to waver or halt, then the troops at A are said to have gained "fire superiority" over the troops at B.

The measure of the effectiveness of fire, in peace-time firing, is that of the physical or material result produced on those targets by the fire in question.

It is logical to assume that with troops of a given morale a great number of casualties will produce a greater moral effect

than a small number of casualties. It is also reasonable to assume that the effect on the mind is more intense when a given number of casualties are produced in a short space of time than it would be were that same number of casualties spread over a period of much longer duration.

Therefore in peace-time firing the measure of the effectiveness of fire is taken as the number of casualties produced (figures struck in the target) in a unit of time.

Assuming an accurate and properly distributed fire, how do rates and volumes modify the effectiveness of fire?

Consider first the animate target beyond the reach of defilade. In this case there are two factors to be considered in the measure of effectiveness. They are the number of casualties produced and the length of time that it takes to produce them.

214. The number of casualties produced is dependent upon the volume of impact. Volume of impact is dependent upon the number of shots fired, and so, if the amount of fire is considered merely as a means of securing equal distribution, it may be said that volume of impact is dependent on volume of fire. Hence the number of casualties produced is dependent upon the volume of fire—the greater the volume the greater the number of casualties—and thus the greater the effectiveness.

The length of time required to produce a given volume of fire, which is distributed throughout the target area in correct amounts at each aiming point, depends upon the speed with which the shots are delivered and the speed with which the direction of the fire is changed from aiming point to aiming point. Or, to use the terminology previously employed in this discussion, it depends upon the cyclic rate and the distribution factor. Thus the greater the cyclic rate and the distribution factor, the shorter the length of time required to produce a given volume of fire, and hence the greater the effectiveness.

It may be said therefore that in general an increase in effectiveness of fire is produced by increasing the volume of fire, increasing the cyclic rate, and increasing the distribution factor.

215. The other case for consideration is that in which the object of the fire is not so much the production of casualties as it is to render certain positions or areas untenable—i. e., to make it certain that during a certain period of time there will be numerous casualties if the enemy attempt to occupy this position or to enter this area.

As heretofore stated, the effectiveness of such a fire depends upon the rate of impact, assuming an accurate and properly distributed fire. As rate of impact depends upon cyclic rate and the distribution factor, it may be said that these two factors are the ones upon which depends the effectiveness of this class of fire. The volume of such a fire is a factor to be considered to the extent that it must be made certain that there is sufficient ammunition at hand to continue the fire at the required rate for the required length of time.

CHAPTER III.

ADJUSTMENT OF FIRE.

216. Fire is said to be adjusted when the target lies within the effective portion of the beaten zone. Adjustment is more precise or less precise, depending upon whether the center of impact is in coincidence with, or in close proximity to, the center of the target or is somewhat removed from the center of the target.

Adjustment is accomplished by one of the following means:

1. By the use of a single correct elevation; or

2. By the use of a beaten zone artificially increased in depth; or

3. By the use of a single compromise elevation (battle sight) at short ranges, when the emergency is so pressing or the target so large that more precise adjustment becomes impossible or unnecessary.

In deciding upon the method of adjustment to be used in any particular case, it is first essential to determine whether the battle sight or a more precise method is to be employed.

217. CHOICE OF MEANS.—In deciding this question, it is to be remembered that the battle sight is an emergency sight to be used on occasions when some material fire effect is demanded instantly, and when the delay incident to a more precise adjustment would render the fire valueless, notwithstanding the increase in material effect. The battle sight also is used when the objective is so large and at such close range that a more precise adjustment would have no material effect upon the accuracy of the fire. The third demand for the use of the battle sight is a psychological one, and would occur automatically with loss of fire control.

THE BATTLE SIGHT.

The battle sight is useful only within its zone and the height of the target directly affects this zone. By reference to plate 64 it will be seen that when aim is taken at the bottom of a prone figure the fire is useful; i. e., the target lies within the 75 per cent portion of the cone only at ranges less than 510 yards. Similarly, when aim is taken at the breast of the kneeling figure, standing figure, and mounted figure the fire is useful only at ranges less than 600, 670, and 720 yards, respectively.

This plate represents the battle-sight sheaf of the present automatic machine rifle, and corresponds to an elevation of approximately 400 yards.

It is seen, therefore, that adjustment by means of the battle sight consists not only in a decision to use it but also in the selection of an aiming point that will produce the greatest material results, and, in general, this aiming point would be at the lower edge of the figure when prone and at the breast when the height of the target exceeds that of the prone figure.

218. THE USE OF A SINGLE ELEVATION.—When it is decided that the battle sight is *not* to be used, the next question is whether one or more than one elevation is to be employed.

The decision as to the number of elevations to be employed depends upon the range and the degree of precision with which ranges are determined.

It is obvious that, as the 75 per cent zone marks the useful or effective position of the machine-gun sheaf, so one-half the depth of this zone marks the limit of error, in finding the range, which may not be exceeded with any expectancy or probability of effective material results.

When ranging fire is impracticable, the usual methods of determining the range are single estimates by the eye, combined estimates by the eye, or measurement with a range finder.

Experience has proven that single estimates by the eye will result in a probable error of about 15 per cent of the range, and that a combination of the estimates of a few men may reduce this error to 10 per cent. The probable error with the range finders of the self-contained base type is 2 per cent.

For convenience of reference, the depths of the 75 per cent zone at various ranges and the amounts of the permissible and probable errors are tabulated as follows:

Range (yards).	Depth of 75 per cent zone.	Permissible error.	15 per cent error.	10 per cent error.	2 per cent error.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*
200	403	201	30	20	4
300	355	177	45	30	6
400	288	144	60	40	8
500	224	112	75	50	10
600	189	94	90	60	12
700	159	79	105	70	14
800	138	69	120	80	16
900	121	60	135	90	18
1,000	108	54	150	100	20
1,100	102	52	165	110	22
1,200	96	48	180	120	24
1,300	90	45	195	130	26
1,400	84	42	210	140	28
1,500	77	38	225	150	30

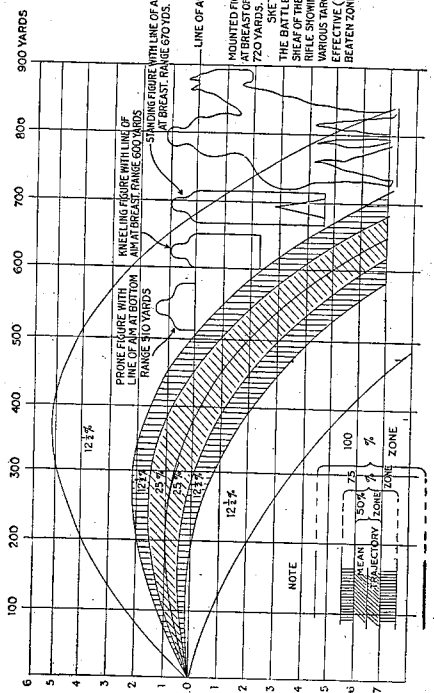
100
200
300
400
500
600
700
800
900 YARDS
GROUND LEVEL
PRONE FIGURE WITH LINE OF AIM AT BOTTOM RANGE 310 YARDS
KNEELING FIGURE WITH LINE OF AIM AT BREAST. RANGE 600 YARDS
STANDING FIGURE WITH LINE OF AIM AT BREAST. RANGE 670 YDS.
LINE OF AIM
MOUNTED FIGURE WITH LINE OF AIM AT BREAST OF HORSEMAN. RANGE 720 YARDS.
THE BATTLE SIGHT (400 YDS) SHEAF OF THE AUTOMATIC MACHINE RIFLE, SHOWING RANGES WITHIN WHICH VARIOUS TARGETS COME WITHIN THE EFFECTIVE (75%) PORTION OF THE BEATEN ZONE.
NOTE
MEAN TRAJECTORY
50% ZONE
75 %
100 % ZONE
12½%
25%

PLATE 61.

A scrutiny of this table reveals the facts that—

With single estimates by the eye (15 per cent error), the probable error exceeds the permissible error at distances beyond 600 yards, and that therefore this range marks the maximum limit at which a single elevation can be employed with profit with ranges determined with this degree of precision;

With a few combined estimates by the eye (10 per cent error), the limiting range for a single elevation is 750 yards; and

With the self-contained base range finder (2 per cent error), it exceeds 1,500 yards.

219. RANGING FIRE.—When conditions are favorable, however, these limiting ranges may all be increased by the use of ranging fire.

The principle of ranging is simple. The sight is set at the range determined, the line of sight is directed upon the objective, a trial shot or string is fired, the impact of the projectiles is observed, an estimate is made of the correction to be applied to the rear sight in order to bring the center of impact to the center of the target, the reading of the rear sight is corrected according to the estimate, the line of sight is brought to bear again upon the objective and the gun is then ready to deliver fire for effect.

It is obvious that the first requisite to successful ranging is that the target and the impact of the projectiles can be seen.

This requirement demands:

First. Daylight and a clear atmosphere.

Second. That the objective and the terrain in its vicinity be visible to the firer or to the observer who assists him.

Third. That the surface of reception be such as to give an indication of impact.

The best indication of impact is given by water. On land the best indication is obtained when the projectiles strike in loose, dry, sandy soil which is devoid of vegetation.

On ground that has been water-soaked by recent rains, or that is covered with a tall undergrowth such as grain, bushes, or rank grass the impact of the projectiles can rarely be seen.

220. There are also certain other factors to be taken into account, whereby a decision is reached as to whether ranging (even if the impact can be seen) will prove a profitable procedure.

These factors are:

First. The zone in which the objective lies, i. e., whether it is within or without the zone of the battle sight.

It is obvious that ranging is an unnecessary procedure and a waste of time against an objective which lies within the battle-sight zone, and against which it is necessary to use that sight, while beyond that zone it may or may not be required.

Second. The degree of accuracy of adjustment of fire required.

Thus, against a target of such area that, even with the maximum probable error, the 75 per cent portion of the cone still covers the target, then a more precise adjustment of fire would make no material increase in the accuracy of the fire and therefore ranging would not be necessary.

Third. The nature of the objective and of the terrain in the immediate vicinity.

Ranging is of no benefit against targets which, by their nature or that of the terrain, can evade fire for effect during the pause for observation of the ranging volley. Such targets are small columns which can effect a rapid and extended deployment, small parties of mounted men or any body of troops which is rapidly approaching defilade.

The fire for effect will always give better results if preceded by ranging against targets which can not evade machine-gun fire. Lines of prone skirmishers and hostile machine guns or field pieces beyond the immediate reach of adequate cover are such targets.

Ranging at moving targets is possible when the objective can not deviate materially from its course. Such targets are small boats attempting a landing, wagon trains, or artillery in column of route upon a road, or advancing or retiring skirmishers.

Ranging fire while under hostile fire is of doubtful value.

Assuming that the impact and the target may be seen, the preceding discussion may be summarized thus:

Ranging *should* be employed—

When the probable error in the determination of the range exceeds half the depth of the effective cone of fire, i. e., beyond 600 yards for single estimates, 750 yards for combined estimates, and then only against targets which can not evade the fire for effect.

Ranging *may* be employed—

Beyond the zone of the battle sight against moving targets which can not deviate materially from their course.

Ranging should be *prohibited*—

Against targets which, by a change of posture, position, or formation, can evade the fire for effect. This prohibition would not apply, for example, to such cases as ranging on a *position*, such as a trench, in contradistinction to ranging on the *target*, which might be the occupants of said trench.

Ranging is *superfluous*—

When the situation demands the use of the battle sight or when a more precise adjustment would make no material increase in the accuracy of the fire.

Ranging is *futile*—

When under hostile fire.

It is readily seen that there are many preliminary conditions to successful ranging, all of which must be fulfilled before resorting to this procedure.

The conclusion follows that ranging can not often be employed; this conclusion is confirmed by the experiences of machine-gun commanders in recent campaigns.

However infrequent the opportunities for ranging, it should be the rule to employ it on every possible occasion when its use promises a more efficacious fire for effect.

221. ELEVATION TO EMPLOY FOR RANGING.—It usually is best to employ what is believed to be the correct elevation or else to take what is known to be too low an elevation. In the former

case a few effective shots may result, and in either case observation will be facilitated, as, other conditions being equal, it is easier to judge of impact that is short than of impact that is over. It is also true that there is a greater probability of obtaining hits when the impact is a given distance short than when it is the same distance over. When the impact is short there is also the possibility of ricochets.

222. The simultaneous employment of all the guns in ranging, using the same aiming point and the same elevation should facilitate observation. Such procedure will often result in giving indications of impact under conditions that otherwise might prove unfavorable.

Ranging by platoon has the advantage of giving each platoon commander immediate access to the data necessary for opening an effective fire on that portion of the target assigned him. This implies, of course, a separate aiming point for each platoon. This method renders observation more difficult, but it may be employed to advantage when conditions indicate that observation will be possible. At times it may be necessary, as, for example, when the objectives assigned the platoons are in different directions or at different ranges.

Ranging by single guns is employed only under conditions that are most favorable for observation. Each gun is assigned its own aiming point. The necessity for this procedure might exist when the objective was widely scattered or when it occupied an irregular line or was on two or more lines at different ranges.

The number of shots to be fired for ranging purposes.—The strings should be long enough to insure observation. On specially favorable soil 5 to 10 shots per gun may be found sufficient; on ordinary ground 15 or 20 shots may be necessary, while on difficult ground or in a poor light 30 shots per gun may give but scant indications.

At first glance this amount might seem an excessive expenditure for ranging purposes. If a fewer number of cartridges will insure observation, so much the better; but if not,

then the full number that are required should be expended without hesitation, as ranging is for the purpose of securing an accurate fire for effect. With proper observation the fire for effect may be presumed to give its maximum results, while without it the enemy may find these results merely an annoyance. Fire should seek not to annoy but to annihilate the enemy.

When the impact is not observed after the first ranging string, it becomes a question whether ranging is to be continued or fire for effect opened without further prelude, some other means of adjustment being sought.

This depends upon the time available before either the target disappears altogether or an overwhelming hostile fire is brought to bear upon the guns, the location of which often will be betrayed by the first ranging burst.

It will depend, too, upon whether it is considered better to disturb the enemy's aim with fire of *some* effect or to trust to the possibility of securing later the maximum effect after executing additional ranging in the face of an undisturbed hostile fire.

223. *The element of suddenness or surprise is one of the essential characteristics of the successful application of machine-gun fire.*—Continued ranging not only robs the gun of this essential characteristic, but ranging while under a storm of hostile musketry or artillery fire usually is worse than useless, if it can be done at all. Hence the conclusion that the least possible time should elapse between ranging and fire for effect and when in contact with the enemy the employment of more than one string of shots for ranging purposes is the exception. *However, the first ranging strings* MUST *be long enough to insure observation,* for otherwise it is better to dispense with ranging altogether and seek some other means of adjustment.

224. The choice of a point in or near the objective on which to execute the ranging should be made with an eye to facility of observation as the most important consideration. With the

aid of the field glass the terrain in the vicinity of the target is subjected to a rigid scrutiny, the selection falling on that portion which promises the clearest indications of impact.

It is not essential that the ranging fire be directed at the target itself. Favorable soil in the vicinity will answer as well, provided the proper allowances are made when the sight reading is corrected.

When all portions of the terrain appear equally favorable for observation, ranging should be directed at some portion of the target itself in order that advantage may be taken of the possibility of chance effect. Under such circumstances the center of the target should be chosen rather than either flank, as the full effect of the lateral dispersion is thus secured.

The correction of sights as a result of ranging is based upon the observation of the impact and the subsequent estimate as to its distance and direction from the objective.

In known-distance practice the strike of the bullet is on a vertical surface, and when the position is shown by the marking disk the sight is corrected accordingly.

In combat, however, the observation of impact may be on a surface that is rising with respect to the line of sight. In such cases the correction of the sight must compensate not only for the horizontal distance, short or over, but also for the vertical distance above or below the objective.

Referring to plate 65, suppose VV to represent a vertical surface and the point T to be the target. If a shot fired at T strikes at the point H the sight correction to be applied corresponds to the vertical distance HT. If T be assumed to be a horizontal surface AT, the same trajectory will cut the horizontal surface at H'' and the sight correction to be made will correspond to the horizontal distance H''T. If T be assumed to be on the surface STS, rising with respect to the line of sight, the same trajectory will intersect this sloping surface at the point H'. The required correction in this case embodies two elements, a correction for the horizontal distance short,

H′V′, and a correction for the vertical distance below the target, represented by H′T′.

Similarly the correction to be applied to a shot that is over is represented by the distance H″ ′ T″ plus H″ ′ V″.

It is therefore apparent that when the target is on sloping ground the corrections applied to the rear sight will be too small unless in addition to the correction for the actual distance short or over allowance is made also for the angular distance of the point of impact above or below the target.

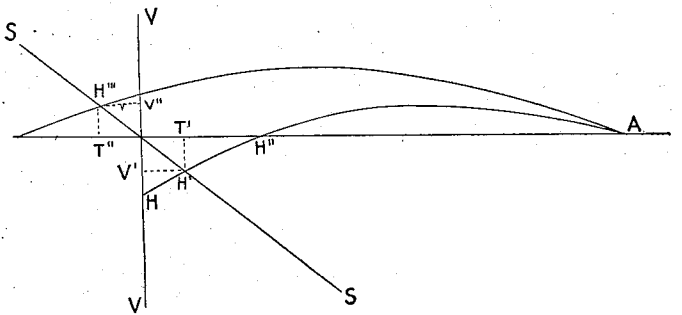

PLATE 62.

In practice the actual distance in yards that the center of impact is distant from the target must, in most cases, be estimated. The vertical correction, however, may be measured with a fair degree of accuracy by using the type EE field glass with the range and mil scale.

To measure the amount of this vertical correction with the field glass, place the graduation of the range scale correspond-

ing to the elevation actually used in coincidence with the target. Then the graduation opposite the point where the impact was noted will be the elevation necessary to take in order to correct for the vertical error. It is to be noted that this vertical correction gives the range (in terms of the sight) to the point of impact.

The vertical correction having been made, then the correction is completed by adding (if the impact is short) or subtracting (if the impact is over) a number of yards equal to the estimate of the horizontal distance from the impact to the objective and setting the sight accordingly.

Plate 63 illustrates this method.

Assume the range to have been estimated at 800 yards. Then with the 800-yard graduation held opposite the target the splash of impact is observed opposite the 1,100-yard graduation and is estimated to be 150 yards short. The full correction therefore would be 1,100 yards (vertical correction) plus 150 yards (horizontal correction) or a final elevation of 1,250 yards as a result of this observation.

Lacking a field glass fitted with a sight scale, this vertical correction can be determined quite as accurately if the observer is provided with a mil scale and a table of elevations in mils. (See range table, par. 120.)

Taking the same example, the observer uses his mil scale to measure the vertical angle between the target and the impact and finds it to be about 7½ mils. He now refers to his range table and finds the elevation for 800 yards to be 9.4 mils and to this he adds the vertical correction of 7½, making a total of 16.9 mils. Referring to the table again, he finds that an elevation of 16.9 mils corresponds to a range of about 1,100 yards. To this 1,100 he adds the estimated shortage of 150 yards and thus obtains the same final correction as before, 1,250 yards.

225. COMBINED SIGHTS AND SEARCHING FIRE.—When the means are lacking with which to determine the range with the requisite degree of accuracy and it is impracticable to employ

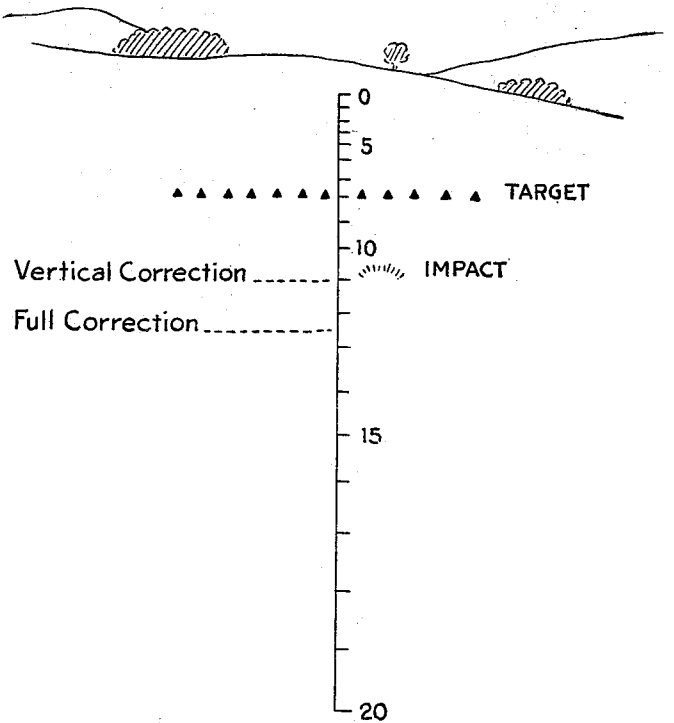
0
5
TARGET
10
Vertical Correction
IMPACT
Full Correction
15
20

PLATE 63.

ranging fire it then becomes necessary artificially to increase the depth of the beaten zone. This is done by using combined sights or searching fire.

When combined sights are used the angular difference between sight readings is for all practical purposes constant for all ranges below 1,500 yards and is equal to about 2 mils. This is equal approximately to the angular difference in elevation between 800 and 900 yards.

226. The information required in regard to the *number* of elevations to be used or the depth of searching (in mils) that is required, with various assumed probable errors, may be had in rough approximation by reference to the following table. The amounts in the body of this table indicate the limiting ranges, in yards, up to which the number of elevations or mils indicated will create the required depth of beaten zone.

Number of elevations required.	Number of mils searching required.	Probable errors.		
		15 per cent.	10 per cent.	5 per cent.
1	0	600	750	.....
2	2	1,000	1,300	.....
3	4	1,200	1,500	.....
4	6	1,400	.....	.....

227. The employment of more than three elevations is of questionable utility involving a large expenditure of ammunition with doubtful effect. No hard-and-fast rule will cover all possible conditions. The machine-gun commander must base his decision upon the conditions of the combat at the time.

228. Ammunition being abundant, its replenishment assured, and a broad and deep target giving promise of a high percentage of hits, the employment of more than three eleva-

tions may be justifiable. On the other hand, ammunition being scarce, its renewal improbable, and the target lacking in density as well as depth, the employment of even two elevations is a doubtful expedient. Between these two extremes, conditions alone determine the use of any particular number of elevations in combination.

229. The combination of elevations should insure the center of the resulting beaten zone corresponding to the estimated range. Thus, using two elevations at a range determined as 1,000 yards, one sight would be 1 mil below 1,000 and the other 1 mil above. With three elevations, one sight would be at 1,000, one 2 mils below, and the third 2 mils above.

When from any cause the number of guns available is less than the number of elevations required, the effect of combined sights may be produced by searching fire.

230. FIRE FOR EFFECT.—A machine gun can not fire continuously throughout an action, but is employed when for short intervals it is sought to concentrate a great volume of fire on a relatively small portion of the enemy's front. The effectiveness of this fire, other conditions being equal, is in proportion to its suddenness, and surprise effect.

To obtain the maximum effect, all orders and instructions relative to the conduct of fire should be given before the fire for effect is opened. If ranging is to be employed, these orders and instructions should be given before the first ranging shot is fired in order that further orders may be confined to announcing the correct elevation and giving the command to fire.

As ranging is executed simultaneously by all the guns under the immediate control of the machine-gun commander, so should the burst of fire for effect be by his order and from all the guns at once. This method will be productive of a greater moral effect.

It has been enunciated as a principle that the shallow-beaten zone of the machine gun demands a wide and deep target to secure the maximum material results. But with equal truth it may be said of any weapon of precision that the larger the

target the more hits are to be expected; hence this principle should not be misconstrued in such a manner that in its practical application the fire of machine guns is withheld unless a broad, deep target presents itself within effective range.

It may happen that machine guns operating with the advance cavalry have occasional opportunities to fire on broad, deep targets, and that more rarely such opportunities would come to machine guns operating in the minor combats preceding a general engagement in pursuit or retreat or in minor warfare. In an infantry engagement of any magnitude, however, in which a decision is sought, such opportunities will be very rare if not entirely lacking, except during the assault.

The usual targets presented in the infantry combat prior to the assault are the heads and shoulders of the hostile infantry in trenches, prone skirmishers, small groups of men engaged in the service of machine guns or field pieces, and groups or individuals advancing or retiring by running or crawling.

The infantry will be obliged to wrest a superiority of fire from troops presenting such targets. Hence the infantry machine gun must lend its aid, not because they promise a great number of hits, but because the advance of the infantry will be checked unless the hostile fire is neutralized.

The machine guns do not open fire every time the skirmishers pause in their advance. The machine-gun commander's mission usually will require him to place his guns in such position that he can deliver an effective fire on the enemy during the assault. Prior to that time his fire is limited to occasions when the infantry is unable to hold its own in the fire fight, or, when not required for this purpose, he may fire on specially favorable objectives promising a large percentage of hits.

231. There should be no hesitancy in directing the fire of machine guns against any hostile force, irrespective of their numbers, the weapon they employ, their formation, and whether or not the probability of material results is great or small, when it is permitted by the mission and demanded by the tactical situation.

EFFECT TO BE EXPECTED AGAINST VARIOUS TARGETS.

Prone skirmish lines.—Their ordinary density is about one man per yard of front. Such a target, though lacking in depth, offers the machine gun a fair remuneration in hits at ranges of about 600 yards or less. At ranges greater than 600 yards the employment of an accurate range finder or of ranging fire is necessary in order to secure material results that are in the least degree commensurate with the expenditure of the ammunition.

The percentage of hits decreases with the density of the skirmish line.

232. Theoretically, the fire of machine guns, beyond close ranges should not be employed against a shallow line whose elements are separated by an interval greater than the natural lateral dispersion of the cone. At 500 yards this interval is about 3 yards.

Practically, however, the necessity for firing on a thin line seldom exists, as riflemen rarely require aid in obtaining a superiority of fire in such cases.

It may be assumed that the skirmish lines attacked by machine guns will be ordinarily of a density of about one-half to one man per yard. Distributed fire must be used against such lines. At the longer ranges and against irregular lines any attempt to "sweep" the target—i. e., to change the line of sight while firing—will result in creating merely a dangerous area somewhere in the vicinity of the objective, the actual number of hits being comparatively small. At close ranges, however, and against dense targets, sweeping fire is effective.

Either continuous or intermittent fire is employed against this class of target.

At distances greater than 600 yards, when it is impracticable to employ either ranging or accurate range finders, recourse to the use of combined sights or searching fire against this class of target is of doubtful value on account of the great expendi-

ture of ammunition necessary to attain the desired results unless the fire be delivered from a flank.

Experience has proven that an increase in material effect may be expected when machine guns engage a linear target from a flank and also when the line of fire is oblique to the front of the target.

Unless the supply of ammunition is abundant and can be renewed promptly, it is better to withhold the fire of the machine guns until a critical stage of the engagement.

233. *Infantry in trenches* is attacked in the same manner as prone skirmish lines.

In the attack of hostile machine guns, fixed fire at each gun is clearly indicated. By distributing the fire against as many guns as possible at the same time, fewer guns are left undisturbed to continue their fire with almost peace-time accuracy.

When engaging a superior number of hostile pieces, the first gun to silence its opponent should be turned at once on one of the guns that has remained unmolested. Under these circumstances it is best to concentrate on the center guns first, and, when these have been silenced, to attack both flanks.

The enemy's guns should be engaged piece for piece by the flank guns when they are inferior in number. The center guns lend their aid where it appears to be needed most, usually against guns where the effect of fire is difficult to observe, or against those whose fire seems undiminished.

234. ARTILLERY.—A frontal attack against shielded guns in position can be of little avail and is to be avoided. Opportunities to attack artillery in position from the flank or rear should be seized, employing the same methods of fire as are used in the attack of machine guns.

235. ADVANCING OF RETIRING SKIRMISH LINES.—On account of their lack of depth, and also the wide intervals that are usual at the longer ranges, such targets will not ordinarily prove favorable objectives at ranges exceeding 1,000 yards. As the shorter ranges are reached, skirmishers in motion are at best a difficult objective.

They can evade the fire by lying down, and their movements being at short irregular intervals, expose them to the fire of the guns for very brief periods. The movement of the skirmishers usually will be from cover to cover. Advantage is taken of this procedure to determine the correct elevation while the skirmishers are halted, so that when they emerge from cover fire for effect can be opened without delay.

Distributed or sweeping fire is used.

If the distance to the nearest cover is very great, it will be necessary to make allowances for the constant change in range by setting the sight a trifle above or below the true elevation.

236. COLUMNS. Recourse is usually had to combined sights or searching fire in order to secure distribution against columns.

237. TARGETS MOVING ACROSS THE LINE OF SIGHT.—Distribution against targets of this character may be obtained by holding on a single point with fixed fire. Fire is opened as the leading element passes the aiming point and is continued as long as any portion of the target remains in the cone of fire. The point of aim is moved ahead of the target as often as necessary.

238. FIRE AGAINST AIRCRAFT.—Experience has shown that machine-gun fire is ineffective against aircraft unless the guns are employed in large masses. Consideration also should be given to the fact that aircraft usually fly far beyond the effective range of small arms and at very high speeds.

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PART V.

TARGETS AND RANGES.

239. Targets are divided into three classes:

(*a*) Target for obtaining the sight setting of machine guns.

(*b*) Known-distance targets (for machine guns).

(*c*) Field targets (for rifle and machine guns).

240. TARGET FOR OBTAINING SIGHT SETTING OF MACHINE GUNS.—This target, known as target B, is a square 6 feet on a side, black circular bull's-eye 20 inches in diameter; center ring, 37 inches in diameter; inner ring, 53 inches in diameter; outer remainder of target. This target is used for the determination of sight settings for machine guns.

241. KNOWN-DISTANCE TARGETS.—There is but one target used for this practice. It is of paper mounted on a rectangular frame 3 feet by 20 feet.

This paper is ruled with horizontal lines 1 inch apart and with vertical lines 3 inches apart.

The aiming points on this target are made with black pasters arranged to represent such formations of troops as may be desired by the instructor.

For reference, however, four arrangements of aiming points are given as types. These are shown in plates 67 and 68 and are known as targets MGA, MGB, MGC, and MGD.

242. Target MGA, figure 1, plate 67, is used for practice in holding and in fixed fire.

The aiming points are single black pasters arranged in 10 vertical lines of three aiming points per line. These vertical

MACHINE GUN TARGETS

Sketch No. 15.

MGA

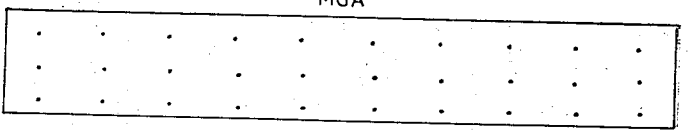


Fig. 1.

MGB

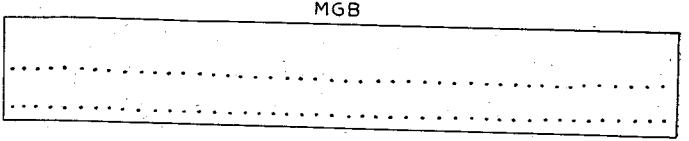


Fig. 2.

MGC

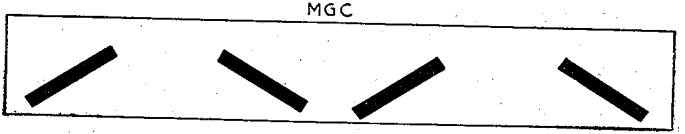


Fig. 3.

PLATE 64.

lines of aiming points are placed in the center of each 2 feet of width of the target, and in each line the upper paster is 9 inches from the top of the target, the lower paster 3 inches from the bottom of the target, and the middle paster 21 inches from the top and 14 inches from the bottom of the target.

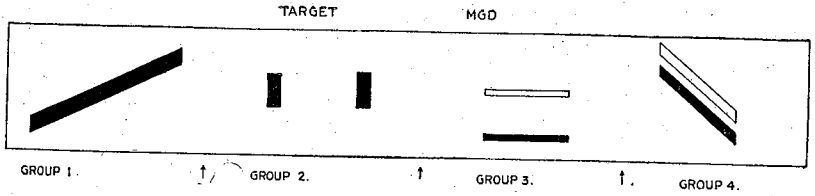
243. Target MGB, figure 2, plate 67, is used for distributed fire, searching fire, and a combination of these two methods. The aiming points consist of two black pasters side by side, and they are arranged in two horizontal lines extending across the entire width of the target. One line of aiming points is placed 3 inches and the other 22 inches from the bottom of the target. The aiming points are placed between two horizontal lines and in the center of the intercept between each two vertical lines.

244. Target MGC, figure 3, plate 67, is used for practice against such a target as would be presented by a column of troops marching on a hillside. The aiming point is a black strip 4 inches wide and 3 feet long placed parallel to the diagonal of each 5-foot width of the target. The four strips alternate on the ascending and descending diagonals; the center of each strip is on a diagonal line bisecting the 5-foot space allotted to it, and the lowest corner of the strip is 3 inches above the bottom of the target.

245. Target MGD, plate 68, is used for instruction and record practice. The aiming points are made of black pasters designed to represent some of the tactical objectives at which machine-gun fire might properly be directed.

The "scoring spaces" coincide with the aiming points in two of the cases. In the other two cases the scoring spaces are placed on the target at the proper ordinate above the aiming point, so that the score may be determined at once.

The target is divided vertically into four equal sections, in the centers of which the designated aiming points are placed as described in paragraph 246.



Sketch No. 10.

PLATE 65.

Fifteen yards of skirmish line, at 300 yards; 50 mils in length, 5 mils deep, extending across 15 vertical scoring spaces, 15 points. Point-blank range target and scoring space coincide.

Two squad columns, at 300 yards, 20 points.

Thirty-five-yard trench, at 1,000 yards; 25 mils long, 1 mil deep, extending across 8¼ scoring spaces, 25 points; 1,000 yards scoring space above.

Fifteen-yard skirmish line, at 600 yards; 25 mils long, 3 mils deep, extending across 7½ vertical scoring spaces, 15 points; 600 yards scoring space above.

GROUP 1.

246. *Objective:* A 15-yard section of skirmish line on a hillside at a range of 300 yards.

Aiming point: A black strip 50 inches long and 5 inches high placed on the target with the lower enemy right corner on the 5-inch line, extending diagonally upward to the enemy left, and crossing 15 of the vertical sections of the target. The ends of the strip coincide with the two vertical lines on the target, including the 15 vertical sections, the resulting form of the aiming point being a parallelogram (a rhomboid).

Scoring spaces: The range being point blank, the scoring area and aiming point coincide, and the score is determined from the hits in the black aiming point. The vertical lines on the target are continued through the black aiming point, dividing the latter into 15 rhomboids, each of which constitutes a scoring space.

Possible score, 15 points.

GROUP 2.

Objective: Two squad columns at a range of 300 yards, at an interval of 8 yards.

Aiming points: Two black rectangles each 10 inches long and 3 inches wide, placed with the lower edge on the 15-inch line of the target, and with eight vertical sections of the target (24 inches) interval.

Scoring spaces: The range being point blank, the scoring areas and aiming points coincide. Each aiming point is divided into 10 rectangular scoring spaces, each 1 inch high and 3 inches wide, by continuing the horizontal lines of the target across the black surface.

Possible score, 20 points.

GROUP 3.

Objective: A 25-yard section of trench at 1,000 yards.

Aiming point: A black strip 25 inches long and 1 inch high placed between the 5-inch and 6-inch lines and extending across 8¼ vertical sections of the target.

Scoring spaces: A rectangle with dimensions identical to those of the aiming point is outlined exactly above it and between the 15 and 16 inch lines. This rectangular scoring area is divided vertically into 25 scoring spaces, each 1 inch square.

Possible score, 25 points.

GROUP 4.

Objective: A 15-yard section of skirmish line on a hillside at a range of 600 yards.

Aiming point: A black strip 25 inches long and 3 inches high placed on the target with the lower enemy left corner on the 5-inch line and extending diagonally upward to the enemy right across 7½ vertical sections of the target. The ends of the strip are vertical, the resulting form of the aiming point being a rhomboid.

Scoring spaces: A rhomboid with dimensions identical to those of the aiming point is outlined exactly above it, the upper edge of the aiming point forming the lower edge of the scoring space. This scoring area is then divided into 15 equal scoring spaces by bisecting vertically each rhomboidal section made by the vertical lines of the target.

Possible score, 15 points.

Total possible score, 75 points.

FIELD TARGETS.

247. TARGET E.—A drab silhouette about the height of a soldier in the kneeling position, made of bookbinders' board or

other similar material. Hits on all field targets count 1, and any shot cutting the edge of a silhouette is a hit.

248. TARGET F.—A drab silhouette about the height of a soldier in the prone position, made of bookbinders' board or other similar material. The life of targets E and F can be materially prolonged by pasting on fresh paper silhouettes when the figure becomes too much damaged by shots. These targets are used as stationary targets as well as on the moving and disappearing appliances. When necessary these targets are fastened to wooden staves with tacks and tin washers.

249. TARGET G.—Falling target. The target is made of soft-wood about the shape, size, and color of the prone silhouette F. These targets should be placed in small pits (1 by 2 feet) so that about 9 or 10 inches of vertical protection is given the base and mechanism; only the face of the target should show to the front. If the wooden figure becomes unserviceable, it may be repaired at the post.

250. TARGET H.—Targets E or F inserted in a slit at the end of a marking disk staff or pole and fastened with wooden pegs. The staffs are held in the hands of markers or in brackets on the inside of the crest of the pit. The targets are held faced to the front. When struck they are turned rapidly so as to show the white side. and then back to the original position.

251. TARGET I.—Beam disappearing target. The visible target represents a line of prone or kneeling figures at suitable intervals. In close order eight figures are mounted on each beam. The figures are targets E and F, mounted on the regulation staves, which are modified by having the points cut off, so that but 6 inches project below the bottom of the figures.

The beam itself is made up of one piece of 2 by 6 inches by 20 feet long, one piece 1 by 6 inches by 20 feet long, and 1 by 6 by 20 inch sections fitted between them, as shown in plate.

The beam is laid in a shallow trench, targets horizontal, and a stake is driven in front of the beam at each end. The ropes from the operating standard lead to the pit (direct and via the

rear ring stake) and the beam is turned through 90°, exposing and lowering the targets by pulling on the appropriate ropes. The rope system is in duplicate, so that if one rope is cut by a bullet the target can still be worked. Two or more beams can be coupled together and the whole operated from the center. There should be two end stakes for each beam. The operating standard should be painted a neutral color, have earth rubbed on it, or have bundles of vegetation tied to it. The ropes should also be of a neutral color.

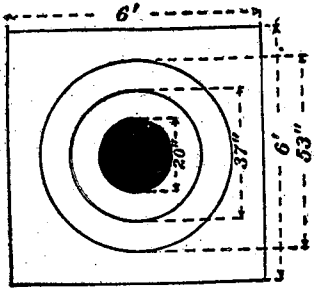
This apparatus requires but one man for its operation, even if two beams are coupled together. The pit should be deep enough to give protection, and the earth therefrom should be spread out into a low embankment and concealed by grass or brush.

252. TARGET K.—Sled target. The disappearing target beam (target I), is lashed lengthwise to two sleds. A rope from 200 to 300 yards long is used to pull this target and an escort wagon and team has been found to be the best motive power. The rope can be run through a snatch block, and the team concealed by inequalities of the ground. If no cover can be found for hiding the sled before it starts, it can be easily masked with brush, grass, etc., which will fall when the targets start.

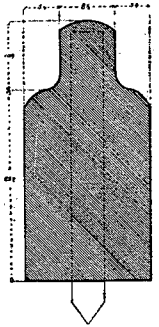
RANGES.

GENERAL CONSIDERATION.

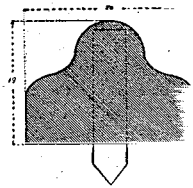
253. CLASSES.—There are two general classes of ranges: Class A ranges, which are more or less limited in extent and which are equipped for known-distance rifle practice. This range can also be used for machine gun known-distance firing and is used for the purpose of determining the sight setting of the guns. Class B ranges, which are of extended area and diversified terrain, and which are used for combat firing. As machine-gun organizations will often be limited to class A



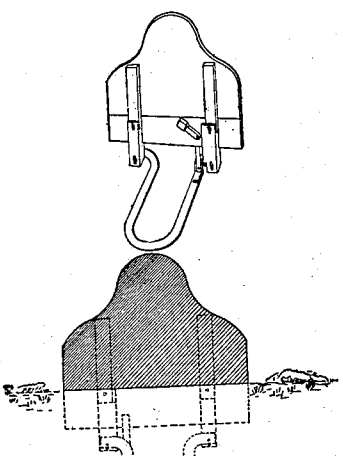
TARGET B.



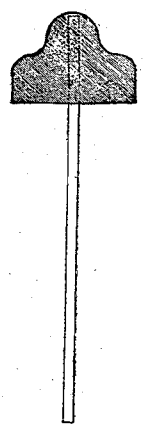
TARGET E



TARGET F



TARGET G



TARGET H

PLATE 66.

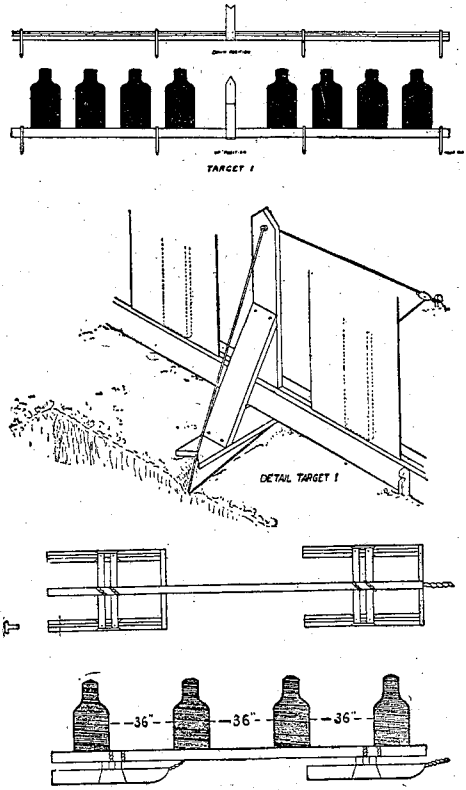
ranges and will usually take part in field firing with other troops on class B ranges, it is essential that all machine-gun officers be thoroughly familiar with the different class of ranges.

254. RULES FOR SELECTION.—As the nature and extent of the ground available for target practice and also the general climatic conditions are often widely dissimilar for different military posts, it will not be possible to prescribe any particular rules governing the selection of ranges but only to express certain general conditions to which ranges should be made to conform as far as may be practicable. In view of the extreme range and penetration of the bullet used in the service, it will be found necessary in the case of many posts to have machine-gun practice conducted at a distance of several miles from the post, necessitating the establishment of a camp on or near the range. The machine-gun practice can then be conducted uninterrupted by the routine of post duties.

255. SECURITY NECESSARY.—For posts situated in thickly settled localities, where the extent of the military reservation is limited, the first condition to be fulfilled is that of security for those living or laboring near or passing by the range. This requirement can be secured for a class A range by selecting ground where a natural butt is available or by making an artificial butt sufficiently extensive to stop wild shots.

The following diagram shows the shape and dimensions of the area within which life or property might be endangered by rifle or machine-gun fire in a given direction, and outside the boundaries of which there exists a reasonable degree of safety.

In determining the shape and dimensions of this area certain basic assumptions are made. *Actual conditions must conform to these basic assumptions if there is to be a reasonable assurance of safety outside the boundaries of this area.*



TARGET K.
PLATE XXIII.

PLATE 67.

These basic assumptions are as follows:

1. That the firing point is on the line CD and that the firing line is deployed facing toward B and on a front of not to exceed 200 yards. If the front of the firing line does exceed 200 yards, then the width of the zone CDEF must be increased accordingly.

2. That the target lies within the boundaries of the zone CDEF, the width of this zone being increased if the target presents a front of over 200 yards.

3. That the direction of the fire in azimuth will not deviate, *either through accident or design*, by more than 6° from the median line AB. Should there exist the probability of a deviation greater than 6°, then the angles GCE and FDH, by which the boundary lines GJ and HK are located, must be increased accordingly.

4. That, on ordinary soil, the direction taken by bullets which happen to ricochet will not deviate more than 30° from the median line AB.

When the surface of the ground within the area CDKJ presents such features as woods, exposed rocky formations, steel or iron structures, or any other natural or artificial features that might cause ricochets to be deflected at angles greater than 30°, then the angles MCE and NDF, by which the boundaries MC and ND are located, must be increased accordingly.

When such an increase in these angles becomes necessary, the sides MC and ND do not change in length but remain each 1,400 yards. The sides IM and LN remain parallel to the median line AB, but are farther apart and longer. For all practical purposes absolute safety from ricochets is attained when, under most unfavorable conditions, these angles are increased from 30° to 85°.

It will be noted that these four conditions modify only the width of the danger zone.

These widths may also be reduced by proper defilade on a protected range.

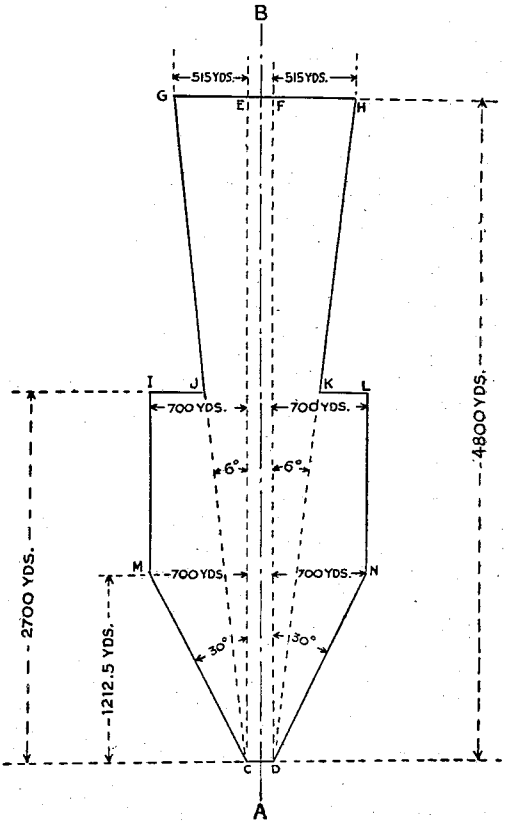


PLATE 68.

Boundaries indicated by unbroken lines.

The distance from the firing line, CD, to the line IJKL is 2,700 yards and marks the extreme range of the final impact of ricochets. There would be no conditions that would necessitate an increase in this distance, though proper defilade and proper surfacing of the ground on a protected range might permit it to be shortened.

For practical use in connection with firing on class B ranges a diagram like the one shown above is drawn on tracing linen or other similar material and a scale of yards added on the median line AB, the zero of this scale at the firing line CD. The scale of this drawing would be the same as the scale of the map of the class B range.

By applying this drawing to the map it can be told at a glance whether or not it is safe to fire from a given point and in a given direction. A safe site for a given firing exercise having been determined upon, it also will serve to show what measures must be taken to keep this area free of traffic while the firing is in progress.

256. DIRECTION OF THE RANGE.—If possible, a range should be so located that the firing is toward or slightly to east of north. This gives a good light on the face of the targets during the greater part of the day. However, security and suitable ground are more important than direction.

257. BEST GROUND FOR CLASS A RANGE.—Smooth, level ground, or ground with only a very moderate slope, is best adapted for a range. If possible the targets should be on the same level with the firer or only slightly above him. Firing downhill should, if practicable, be avoided.

258. SIZE OF RANGE.—The size of the range is determined by its plan and by the number of troops that will fire over it at a time. There are two general plans used in range construction—one with a single target pit and firing points for each range, the other with its firing points on one continuous line, the target pits for the various ranges being in echelon. The latter type requires more ground but admits of firing at different ranges at the same time.

259. ARTIFICIAL BUTTS.—If an artificial butt is constructed as a bullet stop, it should be of earth not less than 30 feet high and with a slope of not less than 45°. It should be extended about 5 yards beyond the outside targets and should be placed as close behind the targets as possible. The slopes should be sodded.

260. HILLS AS BUTTS.—A natural hill to form an effective butt should have a slope of not less than 45°; if originally more gradual it should be cut into steps, the face of each step having that slope. As a temporary expedient the face of the hill may be plowed perpendicularly to the range, but as the bullets soon cut down the furrows this measure must be frequently repeated to prevent the danger of ricochets.

261. NUMBERING OF TARGETS.—Each target should be designated by a number. The numbers for ranges up to 600 yards should be at least 6 feet in height and should be painted black on a white background. The Arabic is preferable to the Roman notation, being more readily comprehended by the soldiers; if made of the size suggested, they will always be quickly recognized. They should be placed on the butt behind each target, but not so far above as to prevent the soldier seeing the number when aiming at the target.

262. FIRING MOUNDS.—If it becomes necessary to raise a firing point on account of low ground, a low mound of earth no higher than absolutely required should be made. The mound should be not less than 8 feet square, level, and sodded. If the entire firing line is raised, the firing mound must be not less than 8 feet wide on top, level, and sodded if possible.

263. PIT SHED.—A small house or shed should be built in or near the target pit, in which the marking disks and signal flags and spare parts of the target frames for making immediate repairs should be stored. It should be sufficiently large to afford a shelter for the markers in case of a sudden storm.

264. DANGER SIGNALS.—One or more danger signals will be displayed near the range to warn passers-by when firing is in

progress. These signals will not be placed in such a position as to serve as streamers for judging wind on the range. They should be placed on the roads or on the crest of the hill where they can be plainly seen by those passing.

265. RANGE HOUSE.—On large ranges where competitive firing is held a house containing a storeroom and several office rooms should be erected in some central place, off the range, but in its immediate vicinity. Such facilities as will enable visitors to satisfactorily witness the firing should also be provided.

266. SCORERS' TABLES.—The range should be provided with scorers' tables and benches.

MACHINE-GUN RANGES.

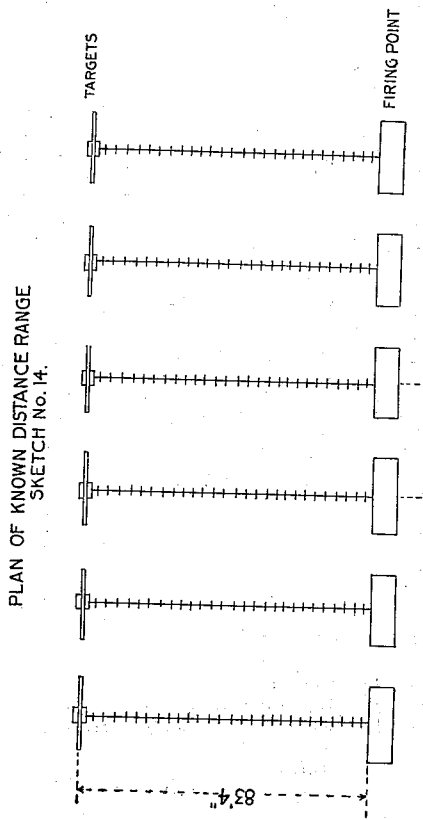
267. AREA.—For each target used, the machine gun known distance range should be a level open space about 40 yards in length (in the direction of the line of fire) and 10 yards in width.

268. SELECTION OF SITE.—With obvious modifications, the rules for the selection and preparation of class A ranges apply with equal force to the machine-gun range.

269. PLAN OF RANGE.—The target frame is carried on a truck, which runs on a light track leading from the firing point to the position of the target, $27\frac{7}{9}$ yards distant.

At this distance (1,000 inches) 1 mil subtends an angle at the target of 1 inch. At a range of 1,000 yards 1 mil subtends an angle of 1 yard; therefore all calculations, firing data, etc., on the machine-gun range of $27\frac{7}{9}$ yards are correct to scale.

When but a single target is in use the truck and track may be dispensed with and the target frame supported by posts set in the ground, but when several targets are to be used at the same time the truck and track feature will be found to save much time, as any target may then be drawn back to the firing point, examined, marked, scored, and pasted without waiting for the fire to cease at any other firing point or without delaying the fire at any other points. Plate 69 shows plan for six targets.



PLAN OF KNOWN DISTANCE RANGE
SKETCH No. 14.

PLATE 69.

270. DISTANCE.—The distance from the firing point to the target is $27\frac{7}{9}$ yards (83 feet 4 inches), the only range at which known distance firing is held. At this distance the intercept of 1 mil is equal to 1 inch. The range measure is taken from the center of motion of the gun to the target. For example, with a tripod mount, this is the pintle, with a barrel rest, the point of support near the muzzle.

271. PROTECTION FOR MARKERS.—While firing is in progress, the markers remain in rear of the firing point; hence no pits or other special measures for their protection are required.

272. INTERVAL BETWEEN TARGETS.—When practicable, the interval between targets should not be less than 10 feet.

273. TELEPHONE SERVICE.—No telephone service is needed except when local conditions require communication by wire between range and some other locality, such as the camp or garrison.

CLASS B RANGES.

274. CLASS B RANGE.—Certain extensive reservations in the United States and the Philippine Islands will furnish ample and suitable ground for combat firing. At times extensive tracts of unoccupied land or land from which the crops have been harvested may be rented near the post. At other points where leased tracts are at the disposal of the garrison for purposes of target practice or maneuvers, facilitates for combat firing can probably be found. Any ground suitable for maneuvers will also be suitable for combat firing, if the safety of the neighboring inhabitants be taken into consideration and provided for.

Tracts that have been set aside as permanent class B ranges may be improved by the construction of permanent shelters for the markers and pitmen, which should be made inconspicuous. Otherwise these ranges should be kept in the natural state, but changes made to facilitate the practice or to save labor from year to year should be such as not to provide assistance to those under instruction.

For methods of determining danger zones, see paragraph 255.

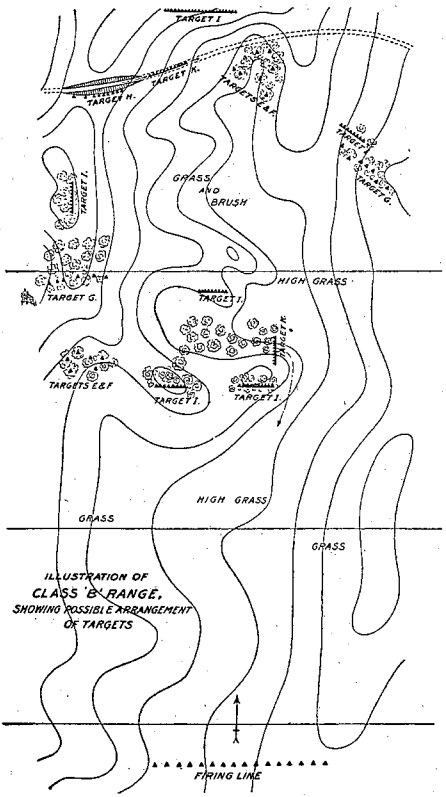

TARGET I
TARGET K
TARGET H
TARGETS A & D
TARGET C
TARGET B
TARGET L
GRASS AND BRUSH
HIGH GRASS
TARGET G
TARGET J
TARGET M
TARGETS E & F
TARGET I
TARGET J
HIGH GRASS
GRASS
GRASS
ILLUSTRATION OF CLASS 'B' RANGE, SHOWING POSSIBLE ARRANGEMENT OF TARGETS
FIRING LINE

PLATE 70.

RANGE REGULATIONS.

275. THE DIRECTOR is the personal representative of the commanding officer. He should be, when practicable, a field officer, and will have general supervision of the firing and of the target range during the practice season. He will not supervise the details of the instruction of the companies practicing on the range, but will maintain order, regulate the distribution of ranges and targets to organizations, prevent infractions of regulations, and in general assist by every proper means to secure efficient and accurate service from the working force of the range.

He will see that all necessary precautions are taken for the safety of the markers and such spectators as may be present.

In the performance of his duties he—

1. Prepares a progressive course of instruction and submits same to the commanding officer for his action.

2. Requests the detail of suitable officers to act as umpires, range officer, and recorder.

3. Takes steps to secure a sufficient number of large scale contoured maps of the class B range.

4. Causes the umpires to prepare problems in accordance with the course of instruction as approved by the commanding officer, and within the limits of the range available, to select the ground on which these exercises are to be fired.

5. The problems having been prepared, he causes them to be submitted to the range officer and requires him to make an estimate of the kinds and amounts of target material required for these problems, and to submit timely requisition for same.

6. Requires the range officer to have constructed the necessary shelter for markers, lines of communication, etc., and to have the range prepared for the exercises according to the schedule.

7. Requires the umpires to prepare a detailed schedule showing—

(*a*) The day or days on which each problem is to take place.

(*b*) The organizations or subdivisions which are to participate.

(*c*) When, where, and to whom each organization or subdivision will report for participation in each exercise.

(*d*) Details as to equipment, ammunition, uniform, etc., required for each exercise.

8. Requires copies of this schedule to be furnished to the commanding officer, range officer, recorder, each umpire, and each organization that is to participate.

9. Requires the range officer to prepare, in accordance with this schedule, a list of men needed for duty on the range from day to day as—

Foreman.
Markers.
Agents of communication.
Range guards.
Laborers, etc.

This list, after approval, is submitted to the commanding officer.

10. During the period covered by the schedule of exercises, he is charged with seeing that the instruction is thorough; that the schedule is carried through without friction, waste of time, or unnecessary delay; that proper safety precautions are taken; and that the records and reports are properly kept and rendered.

276. *The recorder* acts as an adjutant for the director. He is also charged with the duty of keeping the records of the exercises, and of computing such statistical data, theoretical standards, etc., as may be required by the umpires.

He is provided with the necessary clerical assistance.

277. THE RANGE OFFICER.—The duties of the range officer are to prepare the targets, to superintend their placing and manipulation, to see that the range is safe, and where neces-

sary to post range guards to prevent persons from entering the area of fire; to record and report the results of firing.

Every precaution will be taken to provide for the safety of the markers, target men, and others whose duties require them to be anywhere within or near the area of fire. When it appears to be necessary, a point which will be continually in view of the officer or noncommissioned officer in charge of the firing line throughout the exercise will be selected from which to display the danger signal. This point will be known to all engaged in the firing. No firing of any kind will be done while the danger signal is displayed. Should the danger signal appear while an exercise is in progress the command will be halted and all firing and movement will cease. When the danger signal is removed the exercise will be resumed.

278. Officers in charge of class B ranges should understand the construction of field targets, the manner in which they are assembled, and the details of their operation. There should be a contoured map of the range on which is shown the location of all pits and of all permanent or semipermanent telephone or buzzer lines; they should be thoroughly familiar with the topography of the range and should be prepared to give advice as to the location of targets and their manipulation, and to select the terrain for problems when required to do so.

Range officers should be furnished, a week in advance, with a schedule showing the nature of the work to be conducted. They should be given timely information as to changes in the schedule or in any particular firing exercise.

When more than one problem is to be conducted in the same locality, the range officer should site the problems so as to prevent the fire of one becoming dangerous to the other.

The range officer usually is furnished with a permanent detail of such enlisted foremen, artificers, laborers, etc., as are necessary.

279. THE UMPIRES, under the supervision of the director, are charged with the duties of preparing the problems, direct-

ing the range officer as to the arrangement and manipulation of targets for these problems, conducting the problems, observing the solutions of the problems, arriving at judgments as to the correctness of the solutions, and, based upon those judgments, delivering critiques. When required, they furnish the recorder with a written synopsis of the critique.

280. USE OF DEVICES FOR DETERMINING FORCE AND DIRECTION OF WIND.—Anemometers, wind clocks, and other instruments, and flags, vanes, or streamers for determining the force and direction of the wind will be allowed on the range during instruction practice, but not during qualification firing.

281. DRESS AND EQUIPMENT.—In all classes of firing the service uniform and service hat will be worn, the coat may be omitted when authorized by the post commander.

For combat practice, the service uniform for field duty will be worn (see tables of occasions, Uniform Regulations), together with such field equipment as the commanding officer may prescribe as one of the conditions of the exercise.

Officers will, when firing, wear the same uniform and equipment as the men. In conducting combat firing exercises officers will be equipped with field glasses and pistols; sabers will not be worn.

282. QUALIFICATION TEST.—This is for two purposes: First, to afford the soldier an object lesson of his progress; second, to obtain a record by means of which the soldier may be graded in awarding insignia and increased pay. The rules for the qualification test must be fixed and be applicable to all alike. These rules must be strictly observed by all, and scores must be recorded accurately.

In this practice coaching of any nature is prohibited. Each firer must make his correction as a result of his own observations. After a soldier has taken his position at the gun no person shall render or attempt to render him any assistance except as provided for in the regulations prescribing the test.

283. FIELD GLASSES.—Officers and enlisted men will be allowed and encouraged to use field glasses.

284. SCORING.—The record of the score from which classification will be made will be kept at each firing point by a noncommissioned officer who will be assigned, except at a one-company post, to a point where his own company is not firing. The scoring will be closely supervised and the record verified by a company officer. Scores will be recorded on the range with pencil on sheets prepared for that purpose.

A separate sheet will be kept for each man firing, and as soon as the man's score at any range is completed the scorer will sign the sheet and the company commander will take it up, initial it, and keep it in his personal possession until the scores are entered on the company target record. This entry is made by the company commander.

285. The company target record will be kept in the personal possession of the company commander and not allowed in the hands of an enlisted man from the beginning of the record practice until the required reports for individual known distance practice have been rendered.

All entries in the company record will be made in ink, and no corrections or alterations will be made except by the company commander, who will initial each correction.

The board for the examination of men for classification will accept the company's record of individual known distance practice for that part of the qualification test.

286. NONCOMMISSIONED OFFICER IN CHARGE OF TARGETS.—A competent noncommissioned officer, with such assistants as the post commander may deem necessary, will be detailed permanently during the target season in charge of arrangements at the targets.

He will be under the direction of the range officer and will be responsible for the efficiency and discipline of the target details. It will be his duty to see that targets are ready for the firing desired and that all targets are serviceable; also to see that as the target details report they are provided with the proper flags, paste, pasters, etc.

PART VI.

CHAPTER I.

RECORDS AND REPORTS.

287. The following are required:

1. A performance record for each gun.
2. A record of individual known distance, record firing, and qualification tests.
3. Record of combat firing.
4. The report of individual known distance practice.
5. The report of individual qualification tests.
6. The report of combat firing.

288. *The performance record for each gun.*—There will be kept a daily record of all firing, showing the lot of ammunition used, the number of rounds fired from each barrel, and the gun adjustments. This record will show any parts replaced and any troubles or jams which occurred during the day's firing with a note of how these troubles were reduced. This daily performance record will be kept, if possible, with the gun at all times.

289. The record of individual known-distance record firing and qualification test consists of a separate sheet for each individual firing the known-distance course. On these sheets are entered the results of the qualification test as follows:

A. By the company commander. Known-distance record firing.

(*a*) Scoring spaces struck in—

Group 1. Group 3.
Group 2. Group 4.

Total scoring spaces struck.

(*b*) Time of firing (excluding time out for jams).
(*c*) Time out for jams (excluding those due to broken parts.
(*d*) Total time (sum of "b" and "c").
(*e*) Score.

B. By the examining board for final classification (par. 131). The percentage made in each of the following subjects:

Matériel.
Determination of the range.
Sight setting and recognition of targets.
Field firing.
Total.
General average (including known-distance record firing).
Final classification.

The company commander is the custodian of this record, blank forms for which will be furnished by The Adjutant General of the Army.

290. The record of combat firing in each company contains the statement of each problem or exercise used and the statistical data and synopsis of the critique pertaining to each unit participating in such problem.

The custodian of these records is the company commander.

No blank form is furnished for this purpose.

291. The report of individual known-distance practice is rendered by the company commander to the regimental commander, or in the case of special organizations to the commanding officer of the unit to which attached as soon as practicable after the completion of the individual known-distance practice (par. 110).

This report consists of a list showing the scores of officers and enlisted men who have made 65 per cent or over in the known distance record firing.

No blank is furnished for this report.

292. The report of the individual qualification test is made by the company commander at the conclusion of the test and will include:

(*a*) The names of officers and enlisted men rated as expert rifleman, machine gun; sharpshooter, machine gun; and marksman, machine gun.

(*b*) The percentages made by each in all of the prescribed subjects.

(*c*) The general average of each officer and man.

The data is taken from the record of individual known distance record firing and qualification test.

The Adjutant General will furnish the necessary blanks for this report.

293. The report of combat firing is rendered by the organization commander, through military channels, to the division commander.

This report consists of two parts. Part I is based upon the company records of combat firing. It will be in narrative form and will include—

(*a*) A general statement as to the combat firing of each organization.

(*b*) The complete statement of all problems used.

(*c*) Recommendations for improvements in the course of combat firing.

Part II is the report of the commanding officer upon the record combat firing problems, Chapter V, paragraph *188* and includes—

(*a*) A complete statement of the problem.

(*b*) A statement as to the manner of its execution.

(*c*) The complete statistical data.

(*d*) Notes on the critique of the problem.

(*e*) Such comments as may be deemed pertinent.

CHAPTER II.

CLASSIFICATION, INSIGNIA, AND EXTRA COMPENSATION.

294. Classification applies to officers and enlisted men.

All officers and men belonging to machine-gun organizations and who join prior to known distance practice will take that practice except as noted in paragraph 4.

295. GRADES OF MACHINE-GUN MEN AND BASIS OF QUALIFICATION.—Individuals of a machine-gun organization are graded according to the proficiency exhibited in the qualification test as expert rifleman—machine gun, sharpshooter—machine gun, marksman—machine gun, and unqualified.

The unqualified class includes, in addition to the men who did not make the required percentage for qualification as marksman or better, all those men who are borne on the rolls of the organization and who have not taken the qualification test.

The individual qualification test (par. 131 et seq.) is arranged on a percentage basis and is so designed that with care in instruction a soldier with an average education and some machanical ability can satisfactorily pass the test.

INSIGNIA.

296. CLASSES.—To each officer and soldier qualifying for the first time as expert rifleman—machine gun, sharpshooter—machine gun, and marksman—machine gun, certain insignia indicating their skill in marksmanship will be issued. In case of loss or damage new issue may be made as provided for in paragraph 298.

297. MACHINE-GUN MEN'S INSIGNIA. (*a*) *Marksman's pin.*—To marksmen, when first qualifying as such, will be issued a marksman's pin. A soldier having qualified as a marksman may wear this pin as long as he continues to draw the increased pay for that qualification.

(*b*) *Sharpshooter's badge.*—To the sharpshooter a silver badge will be issued. For the first qualification in this grade the badge will consist of a pin and a cross; the soldier having once qualified as a sharpshooter may wear the badge while he is entitled to draw increased pay for that qualification. To those who have qualified as sharpshooters for three years, not necessarily consecutive years, nor in the case of enlisted men in the same enlistment, a silver bar will be issued on which the three years of their qualifications will be indicated, and this will be attached to the badge between the pin and the cross. For each additional three years of qualification an additional bar will be issued and each in succession attached below the one previously supplied and above the cross.

(*c*) *Expert rifleman's badge.*—To the expert rifleman will be issued a silver badge. The soldier having qualified as an expert rifleman may wear the badge while he is entitled to draw the increased pay for that qualification. To those who have qualified as expert rifleman for three years, not necessarily consecutive years, nor in case of enlisted men in the same enlistment, a silver bar will be issued on which the three years of their qualifications will be indicated, and this will be attached to the badge below the pin. For each additional three years of qualification an additional bar will be issued and each in succession attached below the one previously supplied.

298. DUPLICATES.—These insignia will become the property of the persons to whom issued. If they are lost by the owner or in transmission to him, or if they become unsightly from long wear, they may be replaced without cost to the owner. But in all cases the official certificate of the company commander to the effect that he has investigated the circumstances of the loss or damage and finds that no negligence can be imputed to the soldier will be required as evidence upon which to make the new issues. In case of loss claim must be made within 60 days from date of loss. Duplicates, if desired for use on separate coats, will be sold to those entitled to wear the insignia.

299. How OBTAINED.—Immediately after the close of the practice season the company commander will report by letter to the commanding officer the names of men in his organization who have made a new or renewed qualification. With this letter the company commander will submit a requisition for the required number of badges and bars. This requisition will be disposed of as any other special ordnance requisition.

300. EXTRA COMPENSATION.—The soldier will receive such extra compensation for qualification in machine-gun firing as may be authorized by law and regulations.

Immediately after the completion of the qualification test, the names of men who qualify in the various grades for which extra compensation is awarded will be published in orders. These orders will be issued by commanders empowered by regulations to issue orders for the appointment and promotion of noncommissioned officers, or in exceptional cases by higher commanders, upon receipt of properly authenticated evidence as to qualification, and will show the date of actual qualification from which the soldier is entitled to additional pay.

PART VII.

COURSES FOR ORGANIZATIONS NOT IN THE REGULAR SERVICE.

301. The course of known-distance practice and combat training for the National Guard, Federal Reserves, Volunteers, and all other organized Federal forces not in the Regular service, will be, as far as practicable, the same as prescribed herein for the Regular Army.

Local conditions alone determine the manner and amount in which the complete courses must undergo modification. In modifying the courses, consideration is given to the state of training found in the organization, to the local facilities for range practice and maneuver, to the total time available for training and to the available ammunition allowance.

The standards for individual and organizational classification and for the issue of insignia will be the same as prescribed herein for the Regular service.

When local conditions are such as to prevent the holding of the prescribed tests for an organization or for the individual thereof, then there will be entered on the report the remark: "Test not possible under local conditions. Individuals (or 'organizations' or 'organization and individuals') not classified."

APPENDIX.

SYLLABUS OF COMBAT TRAINING.

Combat training may be divided into several classes.

First. Those exercises designed to train individuals or to give practice in teamwork. These exercises are classed as individual and collective, the collective exercises being for squads, platoons, companies, etc., and either including or excluding the transport.

Second. Those exercises classed as technical exercises and fire problems and designed to give practice in technique alone, or to give practice in the application of technique to the accomplishment of a given tactical mission.

Third. According to the instructional methods, such as map problems, terrain exercises, tactical walks, landscape practice, field firing exercises, etc.

The machine-gun organization has but one means of fighting—*fire power.*

The combat training of the organization has for its ultimate object the making of the organization as a whole, and of each of its subdivisions when called upon to act alone—a smoothly working team. The leaders of these teams should have their tactical judgment cultivated to such a point that they know almost intuitively when, where, and how to apply the fire power at their command.

The subordinate members of the teams must have the technical skill requisite to produce the maximum fire effect in accordance with the directions of their leaders.

In taking up any particular phase of training, knowledge of certain fundamental principles and skill along certain basic lines

must be assumed. In the case of combat training, therefore, it is assumed that the gun crews are trained in marksmanship as individuals and as teams, and that the individuals of the transportation and supply units of the organization have the requisite technical skill to perform their duties properly.

Combat training has for the leaders a double purpose.

In the first place, it serves as an indication of the leader's ability as an instructor, i. e., the discipline and technical skill displayed by his subordinates, or the absence of these qualities, may be taken as an index of the manner in which a leader has trained his subdivision. Or, perhaps, such indications may point to the fact that certain leaders have no aptitude as instructors; that certain subordinates have no aptitude for or have not been under instruction long enough to attain facility in their duties; that insufficient time is allotted for the training of certain subdivisions, e. g., squads, gun crews, platoons, transport personnel, etc.; or that the responsibility of certain leaders for the training of their units is such in name only, their function in this respect having been usurped by higher authority.

In the second place, combat training serves as a means for developing in leaders the functions of leadership. It teaches them, in their respective spheres, how to make use of the technical skill of their subordinates, how to coordinate the work of the various individuals and subdivisions, and how to apply this coordinated skill in compliance with the orders or directions received from higher authority.

To carry this instruction to a logical conclusion, not only should it be continued until the leader has attained the requisite facility in the performance of his duties in combat, but it should be such as will assure the maintenance of this facility.

Training is intensive until the required standard of proficiency is attained. Thereafter individuals or teams are given only such *practice* as will enable them to maintain that standard.

It is important to avoid training or practice to the point where teams or individuals become "stale."

That the maximum instructional value may accrue from combat training, it is necessary that any scheme of instruction be progressive. The subdivisions of any unit must be trained individually before an attempt is made to train them collectively. Thus the squad leader, the gunner, and the gunner's assistants are trained as individuals before their combined efforts are coordinated in the training of the gun squad. The platoon leader is trained as an individual and the gun squads as individual teams before combining them for platoon instruction. The same principle applies to the training of the higher units of organization.

Combat training then includes:

Individual instruction of—
- Gunners.
- Squad leaders.
- Section leaders.
- Guides.
- Platoon leaders.
- Company commanders.
- Agents of communication.
- Scouts.
- Range takers.
- Leaders of transportation and supply units.
- Leaders in the combined action of several companies.

Collective instruction of—
- Gun squads.
- Gun platoons.
- Transportation and supply units.
- Gun companies.
- Two or more gun companies acting together.

The training of these individuals and units includes the following:

GUNNERS.

1. *Target designation* to the point where the gunner can understand a terse designation of an obscure objective or aiming

point and then lay his piece according to the fire order of his squad leader. He should also be able to lay his piece properly on a target designated by a sketch or range card.

2. *Methods of fire* against various objectives as—

Straight and irregular lines.
Columns.
Moving targets.
Aircraft.
Artillery.
Machine guns.
Cavalry.
Trenches.
Trains.

This training continues to the point where the gunner can be depended upon to secure the maximum material effect when given a correct fire order. Also he should be able to secure this maximum effect in the absence of his leader at ranges under 600 yards.

3. *Adjustment of fire*, in so far as the gunner is concerned, ordinarily consists of firing strictly in accordance with the directions of his leader.

In cases where the gun is left temporarily in position with a single man as its crew, this man, in his capacity of gunner, must understand the principles and practice of ranging and the use of the battle sight. Such fire ordinarily is confined to the shorter ranges, and hence skill in the estimation of distances beyond 600 yards is of questionable value.

The gunner must understand adjustment to the extent of—

(*a*) Firing as he is told when acting under a leader.
(*b*) Skill in ranging at distances less than 600 yards.
(*c*) Skill in estimating distances less than 600 yards.
(*d*) The use of the battle sight.
(*e*) Sight setting of his gun for any given range.

4. *Fire discipline*, for the gunner, consists in the subordination of his will to that of his leader.

It involves an intelligent understanding of fire orders, and the technical skill involved in their execution. This includes the requisite marksmanship and mechanical skill with his gun.

It is then that *state of mind* which places his knowledge and skill at the disposal of his leader—to be used promptly and efficiently as the latter may dictate.

SQUAD LEADERS.

1. *Target designation* to the point where they can understand a terse description of an obscure objective or aiming point and can, in turn, describe their portion of the objective in terms a trained gunner can understand.

2. *Methods of fire* to the point where, in compliance with the fire order they have received, they are to translate their order into quick, clear, and accurate commands.

3. *Adjustment of fire*, for the squad leader, involves:

(*a*) Skill in estimating distances under 600 yards and in utilizing the combined estimates of the members of his squad at distances under 1,000 yards.

(*b*) Skill in the use of the range finder and mil scale.

(*c*) Such a knowledge of sights (tangent and telescopic) that he can give his gunner the correct sight setting.

(*d*) Use of the field glass in target finding and the observation of fire.

(*e*) Ranging.

(*f*) Sight setting of his gun for any given range.

4. *Fire control* to the point where they quickly grasp the spirit of a fire order and translate it promptly into commands to their squads. It includes also the habitual maintenance of fire discipline within the squad.

5. *Communication* to include proficiency in the—

(*a*) General service code.
(*b*) Semaphore code.
(*c*) Hand and arm signals.
(*d*) Whistle signals.
(*e*) Letter codes.

6. *Reconnaissance and sketching includes*—
   (*a*) Training as patrol leader.
   (*b*) Route sketches.
   (*c*) Position sketches.
   (*d*) Landscape sketches.

7. *Selection and occupation of positions* as applied to a single squad.

8. *Fortification and concealment* as applied to a single squad.

9. *Tactics*, fundamental principles as applied to single squad acting in platoon or alone.

10. *Ability to instruct* the members of the gun crew in all their duties.

11. *Maneuver* of the squad.

GUIDES.

1. *The duties of the squad leader* must be familiar to the guides.

2. *Fire control* to the point where they can enforce strict and prompt obedience to the orders of the platoon leader.

3. *Communication* between the platoon and the company commander is a duty of the guide when no agent is provided for that purpose.

4. *The duties of platoon leader* are not an immediate requirement of the guide. The events of an active campaign, however, may place the guide in command of a platoon at any moment, and hence he is considered as a platoon leader in the making. Advantage is taken of every opportunity to bring about his perfection in these duties.

PLATOON AND SECTION LEADERS.

1. *Tactics.*—A thorough knowledge of the fundamental principles for a platoon acting alone or as a part of the company. This includes the maneuver of the platoon.

2. *Fire control* to the point where they can grasp the spirit of the company commander's order and translate it quickly into complete and accurate commands to the platoon.

3. *Technique.*—Knowledge and practice to be complete and thorough.

4. *Theory of fire.*—Possess a thorough knowledge of the fundamental principles and the ability to apply these principles to concrete cases.

5. *Instruments.*—This includes a thorough knowledge and practical skill in the use of—

Field glasses.
Range finders.
Sights, all varieties.
Mil scale.
All devices used for fire control—
Prismatic compass.
Clinometer.
Level.

6. *Reconnaissance and sketching.*—Thorough knowledge and practical skill.

7. *Communication.*—Practical skill in—

General Service Code.
Semaphore Code.
Hand and Arm Signals.
Whistle Signals.
Letter Codes.

8. *Fortification and concealment.*—Types of cover for single guns and the combination of the emplacements of the guns of the platoon in conformity with the terrain and the tactical situation.

9. *Ability to instruct* squads and all the individuals in the platoon. The instruction of the guide in the duties of platoon leaders is the duty of the captain.

10. *The duties of company commander* pertain to platoon leaders to the extent that they are company commanders in

the making. Platoon leaders must be competent to fill the company commander's place in an emergency.

COMPANY COMMANDERS.

1. *Tactics.*—The company commander's knowledge of tactics must be thorough. It must include not only the handling of his organization in compliance with orders, but also the ability, when called upon, to offer sound advice to the regimental or other commander as to the tactical employment of the company.

This knowledge must be supplemented by sufficient practice to give the company commander unquestioned skill not only in the issuing of the regimental commander's order to the machine-gun company but also in executing that order. This includes the maneuver of the company.

2. *Technique.*—The company commander's technical *knowledge* should embrace the entire field of machine-gun work.

3. *Instruments.*—A practical working knowledge of all the instruments in use in the company is required of the company commander.

Skill is required only in the use of those instruments with which he exercises fire direction and control:

Field glass.
Prismatic compass.
Clinometer.
Mil scale.

4. *Theory of fire.*—The company commander's knowledge of the theory of fire should be profound.

5. *Fortification and concealment.*—The company commander's knowledge of this subject must be complete and thorough. It includes not only the details of construction and the expedients that may be employed for single guns but also embraces the use of guns in combination and the placing of his guns in conformity to a given tactical mission on a given terrain and in cooperation with the other arms.

His skill, in this phase of his work, must be developed to the point where he can view the situation through the eyes of a higher commander; decide promptly upon the type of cover to be used and the position or positions for each gun; and, then, without undue delay, embody this decision in a clear-cut order to his organization.

6. *Ability as an instructor.*—The company commander is primarily an instructor of platoons and the supervisor of all other instruction in the company. In addition to this, however, he must be able to teach any of his subordinate instructors how to train any of the individuals under their tutelage. Furthermore, he must train the platoon leaders to act as company commanders.

7. *The command of provisional machine-gun battalions* should be a matter of study on the part of the company commander and he should be able to issue tactical and fire orders to such a unit.

8. *Communication.*—

Letter codes.
Hand and arm signals.
Whistle signals.

COMPANY SPECIALISTS.

The specialists in combat are the—

Range takers.
Scouts and
Agents of communication.

The training of all should be along similar lines and would include—

1. *Scouting and patrolling.*—This includes not only the ordinary tactical reconnaissance demanded of a patrol, but also the selection of machine-gun positions and the selection and marking of the routes thereto. Marked skill in recognition and designation of targets is demanded of these men.

2. *Instruments.*—The use of the range finder, field glasses, and mil scale.

3. *Communication.*—

General Service Code.
Semaphore Code.
Hand and arm signals.
Whistle signals.
Letter codes.
Duties of messenger.

Also skill in the use of any other means of communication that may be supplied as part of the equipment of the organization, such as lanterns, heliographs, buzzers, field telephones, etc.

4. *Sketching.*—Route, position, and landscape sketches and range cards.

LEADERS IN SECOND ECHELON.

In the second echelon of a machine-gun company are found the following subdivisions:

(*a*) A unit which, for purposes of identification, is termed the "Support" and whose function it is to replace casualties in the firing line and to keep that firing line supplied with ammunition.

(*b*) A unit in charge of the transportation pertaining to the firing line.

(*c*) A unit in charge of the transportation pertaining to the support and whose function is to seek a new supply of ammunition when necessary.

(*d*) The supply section or field train.

The leader of the field train will rarely if ever have to arrive at a *tactical* decision upon his own initiative. Usually these wagons will march with the field train of the regiment and under the orders of a quartermaster. Hence this unit need not be considered in connection with combat training.

The leader of the support should be trained as a platoon leader.

The leaders of the two transportation units, noted above under (b) and (c), should be trained in—

1. *Maneuver* of their subdivisions in compliance with tactical orders.

2. *Reconnaissance* of routes and the following of routes previously reconnoitered and marked. This includes map reading.

3. *Use of cover* in connection with the selection of routes and positions.

4. *Communication*—

General service and semaphore codes.
Hand and arm signals.
Whistle signals.
Letter codes.

LEADERS OF PROVISIONAL BATTALIONS.

This is included in the training of the company commander.

In all of this individual training it should be borne in mind that not only should the endeavors of instructors be directed toward perfecting the individuals in the duties pertaining to the positions they are actually filling, but also toward fitting each individual to take up the duties of higher grades.

In this connection it is deemed important that there be at least *three understudies* for each position on the firing line. The manner in which this is accomplished is of little moment.

The following outline shows one system that meets this requirement:

Position.	Understudies.
Captain	Lieutenants.
Platoon leaders	First sergeant.
	Guides.
	Section leaders.
Guides	Section leaders.
	3 squad leaders.

Position.	Understudies.
Section leaders	9 squad leaders.
	9 gunners.
Squad leaders	3 gunners.
	12 loaders.
	9 prives.
Gunners	24 privates.
Privates of gun crew	All reservists except those whose adaptability is more to duties pertaining to supply, administration, or transportation. It should be the endeavor to discharge all such reservists with the qualification of "marksman" or better.
Company specialists	All officers and noncommissioned officers must be competent to act as range takers. The understudies for the scouts and agents of communication are taken from the company at large and the selection naturally falls upon individuals who have the necessary aptitude for such work. A proper proportion of reservists also should be trained to these duties.

SQUADS.

1. *Drill.*—This includes the mechanism of the service of the piece, the mechanism of close-order movements, both with and without the transportation, and the mechanism of extended order. This to include the squad acting alone and in platoon.

2. *Maneuver in the zone of hostile fire.*—This training to be in the nature of concrete problems. A movement is required over a given piece of ground and under certain stated tactical conditions. The troops (Infantry or Cavalry), with which the

machine-gun squad is acting, *must* be assumed or outlined if not actually represented, as must also the other elements of the machine-gun company in all problems in which the squad is assumed to be in platoon.

Squad problems not only include those in which the squad leader is acting alone, wherein the squad leader must make his own decision as to formation, movement, and objective, but they also include problems in which the squad is a part of a platoon acting under the definite orders of the platoon leader.

In order to insure proficiency in the use and understanding of signals, these problems will frequently include the condition that the voice is inadequate for purposes of command. Not only must the squad be led by signals, but also the squad leader will receive his orders in a similar manner.

The use of natural cover is an important feature of this training, as are also the adoption of formations that will conceal the identity of the machine-gun unit, and the maintenance of communication with the other elements of the command with which the machine-gun squad is acting.

3. *Reconnaissance and selection of positions.*—While a squad leader usually is not called upon to perform these duties when his squad is acting as part of a company, they become an important part of his duties when the squad is detached.

This training is designed to give practice to the squad leader in using his personnel to assist him in the reconnaissance, in selecting positions in which the balance of the squad is to remain concealed while the reconnaissance is being carried out, and in controlling the squad by signals after the firing position has been selected.

The actual selection of the firing position depends upon the individual training of the squad leader.

4. *Occupation of positions.*—The occupation of positions is the same no matter whether the selection of the position is made by the squad leader or by the platoon leader.

In general, it may be said that there are two ways in which a position is occupied. One is the case in which an emergency

has arisen which demands that the guns be placed in position and open fire with the least practicable delay. The other is the case in which the situation permits greater deliberation.

The training should include both these cases.

Special attention is given to the use of cover.

5. *Fortification and concealment.*—This includes types of cover to be used alone or in infantry trenches; hasty intrenchment and deliberate preparation of permanent field works and the evolution of the latter from the former. For the squad leader it includes also the cultivation of his judgment as to the type of cover to be constructed in the time available.

6. *Target recognition.*—This includes not only the actual search for animate targets, but also the decision as to what portion of the field of fire is to be covered by the gun.

7. *Registration of the field of fire.*—This includes the use of the personnel in the preparation of range cards both for attack and for defense.

8. *Collection and computation of firing data.*—This training includes the use of the personnel, when time permits, to collect the data as to ranges, atmospheric conditions, etc. Otherwise the squad leader makes his own estimates as to these values.

When the squad is acting alone the computation of the data is a function of the squad leader. Based upon the figures determined by his squad, or upon his own estimates, he decides upon what elevation and deflection is to be used; whether or not an aiming point is required and, if so, what that point shall be; and the amount of searching to be used, if any. Upon the correct decision in these cases depends the *accuracy* of the fire, i. e., the number of hits that will be obtained per shots fired.

He decides upon the kind of fire, rate of fire, method of distribution, and upon the amount of fire per unit area or unit front of the target. Assuming an accurate fire, then upon the correctness of these decisions depends the material or moral *efficacy* of the fire, i. e., the number of casualties produced in the ranks of the enemy in a unit of time, or the degree to which it aids in the attainment of fire superiority.

It remains for these decisions to be communicated to the squad in the form of a fire order.

9. *Target designation* is a subject which calls, essentially, for individual training. In this connection, however, it is considered important that every member of the gun crew know the location and extent of the target. Thus any of them could take the place of the gunner or squad leader at any time without leading to confusion.

10. *Fire orders.*—
11. *Adjustment of fire*—
12. *Fire for effect.*—

This training is directed toward the perfection of the teamwork between squad leader and gunner. Their understudies also are given this practice.

13. *Tactics.*—The training included under the 12 subheads enumerated above is entirely technical in its character. It still remains to give the squad practice in applying their knowledge and skill in technique, marksmanship, and mechanism in the solution of tactical problems.

Such problems are called "fire problems" and they are designed to give practice in all the probable tactical phases of combat such as outposts, advance and rear guards, attack, defense, delaying actions, withdrawals, attack and defense of convoys, etc.

GUN PLATOONS.

The technical and tactical training of the gun platoon is, with obvious modifications, along lines similar to those outlined above for the squad.

TRANSPORTATION AND SUPPLY UNITS.

These units are trained in—

Maneuver,
Supply (ammunition and replacement of casualties),
Reconnaissance, and
Communication

in connection with assumed tactical conditions under which their firing line is acting.

THE COMPANY.

The essentials of company combat training are a well-traine leader and well-trained subdivisions. With this as a foundation it remains to perfect that nicety of teamwork whereby, under the properly framed orders of their leader, the subdivisions of the company act promptly, efficiently, and in concert for the accomplishment of a common end.

With obvious modifications, the tactical and technical details of this training is along lines similar to those outlined for the squad.

PROVISIONAL BATTALIONS.

The training of the battalion follows the general scheme heretofore outlined for the companies.

The scope of combat training.—Taking indidvidual and collective training together, it is found that the following is the aggregate of the subjects embraced in a complete course in combat training:

RELATED SUBJECTS:

- *Drill*—
  - Duties of personnel.
  - Fire orders.
- *Maneuver in the zone of hostile fire*—
  - Deployment—
    - Into echelons.
    - Of the firing line.
    - The march into action.
    - Selection and occupation of positions.
    - Supply—
      - Ammunition.
      - Reinforcements.
- *Communication*—
  - Methods employed to maintain—
    - With superior headquarters.
    - With subordinate units.
    - With neighboring troops.
    - With troops which the guns are supporting.

RELATED SUBJECTS—Continued.
Communication—Continued.
System of—
Whistle signals.
Hand and arm signals.
Letter codes.
General service code.
Semaphore code.
Messengers.
Reconnaissance—
Tactical.
Topographical—
Routes.
Positions.
Landscapes.
Fortification and concealment—
Tactical.
Technical.
Training of leaders as instructors.
Tactics.
THEORY OF FIRE.
USE OF INSTRUMENTS:
Range finder.
Field glass.
Sights—
Tangent.
Telescopic.
Prismatic compass.
Clinometer.
Level or quadrant for elevations.
Mil scale.
TECHNIQUE OF FIRE:
Recognition and designation of targets.
Determination of ranges.
Adjustment of fire.
Fire for effect.

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