FM 17–12

WAR DEPARTMENT

ARMORED FORCE FIELD MANUAL

&

TANK GUNNERY

April 22, 1943

FM 17

ARMORED FORCE FIELD MANUAL

TANK GUNNERY

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FM 17–12, Armored Force Field Manual, Tank Gunnery, is published for the information and guidance of all concerned.

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

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ARMORED FORCE FIELD MANUAL

TANK GUNNERY

SECTION I

GENERAL

■ 1. PURPOSE AND SCOPE.—*a*. This manual provides the unit commander and the gunnery officer with a step-by-step outline of tank gunnery training and the necessary explanation and references.

b. The discussion of training methods is limited to tank guns. Necessary information pertaining to assault guns, antitank guns, and mortars is found in the references in appendix II. The plan of training can be adapted to those weapons.

■ 2. DUTIES OF GUNNERY OFFICERS.—*a*. The duties of regimental and battalion gunnery officers are to—

(1) Supervise and coordinate the training of antitank gun, assault gun, mortar, and tank crews in gunnery.

(2) Insure that proper methods of sight adjustment are employed.

(3) Insure that weapons receive proper care and maintenance.

(4) Supervise the training of officers and tank commanders in the preparation and conduct of fire, and in the coordination of fires within the tank battalion.

(5) Supervise all firing.

b. These provisions in no way relieve the unit commander of his responsibility for training.

■ 3. IMPORTANCE OF THE MACHINE GUN.—The ultimate objective of the armored division is vital rear installations. These are attacked less with cannon than with the crushing power of the tank and with its machine guns (figs. 1 and 2). The

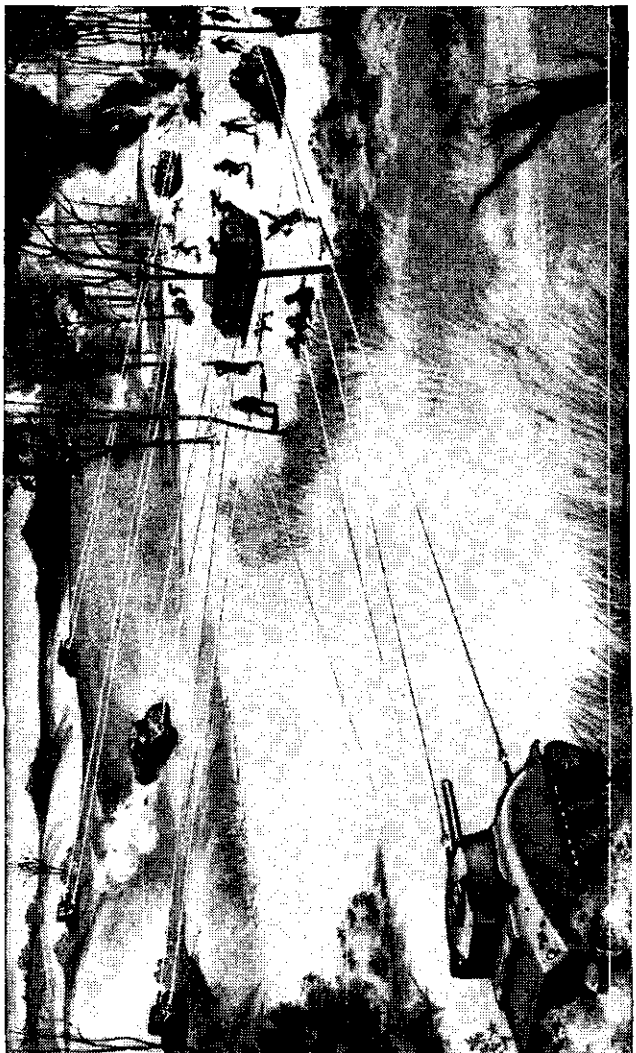


FIGURE 1.—Importance of machine guns—destroying enemy command post.

FIGURE 2.—Importance of machine guns—destroying enemy trains.

main purpose of the tank cannon is to permit the tank to overcome enemy resistance and reach the vital rear areas. While this manual concerns itself with the gunnery of tank cannon, commanders must constantly emphasize the great importance of the tank machine guns. Tank crews must be expert in their use. The gyro-stabilizer is particularly useful for improving the accuracy of the coaxial machine gun when the tank is moving.

■ 4. IMPORTANCE OF FIRE CONTROL.—Battle experience has shown that when tank crews are permitted to fire without close control, the firing quickly gets out of hand and precious ammunition is thrown away wildly. The company commander must control expenditure of ammunition as closely as possible. The platoon commander can, and must, exercise even stricter control; except in the closest and most unexpected engagements, he should personally supervise the firing of the whole platoon and keep it in hand. The tank commander must select every target personally, and strictly control the firing of every round.

SECTION II

OUTLINE OF GUNNERY TRAINING

■ 5. GENERAL.—*a.* Assign a permanent crew to each combat vehicle and train it as a team.

b. Make every member of the crew a trained gunner and able to perform the duties of every other member.

c. Accustom the crew to combat conditions by making training realistic. Use recordings of "battle sounds."

d. Fully stow the vehicles, including individual equipment, during all training periods. If all of the stowage items are not available, construct substitutes.

e. Use blackboard drill. It is extremely useful in explaining all types of laying.

f. Keep abreast of new Training Films, Film Strips, and other training aids and use them. (See FM 21–7.)

g. The park is a poor place to train crews because of noise, dust, traffic, and other interferences. As soon as the state of training permits, take the platoon to an appropriate lo-

cation for training. This also affords considerable practic in selection of ground.

■ 6. STEPS IN GUNNERY TRAINING.—Gunnery training is divided into seventeen steps. Insist on a satisfactory standard for each step. Give simple tests to determine proficiency in each step.

a. Basic training period (first fifteen weeks).—(1) Operation and handling of equipment.

(2) Care and maintenance.

(3) Crew drill.

(4) Simulated firing, direct laying.

(5) Range and speed estimation.

(6) Ammunition.

(7) Subcaliber firing, direct laying.

(8) Proficiency test.

(9) Basic firing, direct laying.

b. Unit training period (second twelve weeks).—(1) Platoon drill, direct laying.

(2) Platoon firing, direct laying.

(3) Drill, indirect laying, single tank.

(4) Firing, indirect laying, single tank.

(5) Drill, indirect laying, two or more tanks.

(6) Firing, indirect laying, two or more tanks.

(7) Combat firing of small units.

(8) Combat firing of large units.

■ 7. FIRST STEP—OPERATION AND HANDLING OF EQUIPMENT.—Do not permit the men to operate any item of the tank equipment until they have been given thorough instruction in its operation and handling. Carelessness is the outstanding cause of broken and damaged equipment. Therefore, constantly check whether or not proper methods of operating equipment are being used. Make the men develop a sense of responsibility for their weapons and equipment. Penalize damage caused by carelessness.

■ 8. SECOND STEP—CARE AND MAINTENANCE OF WEAPONS.—*a. The continued functioning of weapons in battle is dependent on their receiving proper care and maintenance.* Make the crews realize that their lives depend on it. Know-

ing that their guns and sights have been properly maintained will give the men confidence in them.

b. To emphasize care and maintenance of weapons, the platoon commander makes a daily inspection of armament. He checks the general appearance and spot checks one or two parts for mechanical functioning, inspecting different parts each day. In addition to the daily lubrication and cleaning as prescribed in appropriate manuals, armament is completely lubricated every 2 weeks or oftener, depending on the amount of service. Following this lubrication, a detailed inspection is made.

■ 9. THIRD STEP—CREW DRILL.—When the men have learned how to operate and maintain their weapons, start crew drill. Its purpose is to weld the crew into a smooth-functioning team. Follow carefully the prescribed drill and commands for the type of tank used. Maintain strict discipline and attention to business. (See sec. III for detailed procedure.)

■ 10. FOURTH STEP—SIMULATED FIRING.—As soon as the men have become reasonably proficient in preparing for action, begin simulated firing. Following the initial instruction in step 3, training in the third and fourth steps is concurrent. For example, order the crew to prepare for action. Run through three or four firing problems, then order the tank out of action, or abandon tank, etc. (See sec. III for detailed procedure.)

■ 11. FIFTH STEP—RANGE AND SPEED ESTIMATION.—*a.* Start range and speed estimation at the same time as the fourth step in order to provide practical application during simulated firing. Change the place of instruction frequently and select a new type of terrain each time. Practice in range estimation must begin afresh each time the unit moves to a new region, as every change of climate, vegetation, and terrain gives a different appearance to familiar distances. Have some practice in range and speed estimation every day wherever located.

b. Concentrate on the ranges corresponding to the graduations in the sight reticle. Place tanks, half-tracks, antitank

guns, and other targets at these ranges; view them with the naked eye, and through sights, field glasses, and periscopes.

c. Practice under conditions illustrating the following:

(1) Targets appear nearer and the range is underestimated when—

(*a*) The object is in bright light.

(*b*) The color of the object contrasts sharply with the color of the background.

(*c*) Looking over water, snow, or a uniform surface such as a wheat field or in the desert.

(*d*) Looking down a straight road or along a railroad track.

(*e*) Looking downward from a height.

(*f*) Looking over a depression, most of which is hidden.

(2) Targets seem more distant and range is overestimated when—

(*a*) Looking over a depression, most of which is visible.

(*b*) There is poor light or fog, or in the rain.

(*c*) Only a small part of the target is visible.

(*d*) Looking from low ground toward higher ground.

d. Train the men to estimate speeds as *slow* (below 10 mph), *medium* (10 to 20 mph), and *fast* (above 20 mph).

e. The following are good practical exercises; use them frequently:

(1) Assemble the class at an observation point and have tanks and other vehicles driven across the line of observation at various ranges (fig. 3). Announce at what speed (slow, medium, or fast) the vehicles are being driven and the leads necessary at those ranges and speeds.

(2) Have the vehicles appear at various ranges, moving at prearranged speeds. Require the class to estimate the speed, range, and lead.

■ 12. SIXTH STEP—AMMUNITION.—Instruct the men in the characteristics, operation, and effect of the different types of ammunition carried. During simulated firing require the tank commanders to select the proper ammunition to be fired (see par. 33). Give thorough instruction in care and handling of ammunition before doing any actual firing. Insist that ammunition be inspected for defects before being stowed in the vehicles.

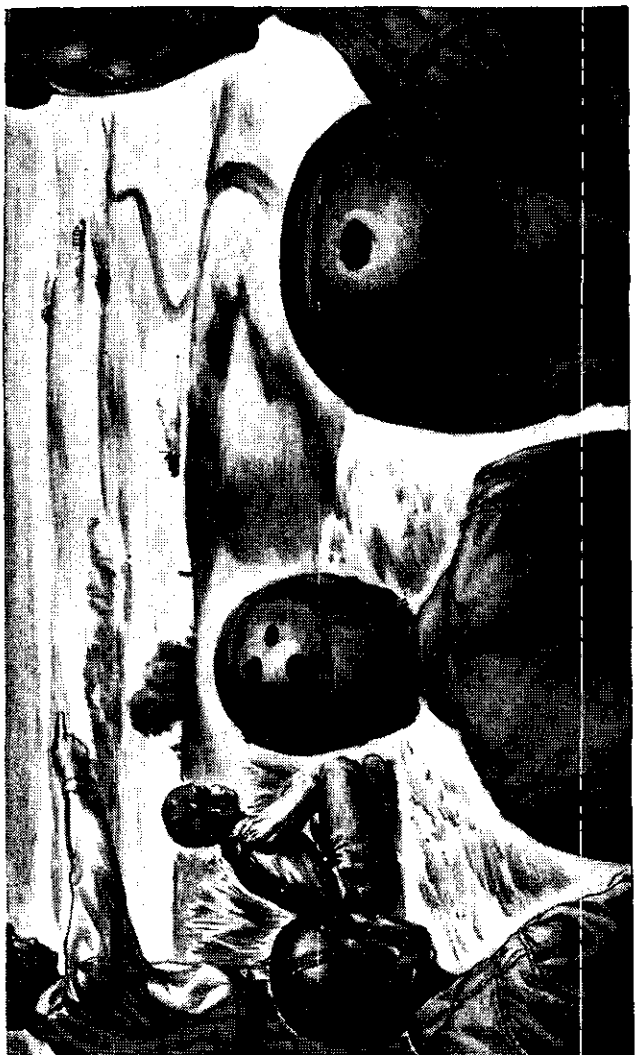


FIGURE 3.—Instruction in range, speed, and lead estimation.

■ 13. SEVENTH STEP—SUBCALIBER FIRING.—*a.* Begin with firing on the 1,000-inch range. Coordinate this training carefully with the instruction governing firing on 1,000-inch ranges as prescribed in FM 23–50 in order to avoid repetition of preliminary instruction. Courses prescribed to be fired as subcaliber training for tank guns are found in AR 775–10. The "parallel hilly" type of moving target course is especially valuable for instruction in tracking. Provide these courses abundantly.

b. Next proceed to caliber .30 subcaliber firing on the field ranges. Reserve tracer ammunition for this firing. Fire at ranges up to 800 yards. Do not permit the gunner to know the ranges to targets in advance. The best targets are actual tanks, both stationary in proper tactical positions and moving.

■ 14. EIGHTH STEP—PROFICIENCY TEST.—The gunner's proficiency test in appendix I will be completed prior to firing service ammunition. Permit no one to fire service ammunition until he has passed the proficiency test.

■ 15. NINTH STEP—BASIC FIRING.—During this period, give each crew member who passed the proficiency test an opportunity to adjust on at least one fixed and one moving target, using service ammunition. Require absolute accuracy. Limit number of rounds, but make each round count.

■ 16. TENTH STEP—PLATOON DRILL, DIRECT LAYING.—*a.* The platoon commander controls and coordinates the fire of his platoon. (See pars. 4 and 50.) His tanks should fight as a platoon and not as individual tanks. Often he concentrates their fire on a single target. This is especially true at ranges over 1,000 yards.

b. Platoon drill combines crew drill and simulated firing by the platoon as a whole. This develops the ability to coordinate and concentrate the fire of the platoon. Practice concentrating the fire of the section and platoon.

■ 17. ELEVENTH STEP—PLATOON FIRING, DIRECT LAYING.—This provides practical application of a platoon drill training. This firing may be done with the coaxial machine gun on combat ranges (not on 1,000-inch ranges), using tracer

ammunition. Concentrate the fire of several tanks on the target.

■ 18. TWELFTH STEP—DRILL, INDIRECT LAYING, SINGLE TANK.—Limit this step to indirect laying with a single tank (see par. 58*a*).

■ 19. THIRTEENTH STEP—FIRING, INDIRECT LAYING, SINGLE TANK.—Devote this firing to indirect laying with a single tank (par. 58*a*). Inject some direct laying problems to make the men realize the ease of shifting from direct to indirect laying.

■ 20. FOURTEENTH STEP—DRILL, INDIRECT LAYING, TWO OR MORE TANKS.—The objective is to concentrate the fire of two or more tanks on a target by indirect laying (par. 58*b*). Practice laying the entire platoon or section from the observation point.

■ 21. FIFTEENTH STEP—FIRING, INDIRECT LAYING, TWO OR MORE TANKS.—This firing is with service ammunition. Lay the tanks from the observation point (pars. 63, 64, and 65). Adjust fire by indirect methods (pars. 69 and 70). Finally lay the tanks using a staked line (par. 66).

■ 22. SIXTEENTH STEP—COMBAT FIRING OF SMALL UNITS.—*a*. Follow the courses in FM 17–15.

b. Tank versus tank firing with M4 medium or M5 light tanks, using caliber .30 ammunition, is appropriate for this step. It is excellent training. Have the tanks completely buttoned up. Remove vulnerable accessories such as lights and sirens. The machine guns are not loaded until the tanks are buttoned up. Exercise strict control over the firing by radio. Use single shots with the coaxial machine guns to simulate the fire of tank cannon.

■ 23. SEVENTEENTH STEP—COMBAT FIRING OF LARGE UNITS.—This is combined training with tanks, mortars, assault guns, antitank guns, and artillery. Use this firing to show the capabilities of supporting weapons. Success in battle demands the coordination of the fire of all weapons. The objective of this training is to develop that coordination.

■ 24. SUMMARY.—*a.* Coordinate gunnery training with the progress of training as a whole. Conduct the first nine steps, to include basic firing, during the basic training period (first fifteen weeks). The remaining steps are appropriate for the unit training period (second twelve weeks).

b. Conduct crew drill and simulated firing constantly. Review previous steps frequently. Have firing as often as ammunition allowances permit. Even though in an advanced state of training, always work on improving the marksmanship of each crew. After maneuvers, changes of station, and like periods, go back and review all steps of gunnery, emphasizing fundamentals. Practice range and speed estimation constantly—it is the key to accurate firing.

c. The most important subject, because it is most easily neglected, is care and maintenance of weapons. This must receive constant thought and supervision, not only by gunnery officers, but by all commanders.

d. Officers' training follows the same phases as enlisted men, but they should receive instruction in indirect laying and discuss its possible uses relatively early in troop school courses.

e. Insist on extreme accuracy at all times.

SECTION III

CREW DRILL AND SIMULATED FIRING

■ 25. GENERAL.—*a.* While performing crew drill and simulated firing, crews are at attention.

b. Stress accuracy. Develop it by constant checks and insistence on minute details. Inaccuracies permitted during training will multiply in battle. Make the men realize that "very close" will *not* do.

c. Develop speed without reducing accuracy. Speed is always subordinate to accuracy. Do not attempt it before the state of training warrants. Obtain speed by constant practice and elimination of lost motion. It cannot be acquired by hurrying nor by nagging.

d. Plan each training period in advance. Unless handled intelligently, crew drill and simulated firing are a deadly

bore. After reasonable proficiency has been obtained, use stop watch competitions to maintain interest. Crew drill and simulated firing defeat their purpose if periods are too long. During basic training, 2 hours is an absolute maximum; after that, 1 hour. To maintain proficiency, hold drills every day, even though drill periods are short.

e. In all firing and simulated firing exercises, have the tank commander designate the target and give the proper fire orders, and have each member of the crew perform all his duties as prescribed in the service of the piece. Use the interphone system for commands, except when training in secondary means of intra-crew communication.

f. To obtain accurate fire, sights must be in adjustment. Adjust sights before each period of simulated firing. This gets the crew in the habit of checking their sights whenever the opportunity arises.

■ 26. SEQUENCE OF INSTRUCTION.—*a. Crew drill.*—(1) First, show the crew members their posts and the correct method of mounting and dismounting from the vehicles.

(2) Second, instruct them in stowing the vehicles. Appropriate stowage lists show the stowage of all items carried in tanks. Work out a definite procedure. After this instruction, have vehicles stowed including individual equipment for *all* training periods.

(3) Third, train the crew in prepare for action, out of action, fight on foot, abandon tank, secure equipment.

b. Simulated firing.—(1) Begin with instruction in individual duties. Then, the duties of teams within the crew (commander and driver, commander and gunner, gunner and loader), and finally, the group composing a single crew. Do not overlook the importance of the driver in gunnery.

(2) Combine simulated firing with driving instruction and simple maneuvers. As targets, use tanks and other vehicles at ranges known to the instructor, but not to the crews. Start with known distance targets in order to obtain accuracy. Get away from them soon. "Known distance firing" is unrealistic.

(3) Begin simulated firing at moving targets by having the men set off leads with respect to stationary targets in

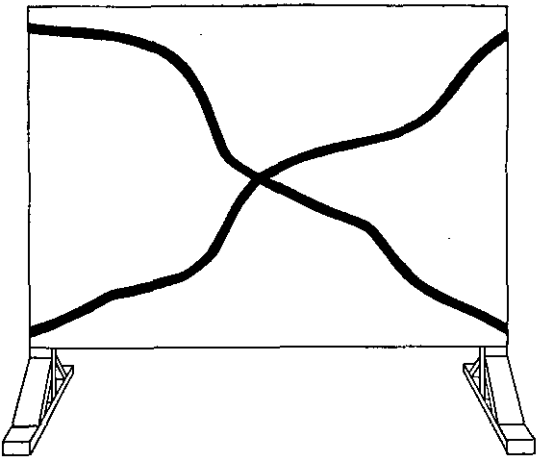


FIGURE 4.—"Snake board" made from scrap lumber and target cloth. (Lines are painted about 2 inches wide.)

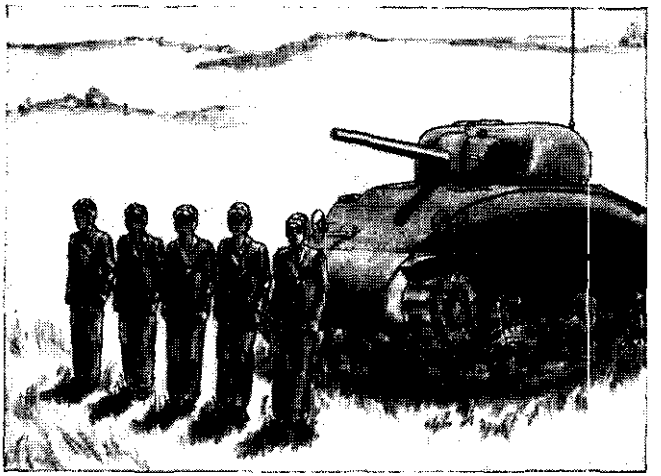
order to insure that they understand just what a lead is, how it is established, and the direction in which a target is led. The "snake board" (fig. 4) is an excellent device for training in coordinating elevating and traversing. Lay the gun at the top of one of the lines and follow it to the other side of the board.

(4) Firing while moving is employed only at point blank ranges (up to 600 yards). Permit simulated moving fire at these ranges only.

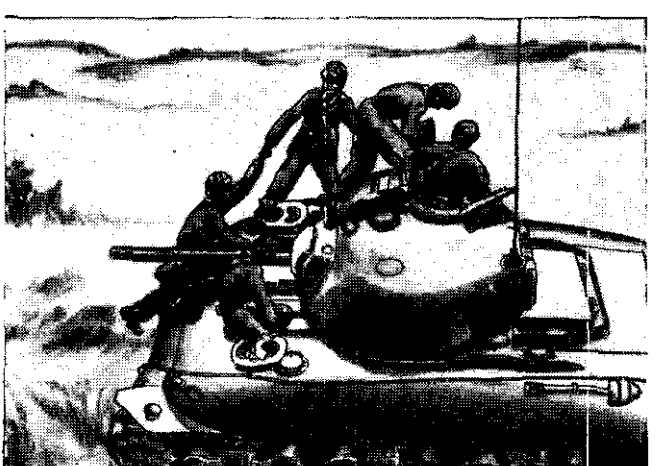
(5) Training should include simulated firing at stationary and moving targets, and firing while moving.

■ 27. PEP DRILL.—*a.* Crew drill and simulated firing becomes dull and lax unless the crews are alerted by unexpected periods of pep drill. Pep drill is a series of precision movements executed at high speed and terminating at the position of attention, either mounted or dismounted. For example, the crews being dismounted, the platoon commander may command, IN FRONT OF YOUR TANKS, FALL IN; MOUNT; DISMOUNT; ON THE LEFT OF YOUR TANKS, FALL IN; FORWARD,

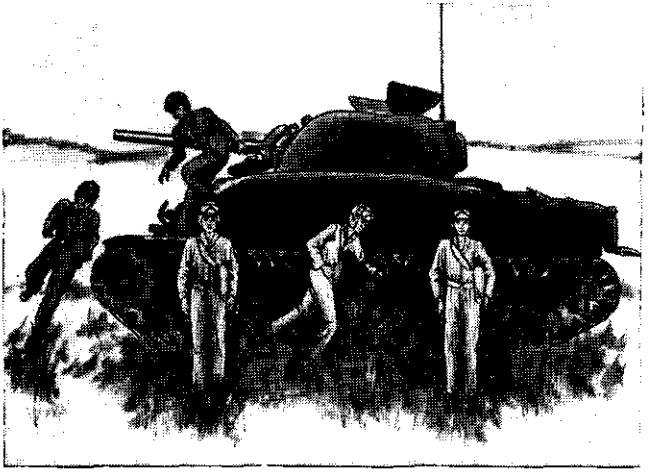
MARCH; BY THE RIGHT FLANK, MARCH; BY THE LEFT FLANK, MARCH; MOUNT. (See fig. 5.)



① FALL IN.



② MOUNT.



③ ON THE LEFT OF YOUR TANKS, FALL IN.

④ MOUNT.

FIGURE 5.—Pep drill.

Pep drill freshens the interest of the crew. When executed with speed and precision, it aids physical development and coordination.

b. Change the posts of all crew members frequently.

■ 28. INDIVIDUALS.—*a. Platoon commander.*—The platoon commander strives to secure teamwork and mutual understanding. Carelessness and lack of enthusiasm, as reflected in his manner and commands, will invariably be reflected in his men.

b. Tank commander.—The platoon commander deals with the crew as a whole through its commander instead of with the individuals thereof. During crew drill, the tank commander watches every movement of his men. He must not interfere with his men, especially those making settings, except when his assistance is obviously required or an error is suspected. He never permits observed errors to go uncorrected.

c. Gunner.—Accuracy is the principal quality to develop in a gunner. Look for and eliminate the following common faults:

(1) Failure to lay precisely on the target.

(2) Failure to verify the laying for direction and elevation for each round after the breech is closed.

(3) In indirect laying, failure to lay always on the same part of the aiming point or aiming stake.

(4) Failure to take up the lost motion in the traversing and elevating gears when firing at a stationary target.

(5) Failure to bring pointers into exact alinement with index marks when using graduated handwheel or azimuth indicator.

(6) Failure to level bubbles exactly.

d. Loader (assistant gunner).—The loader wipes off the ammunition with a rag or waste before loading it. Teach him to insert the round smoothly into the breech recess and push the round home with sufficient impetus to seat it in the chamber. Timid loading, caused by fear of getting fingers caught in the breechblock, results in the breech not closing, and may cause a jammed round. A fuzed round must not strike against any portion of the matériel. Hold a round

to be loaded well out of the path of recoil. Loaders always wear gloves to handle the hot cases ejected from the gun.

■ 29. ORDERS.—*a.* Enunciate orders clearly. Much time is lost when a crew member has to ask for a repetition of part of the data.

b. Develop the voice of command. This is a businesslike, confident tone of voice which conveys assurance to the crew. A screaming voice marks the amateur, as do overloud commands intended for a single crew.

c. When a crew member asks that an order be repeated, a source of error may arise. The repeated command is likely to be taken as a new command by the other men. Possible errors are eliminated by prefacing the repeated command by the phrase, "The command was ————."

d. When the crews have gained proficiency in the service of the piece, the tempo of command *during drill periods* should be slightly faster than can be performed by the *slowest* gunner, thus tending to speed up the slowest crew to the remainder of the platoon.

■ 30. NUMBERS.—Announce numbers as illustrated below:

10—One zero
25—Two five
300—Three hundred
455—Four five five
1400—One four hundred
6000—Six thousand
3925—Three nine two five
4050—Four zero five zero

■ 31. UNIFORMITY OF SETTINGS AND LAYINGS.—Whenever possible, the final motion in laying the gun is made in the direction in which it is hardest to elevate and traverse. Often it is necessary to traverse or elevate beyond the target and then come back onto it. This takes up the lost motion (slack, backlash) in the elevating and traversing gears.

■ 32. CHECKS OF SETTINGS AND LAYINGS.—Check settings and layings frequently. Checking is most valuable when unexpected. Instead of giving the command to fire, the platoon commander commands: CEASE FIRING. After the com-

mand to cease firing, the laying of the gun is not changed. When "firing" at a moving target, have the target stop at the same instant CEASE FIRING is given.

SECTION IV

AMMUNITION

■ 33. SELECTION OF WEAPON AND AMMUNITION.—*a. General.*—Conserve the 75-mm and 37-mm ammunition. Do not use the tank gun against a target when the machine guns can handle it. When necessary, do not hesitate to use both machine guns and tank against a target. (See FM 17–30.)

b. Machine gun.—Use machine guns against exposed personnel targets, as infantry, crews of weapons who are not protected by armor or emplacements, and personnel in unarmored vehicles.

c. Canister (37-mm).—Canister is very effective against exposed personnel at ranges less than 200 yards. It is useless at greater ranges.

d. Armor-piercing ammunition.—Use armor-piercing or combination armor-piercing high-explosive ammunition against medium and heavy tanks. Do not use it at ranges over 500 yards for 37-mm and over 2,000 yards for 75-mm.

e. High-explosive shell.—Use high-explosive shell with delay fuze against unarmored and lightly armored vehicles, antitank guns, and artillery pieces. If HE shell is lacking, use combination AP-HE against these targets. At ranges over 2,000 yards, use 75-mm HE shell against tanks; a hit on the track will disable the tank; fragmentation from near misses harasses the crew.

■ 34. CANISTER.—Canister consists of a metal case filled with lead balls. Upon emerging from the muzzle, the pressure of the balls causes the case to disintegrate, and the balls continue their flight in a pattern similar to that of a shotgun. It is well adapted to fire against personnel.

■ 35. ARMOR-PIERCING AMMUNITION.—Armour-piercing ammunition used with tank gun is of three types:

a. Armor-piercing (AP).—This ammunition is a solid projectile with a tracer element. 75-mm shot, AP, M72, and

37-mm shot, AP, M74, are in this class. The projectile is painted black.

b. Armor-piercing, capped (APC).—This ammunition is a solid projectile with an armor-piercing cap, a windshield, and a tracer element. The cap is of alloy steel, hardened to insure a very hard face with a tough and relatively soft core in contact with the projectile. 75-mm projectile, APC, M61, and 37-mm shot, APC, M51, are of this type. The projectile is painted black.

c. Armor-piercing, high explosive (AP-HE).—This ammunition is an armor-piercing projectile containing an explosive charge and a base-detonating fuze. This is the most effective armor-piercing ammunition because the projectile bursts after penetration. 75-mm projectile, APC, M61 with BD (base-detonating) fuze M66 contains a high explosive charge, and is painted yellow.

■ 36. HIGH-EXPLOSIVE SHELL.—*a. 75-mm shell, HE, M48.*—The PD fuze M48 used with 75-mm shell, HE, M48, is a combination superquick or delay point-detonating fuze. The shell comes set at "superquick." It may be set to burst .05

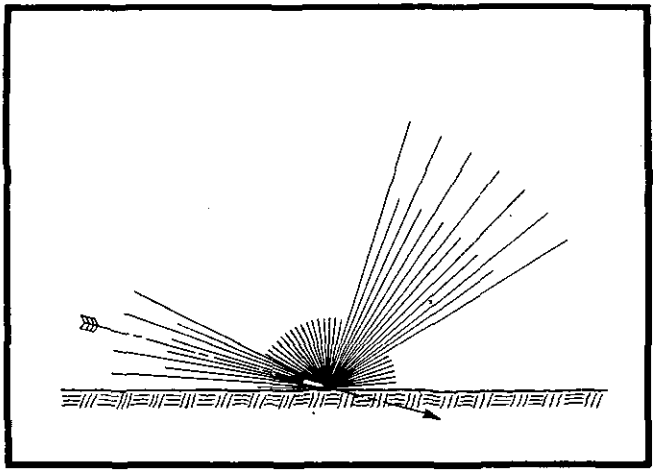


FIGURE 6.—Impact burst.

second after impact by turning the slotted key on the side of the fuze so that the slot points to the word DELAY stamped on the body of the fuze. Always set the fuze at DELAY before stowing the ammunition.

(1) *Superquick action.*—The superquick action is so sensitive that the shell detonates immediately on impact. Therefore, when striking armor plate, a gun shield, or a building, the shell will burst before it can penetrate. The superquick burst is effective against personnel in the open (fig. 6).

(2) *Delay action.*—The .05-second delay action results in the shell penetrating before bursting when it strikes light

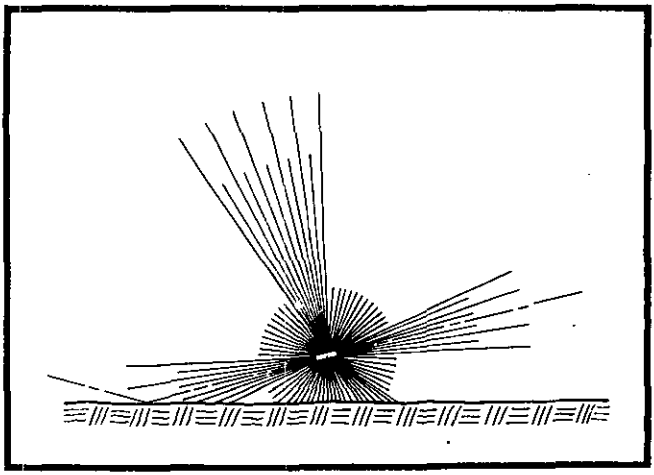


FIGURE 7.—Ricochet burst.

armor, gun shields, or buildings. If the shell strikes the ground, it ricochets, travels 20 to 25 yards beyond the point of impact, and then bursts about 10 feet in the air (fig. 7). Because of the downspray from the burst in the air, a ricochet burst has devastating effect on personnel without overhead cover. It is much more effective than the impact burst obtained from a superquick fuze setting. When the fuze is set at DELAY a hit will destroy or damage the target and

kill or injure nearby personnel; a "short" will give a ricochet which is deadly against personnel (figs. 8 and 9). Thus with the delay fuze, dispersion is in your favor as long as the range error is not excessive.

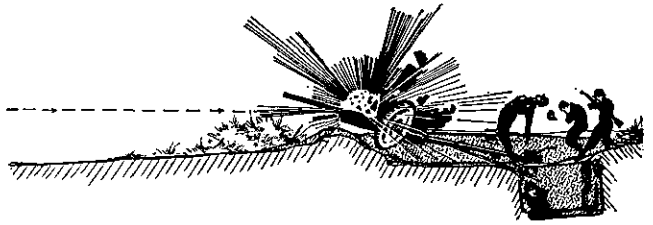


FIGURE 8.—Firing 75-mm shell, HE. With the fuze set at DELAY, a hit will destroy the antitank gun and kill or injure nearby personnel.

b. 37-mm shell, HE, M63.—The M58 fuze used with 37-mm shell, HE, M63, is a base-detonating fuze and does not have a selective setting. This shell bursts on impact.

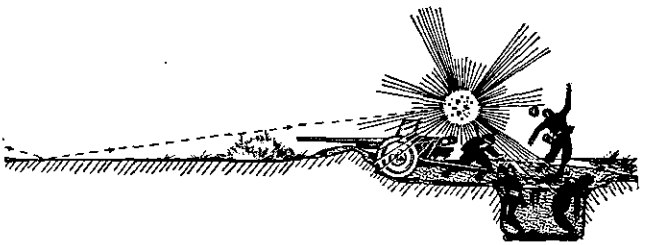


FIGURE 9.—Firing 75-mm shell, HE. With the fuze set at DELAY, a short bursts on ricochet. Ricochet bursts are deadly against personnel.

■ 37. SMOKE SHELL.—Smoke shell for tank guns is under development. The smoke shell now issued for the 81-mm mortar is very effective for screening. (See FM 17–27.)

SECTION V

ADJUSTMENT OF SIGHTS

■ 38. IMPORTANCE OF SIGHTS.—A cannon, to hit its target, must be pointed in the exact direction of the target and given exactly the right range elevation. The crudest method of correcting all errors at once is to lay the gun as well as possible, fire, and watch where the projectile hits. Then try to lay the sight so as to correct the observed error, and fire again. A target which sits still long enough can be hit by this method, but since the target is likely to be shooting back, and cannon ammunition is precious, life may well depend on previous precautions to make the sighting as accurate as possible. Careful adjustment of sights before going into action will greatly reduce the number of rounds wasted and the time consumed before getting a hit.

■ 39. CARE OF SIGHTS.—*a*. Most breakage of sights is caused by careless handling. Handle all sights carefully.

b. Clean the exterior surfaces of the lenses whenever necessary, but use only a soft, dry, clean cloth or lens paper.

c. In handling sights, never touch the glass surface with the hand.

d. Oil the deflection and elevation adjusting mechanisms frequently with light oil to insure their free movement.

e. The head assemblies of periscopic sights are sealed at the factory. Do not disassemble them.

f. Do not remove the telescope from the periscope.

■ 40. PRINCIPLES OF SIGHT ADJUSTMENT.—*a*. To adjust the sight for *direction*, the vertical center line (axis) of the sight and the vertical center (axis) of the gun itself must be adjusted exactly parallel to each other. To adjust the sight for *range*, the zero range marking of the sight must be adjusted exactly parallel to the horizontal center (axis) of the gun.

b. If a rear boresight is not available, remove the firing pin and guide assembly and sight through the firing pin well. If a front boresight is not provided, stretch thin black thread across the muzzle (fig. 10).

c. Extra sights must be separately adjusted. After adjusting each periscopic sight, make a record of the readings on the adjusting knobs.

■ 41. ADJUSTMENT OF SIGHTS USING DISTANT AIMING POINT.—The most accurate method of adjusting sights is by using an aiming point at least 1,000 yards from the tank. If possible,

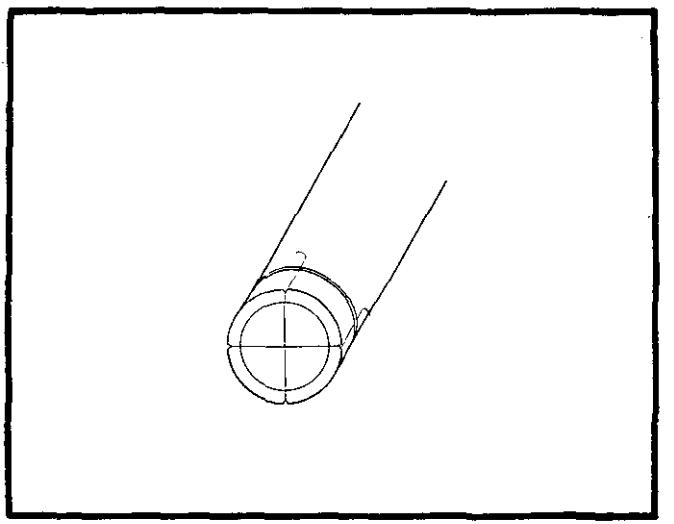


FIGURE 10.—If a front boresight is not provided, *stretch thread* across the muzzle.

select an aiming point which is sharply defined and has straight edges, such as a building, smoke stack, telegraph pole, or lone tree. Make use of horizontal and vertical edges of the aiming point to assure that the sight and gun are laid on precisely the same point (fig. 11).

■ 42. ADJUSTMENT OF SIGHTS USING TESTING TARGET.—Testing targets provide a *means* of checking sight adjustment when distant aiming points are not available. Due to constructional tolerances, tanks will vary slightly, but testing targets will give a reasonably accurate sight adjustment *until sights*

can be checked on a distant aiming point. Place the tank on level ground. Place the testing target from 80 to 120 feet in front of the tank, at approximately the same height from the ground as the gun. Get the correct height by leveling the gun and then moving the target into line with the axis of the bore. The testing target must be perpendicular to the bore of the gun. Rotate the testing target in a vertical

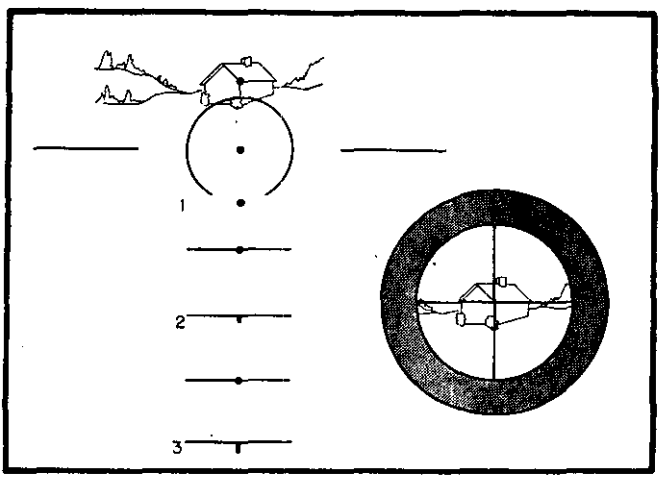


FIGURE 11.—When adjusting sights, use horizontal and vertical edges to insure that the gun and sight are laid on precisely the same point.

plane until the dots on the vertical line of that part of the testing target marked "sights" coincide with the vertical line of the telescope (fig. 12). Then boresight the gun on the appropriate mark for the center of the gun bore. Next adjust the sight to put the zero range line and vertical line of the sight on the mark for the sight.

■ 43. ADJUSTMENT OF SIGHTS FOR 1,000-INCH FIRING.—If offset targets are not used for 1,000-inch firing, the abnormally short range and the miniature target make it necessary to converge the line of sighting and the center line (axis) of the gun at the target. Explain the reason

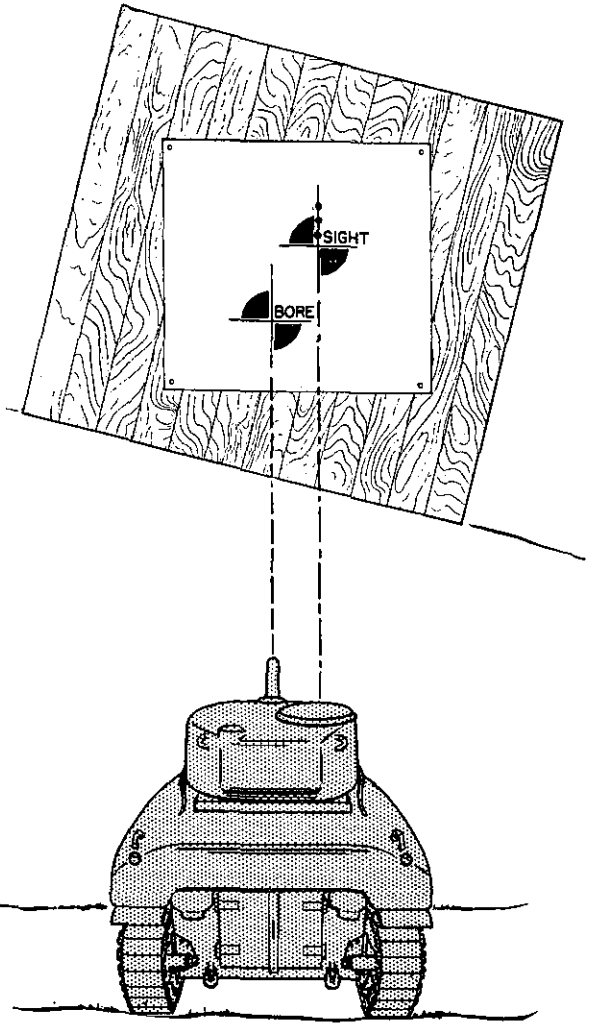


FIGURE 12.—Rotate the testing target in a vertical plane (see par. 42.)

for this artificial distortion of the line of sighting. Point out on a blackboard that for a life-size target at a proper range for service ammunition, the line of sighting and center line of the gun should always be parallel. Show how the distortion used on the 1,000-inch range causes increasingly great errors if the gun is aimed at more distant targets.

■ 44. CHECKING ADJUSTMENT OF LINKAGE ARM.—The linkage arm connecting the periscopic sight to the elevating mechanism may get out of adjustment. To check the adjustment of the linkage arm, proceed as follows: first, adjust the sight on a distant aiming point, then place the tank on a steep slope in order to check the sight when the gun is near its maximum elevation; sight on a distant aiming point as before. Next, place the tank in a suitable position to check the gun near its maximum depression; sight on a distant aiming point again. If the sights were properly adjusted with the tank level, yet do not check accurately when the gun is elevated or depressed, the fault lies in the sight linkage. The linkage is adjusted only by ordnance maintenance personnel.

■ 45. DESCRIPTION OF SIGHTS AND PERISCOPES.—The sights and periscopes now used in tanks are described below.

a. Standard equipment.—(1) *Telescope M38 with periscope M4.*—This is the present standard periscopic sight for 75-mm M3 in medium tanks of the M4 series. The telescope M38 has the present standard armored force reticle (fig. 13), and is graduated for 75-mm gun M3 firing projectile, APC, M61. The sight diagram in figure 43 shows the settings used with other types of ammunition. This sight has 1.5 power magnification.

(2) *Telescope M40 with periscope M4.*—This is the present standard periscopic sight for the 37-mm gun M6 in light tanks M3A1, M3A2, M3A3, and the M5 series. It has the present standard armored force reticle (fig. 13) and is graduated for 37-mm gun M6 firing shot, APC, M51. The settings to be used with other types of ammunition are shown in figure 15. This sight has 1.5 power magnification.

(3) *Telescopes M54 and M55.*—Telescope M54 is the present standard telescopic sight for the 37-mm gun M6 in light tanks

M3A3 and M5A1. Telescope M55 is the present standard telescopic sight for the 75-mm gun M3 in medium tanks of the M4 series. These sights are straight telescopes with 3-power magnification. They have the present standard armored force reticle (fig. 13). Telescope M54 is graduated for 37-mm gun M6 firing shot, APC, M51. Telescope M55 is graduated for 75-mm gun M3 firing projectile, APC, M61. The sight diagrams in figures 14 and 15 show the settings to be used with other types of ammunition.

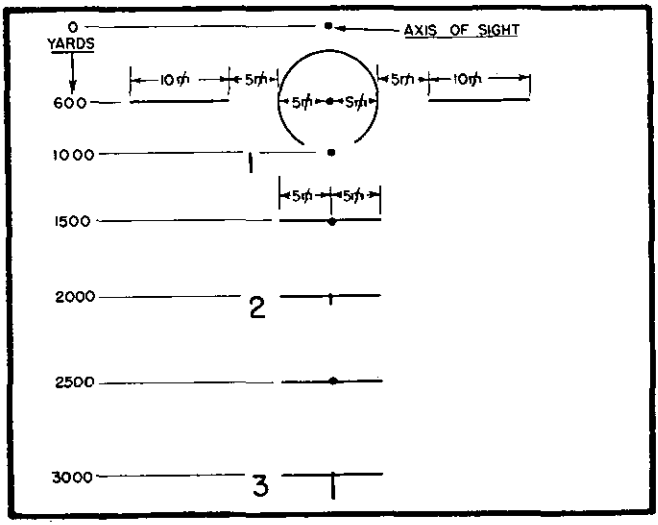


FIGURE 13.—Standard armored force reticle used with telescopes M19A1, M32, M38, M40, M54, and M55.

(4) *Periscope M6.*—This is similar to the periscope M4, except that it does not contain a telescope. It is purely an indirect vision device and is not used as a gun sight. It is the present standard indirect vision device for light tanks M3A1, M3A2, M3A3, the M5 series, and medium tanks of the M4 series.

b. Substitute standard equipment.—(1) *Telescope M19 or M19A1 with periscope M3.*—This sight is used with the 37-mm

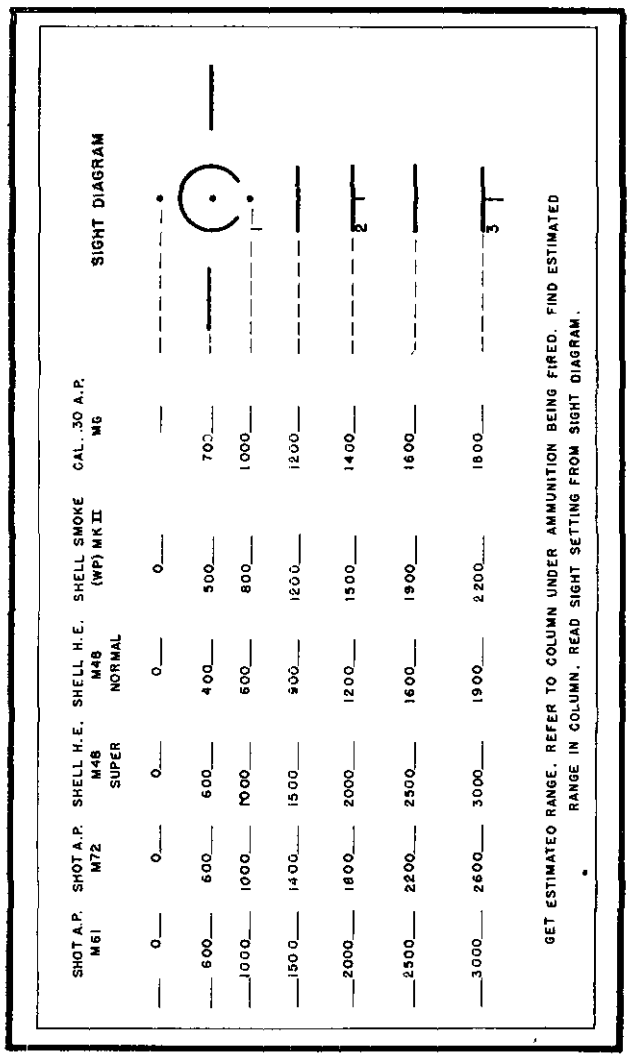


FIGURE 14.—Sight diagram 75-mm gun M3, with telescopes M32, M38, M55.

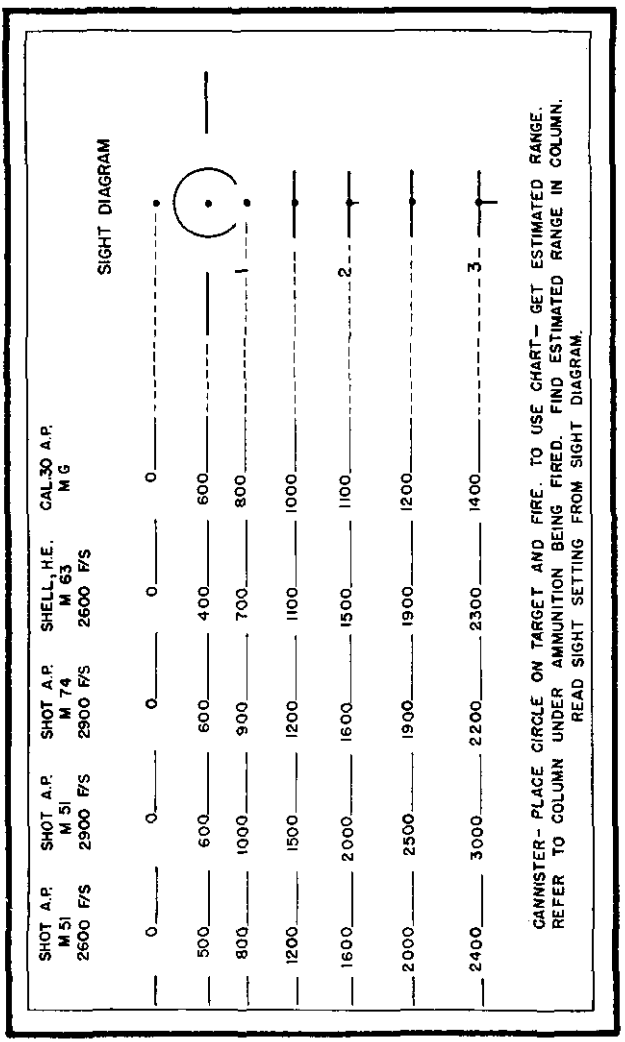


FIGURE 15.—Sight diagram 37-mm gun M6, with telescopes M19A1, M40, M54.

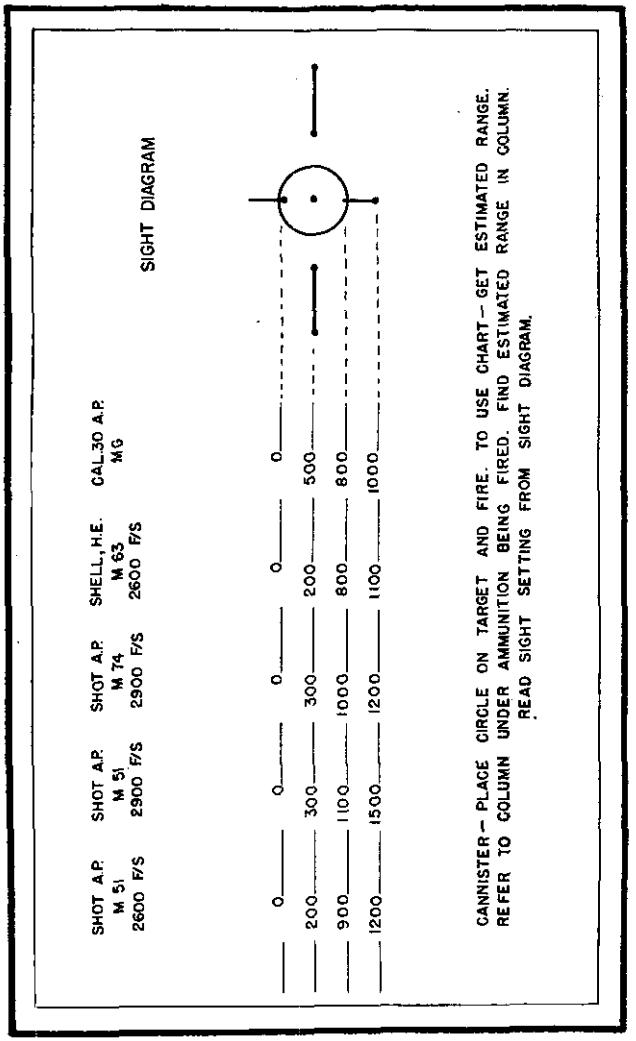


FIGURE 16.—Reticle pattern, telescope M19.

gun M6 in light tanks M3A1, M3A2, M3A3, and M5 series. It is substitute standard equipment and will be used only until telescope M40 with periscope M4 (par. *a*(2) above) is available. Neither telescope M19 nor M19A1 has any magnification. The reticle of telescope M19 is shown in figure 16. It is not graduated for any specific ammunition. The sight diagram in figure 17 shows the settings used with various types of ammunition. Telescope M19A1 has the standard armored force reticle (fig. 13), and is graduated for 37-mm gun M6 firing shot, APC, M51. The sight diagram in figure 15 shows the settings used with other types of ammunition.

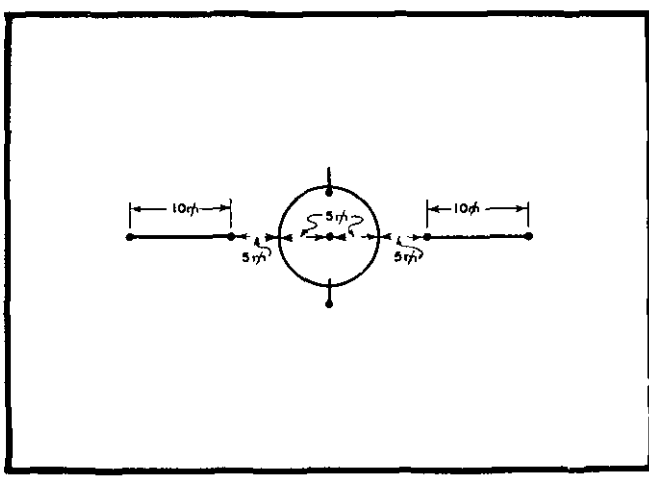


FIGURE 17.—Sight diagram 37-mm gun M6, with telescope M19.

(2) *Telescope M32 with periscope M3.*—This sight is used with the 75-mm gun M3 in medium tanks of the M4 series. The periscope M3 is substitute standard and will be used only until the periscope M4 (par. *a*(1) above) is available. The telescope M32 has the standard armored force reticle (fig. 13) and is graduated for 75-mm gun M3 firing projectile, APC, M61. The sight diagram in figure 14 shows the graduations to be used with other types of ammunition. This sight has no magnification.

(3) *Periscope M5.*—This is similar to periscope M3, except that it does not contain a telescope. It is purely an indirect vision device and is not used as a gun sight. It is installed in light tanks M3A1, M3A2, M3A3, the M5 series, and medium tanks of the M4 series. It is substitute standard equipment to be used only until the periscope M6 is available.

c. Miscellaneous combinations.—The following combinations of telescopes and periscopes may be found in a few tanks:

(1) Telescope M19 or M19A1 with periscope M4.
(2) Telescope M32 with periscope M4.
(3) Telescope M38 with periscope M3.
(4) Telescope M40 with periscope M4.

SECTION VI

DIRECT LAYING

■ 46. GENERAL.—*a.* Direct laying occurs whenever the gunner sights his gun directly on the target.

b. The tank does its most deadly firing from a "hull down" position in which the mass of the tank is concealed from the enemy and the tank commander observes from the turret and assists the gunner to adjust fire (fig. 18). Frequently he can conceal the entire tank by standing on top of it to adjust the fire.

c. Study appropriate sections of FM 17-30 in conjunction with this section.

■ 47. EFFECT OF RANGE.—The range to the target will have a profound effect on the manner in which the adjustment is conducted.

a. At ranges under 1,000 yards, the gunner often is able to put the strike on the largest by means of the reticle. At longer ranges, a hit is best obtained by bracketing.

b. At short ranges, targets are attacked by individual tanks. At long ranges, the fire power of the platoon often will be most effective when the commander concentrates the fire of several tanks on a single target.

FIGURE 18.—The tank does its most deadly firing from a "hull down" position with the tank commander observing from the turret, or even standing on top of the tank to observe.

c. At ranges below 600 yards, *expert* crews can obtain hits when firing from moving tanks. At longer ranges, it is always necessary to stop before firing.

■ 48. DETERMINATION OF RANGE.—*a. Estimation by eye.*—This is the usual means of determining range.

b. By firing a coaxial machine gun.—Fire the machine gun with an estimated range and roll the strike into the target. The point on the reticle at which the strike appears is the range setting for the machine gun. Refer to the sight diagram and determine the corresponding range setting for the tank gun.

c. Improvement of initial range.—If the first round fired from the 75-mm gun misses the target, the observed error of this round will give a new range for the second round, and so on until hits are scored. (See par. 54.) At short ranges, a good gunner should hit with his first round.

d. By firing a tank gun.—Where a platoon is concentrating its fire on a target, the platoon commander may determine the range with one gun and then announce it to the rest of the platoon.

■ 49. FIRE ORDERS.—*a.* Before giving fire orders, alert the gunner. Say "Gunner" (turret gunner) or "Bog" (bow gunner). Give the orders in the following sequence:

Sequence	*Example*
(1) Target description	ANTITANK
(2) Type of ammunition to fire	HE
(3) Direction to traverse turret	TRAVERSE RIGHT
(4) Stopping traverse	STEADY—ON
(5) Range	ONE, TWO HUNDRED
(6) Lead	ONE ZERO
(7) Command to open fire	FIRE

b. Use the following words to describe the usual targets:

(1) Any tank	TANK
(2) Armored car	ARMORED CAR
(3) Any unarmored vehicle	TRUCK
(4) Men	DOUGHS
(5) Machine gun	MACHINE GUN

Sequence	*Example*
(6) Any antitank gun or artillery piece	ANTITANK

c. Describe the ammunition as follows:

(1) Armor-piercing	SHOT
(2) High-explosive	HE
(3) Smoke	SMOKE
(4) Canister	CANISTER
(5) Caliber .30 machine gun	CALIBER .30

■ 50. COORDINATION AND CONCENTRATION OF FIRE.—The fire power of the platoon is most effective when it is coordinated by the platoon commander (see par. 4). He indicates when each section or tank is to open fire or cease fire. He prevents waste of ammunition on unimportant targets or enemy tanks which are already knocked out. He designates targets for elements of his platoon by—

a. Dismounting tank commanders and pointing out targets (tanks usually in defiladed positions).

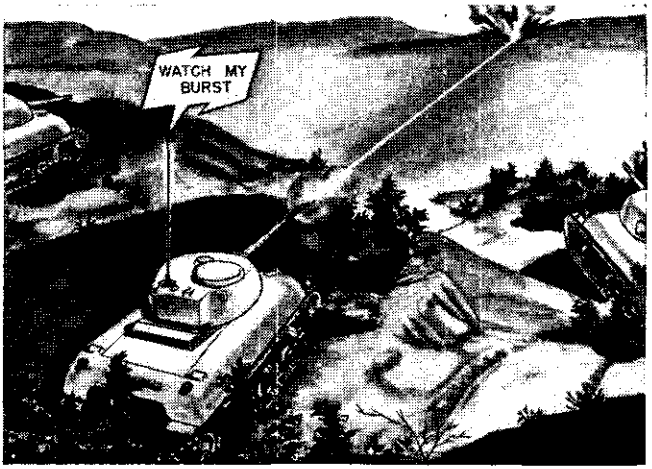
b. Indicating position of target with HE shell, or tracer, announcing "Watch my burst (trace)." (See fig. 19.)

c. Designating targets with reference to prominent objects.

■ 51. LAYING FOR DEFLECTION.—*a. Stationary targets.*—Lay the vertical center of the reticle on the center of the target (fig. 20).

b. *Moving targets.*—(1) For the first round, lay the vertical center of the reticle on the target, using the range setting announced by the tank commander. Track for a short distance to get the "feel" of the target. Then swing out ahead with the lead announced by the tank commander. Establish the lead from the center of the target. When the correct lead is established, fire. *Do not stop traversing when firing.* Do not lay the gun ahead of the target and wait for it. Continue to track the target and adjust lead and range in accordance with observation of the strike or the commands of the tank commander. Fire whenever the correct lead is established.

(2) The unit of measure for leads is the mil (par. 59). For practical purposes, the lead in mils for a given target speed and direction is the same at all normal tank ranges



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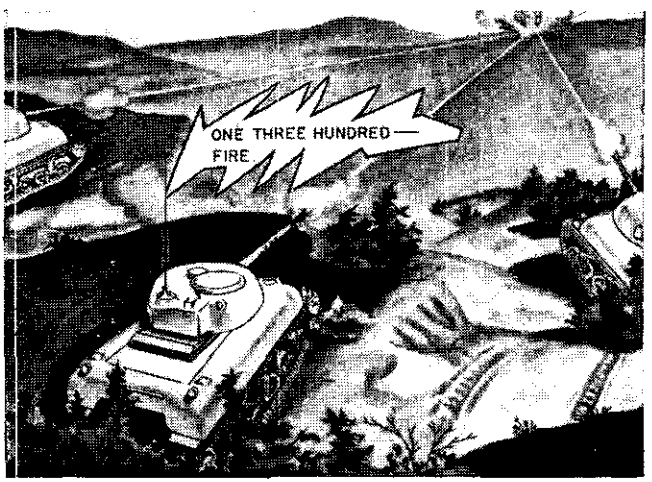

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FIGURE 19.—Platoon commander concentrating the fire of his platoon.

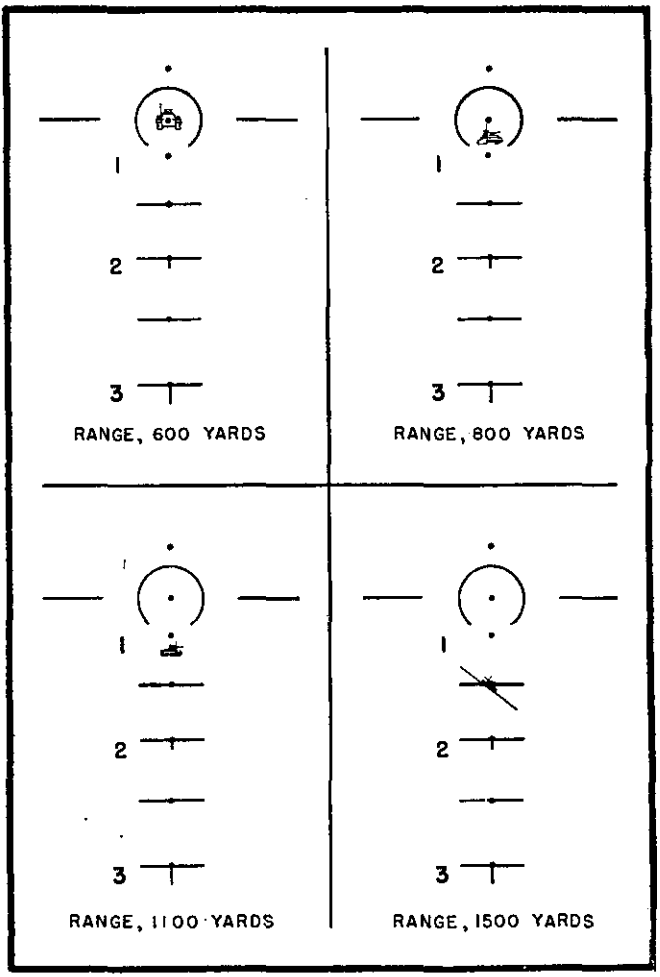


FIGURE 20.—Stationary targets—laying on the center of the target.

(fig. 21). The length of the target does not affect the lead. The present standard reticle is so designed that the gunner can set the lead with reasonable accuracy (fig. 13). Skill is acquired only by practice, and not merely by learning a lead table. Use lead tables primarily for the first round. Initial leads are usually announced in multiples of 5 mils.

c. Power traverse.—The present power traversing mechanisms are not sufficiently delicate to make small adjustments in deflection. Use the hand traverse in the final stages of laying the gun.

37-mm gun, M6, firing shot, APC, M51 (2900 f/s m/v)

Speed of target	Target traveling perpendicular to line of fire	Target traveling at 45° to line of fire
Slow (0 to 10 mph)	5	3
Medium (10 to 20 mph)	10	7
Fast (20 to 30 mph)	15	10

75-mm gun, M3, firing projectile APC, M61 (2030 f/s m/v)

Speed of target	Target traveling perpendicular to line of fire	Target traveling at 45° to line of fire
Slow (0 to 10 mph)	5	3
Medium (10 to 20 mph)	10	7
Fast (20 to 30 mph)	20	15

FIGURE 21.—Leads in mils.

■ 52. LAYING FOR RANGE.—*a. Stationary targets.*—(1) *General.*—The gun is laid for a given range when the graduation for that range is laid on the target.

(2) *Armor-piercing ammunition.*—When firing armor-piercing ammunition or combination armor-piercing high explosive, lay on the center of the target (fig. 20). The desired trajectory is one which, if the projectile were to continue

through the target, would strike the ground *beyond* the target (fig. 22).

(3) *High-explosive shell.*—When firing HE shell, set the fuze at DELAY and lay on the center of the target. The desired trajectory is the same as with armor-piercing ammunition.

(4) *Smoke shell.*—When firing smoke for screening purposes, the burst must be placed so that the wind carries the smoke between the enemy and the tank. Observe the drift of smoke from the first burst and then correct your laying. In a brisk breeze the smoke must be fired some distance from the point to be screened. In a high wind smoke is ineffective. (See FM 17–27 and 17–30.)

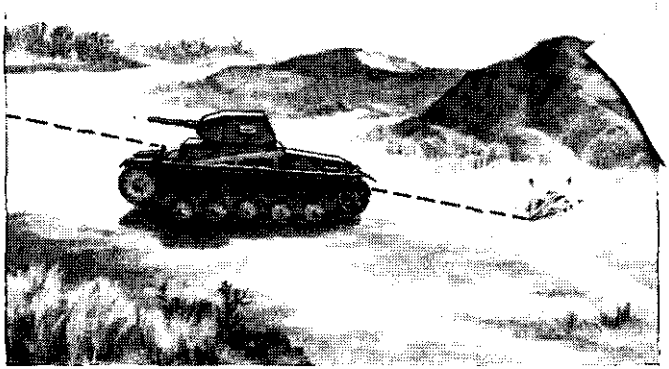


FIGURE 22.—Desired trajectory—laying on center of target.

b. Moving targets.—Lay on the center of the target. If the target is moving toward you, use a range setting 100 yards less than the estimated range. If the target is moving away from you, use a range setting 100 yards greater than the estimated range.

■ 53. OBSERVING FIRE.—*a. Armor-piercing ammunition.*—Sensing fire with armor-piercing ammunition is based on observing the path of the tracer and not on the strike of the projectile. Only where impact is on dry, open terrain can the strike of AP projectile on the ground be sensed.

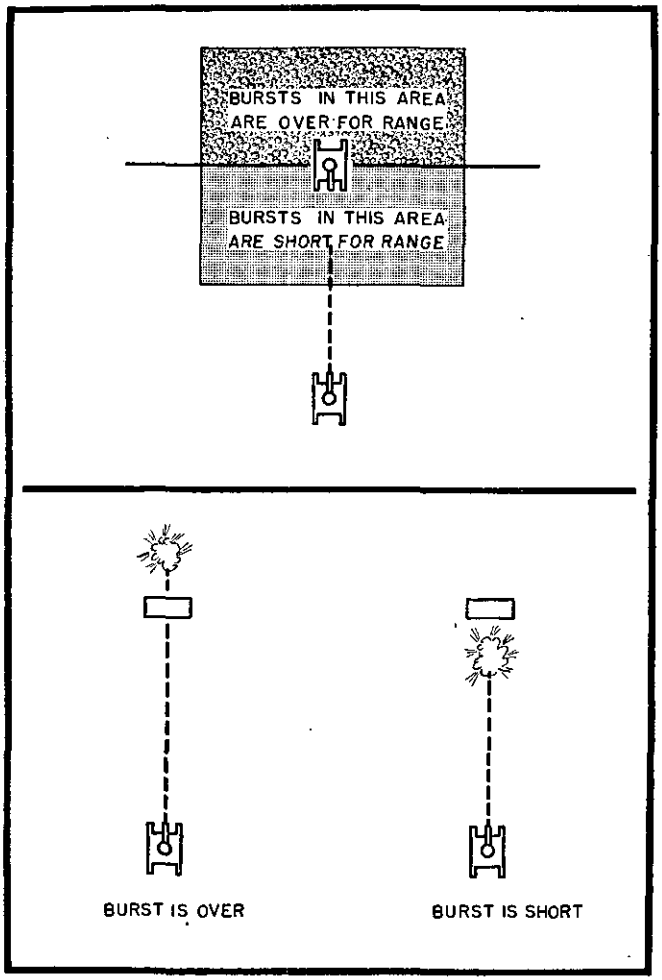


FIGURE 23.—Overs and shorts.

b. Shell.—Sensing a round of smoke or HE shell is comparatively easy due to the burst.

c. Sensings.—(1) An observer bases his sensings on what he sees while the burst is before his eyes, and not on his recollections.

(2) If the target is clearly defined against the burst, the range is "over." If the target is obscured by the burst, the range is "short" (fig. 23).

(3) If the target is obscured and then immediately silhouetted by smoke or dust, or vice versa, the range is nearly that of the target.

(4) Make sensings promptly except when you must wait in order to see whether the smoke drifts "short" or "over."

(5) When sensing on the drifting smoke from a burst of HE shell, consider whether the direction of the wind is such as to give a false or true sensing.

■ 54. ADJUSTING FIRE.—*a. General.*—The tank commander always observes all firing from the turret hatch if enemy fire permits. Frequently the gunner will be unable to observe consecutive rounds; that is, he will see one round clearly but the next will be obscured by dust or smoke. Therefore, the tank commander gives the gunner proper orders for the range and deflection change on every round. If the gunner can observe clearly, he makes his own corrections; if he fails to observe the round clearly, he applies the corrections indicated by the tank commander. It is evident that close teamwork and understanding are necessary between the tank commander and gunner. For example, it happens very frequently that the tank commander, watching the tracer, can see that an AP projectile has missed the target by a very few inches. The command LEFT A HAIR will put the gunner exactly on his target with a minimum of conversation.

b. Automatic correction method.—When visibility is good, the following system is effective at ranges up to 1,000 yards. As soon as the gun is fired, bring the target to the same point in the sight as it occupied when the gun was fired. Watch for the base of the burst or strike of the first round. When you see the base of the burst or strike of the projectile,

traverse and elevate so that the target now occupies the same place in the sight as the base of the burst or strike did (fig. 24). Fire the next round with this laying. This procedure applies an automatic correction for both deflection and range. To be effective, the *base* of the burst or strike must be placed on the target. The command to use this method is: PUT BURST ON TARGET.

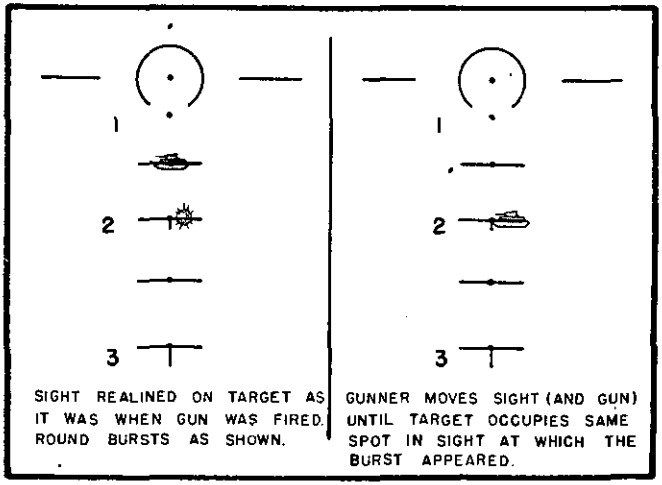


FIGURE 24.—Automatic correction method.

c. *Bracketing.*—(1) At ranges over 1,000 yards (or even less, when visibility is poor) bracket the target. An "over" and a "short" in range give a bracket (fig. 25). When you obtain a bracket, split it and continue to split it until you get effective fire. Inexperienced men usually underestimate the distance of a round from the target and make too small range changes (called "creeping").. Creeping wastes much time and ammunition. Avoid it by making bold range changes. At ranges 1,500 yards or less the first range change is 200 yards. At greater ranges, the first change should be at least 400 yards. Announce deflection changes in mils. In tanks with a graduated elevating handwheel (par. 61*b*), also

announce range changes in mils (figs. 26 and 27). Memorize the change in mils for a 100 yard range change for key ranges (fig. 28).

(2) Instructors should teach bracketing by blackboard drill and later on the terrain board or sand table. The instructor touches a stick to the terrain board or sand table at the point of burst and the gunner or tank commander is required to sense it with respect to the target and give the proper range and deflection change. The student should

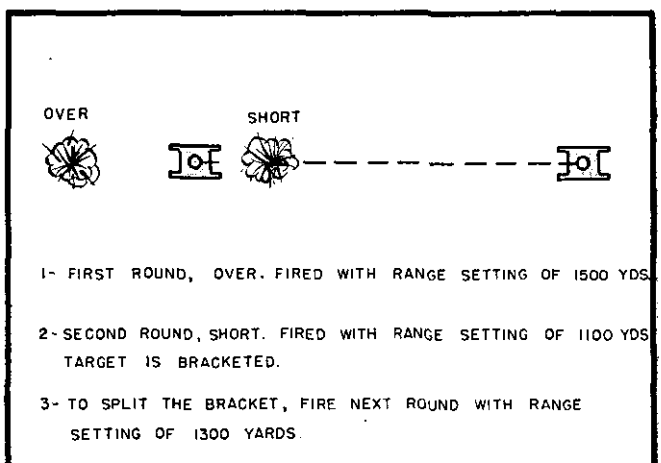


FIGURE 25.—Bracketing the target.

use field glasses. No crew should fire service ammunition without having fired many problems on the terrain board. This type of training is entertaining to the men. It can be carried on indoors, or equally well during any dull moments outdoors. Ingenious instructors will devise elaborate indoor ranges using smoke puffs, air rifles, etc; but the training can be given equally well with a twig and a bare patch of earth. The importance of this type of training cannot be exaggerated.

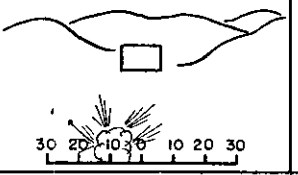
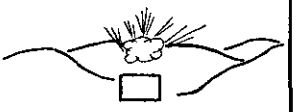
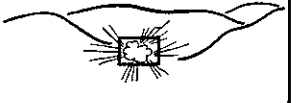
COMMANDS	RESULTS	SENSINGS
(TARGET: ANTITANK GUN) GUNNER, ANTITANK, H E, TRAVERSE RIGHT, STEADY..... ON ONE FIVE HUNDRED, FIRE. (100 YARD RANGE, CHANGE = 2 MILS.)		SHORT
RIGHT 10, UP 8, FIRE		OVER
DOWN 4, FIRE		SHORT
UP 2, FIRE		HIT

FIGURE 26.—Tank commander adjusting fire; tank equipped with graduated elevating handwheel.

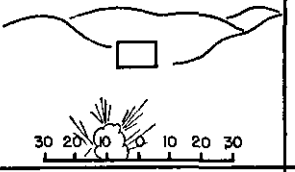
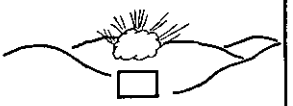
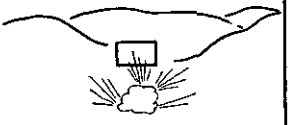
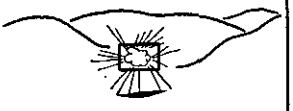
COMMANDS	RESULTS	SENSINGS
(TARGET: ANTITANK GUN) GUNNER, ANTITANK, H E, TRAVERSE RIGHT, STEADY.....ON ONE FIVE HUNDRED, FIRE		SHORT
RIGHT 10, UP 400, FIRE		OVER
DOWN 200, FIRE		SHORT
UP 100, FIRE		HIT

FIGURE 27.—Tank commander adjusting fire; tank not equipped with graduated elevating handwheel.

Memorize the following and use for all firing with shell HE, M48 (supercharge) and projectile APC, M61:

Range	Change in mils for 100-yard range change
Under 1,600	1.5.
1,600 to 3,000	2.0.
Over 3,000	Use the firing table.

FIGURE 28.—Change in mils for 100-yard range change.

■ 55. FIRING WHILE MOVING.—*a. General.*—(1) Firing with the 75-mm gun while moving is inaccurate and causes an uneconomical expenditure of ammunition. Do it *only in an emergency* and at ranges of 600 yards or under. (See FM 17–30.)

(2) Firing while moving requires close teamwork between driver and gunner. Drive at a constant speed; acceleration and deceleration upset the action of the stabilizer. Drive in a straight line, otherwise the gun yaws as the tank turns. The driver warns the gunner when rough terrain is ahead. When going over rough terrain, do not "fight" the gun (attempting to keep it on the target by spinning the elevating handwheel), but wait until a constant speed is regained and the action of the stabilizer has smoothed out.

(3) The stabilizer will not lay the gun. It merely tends to keep the gun where it has been laid; that is, it eliminates extremely jerky movements caused by the movement of the tank. Even with a stabilizer, the gun does not hold constantly on the target. Watch the swing of the gun through the target and fire as the proper sight setting crosses the target.

b. Stationary targets.—(1) *Firing to the front or rear.*—When firing to the front or rear, fire when the vertical crosshair center of the sight is on the target, and as the 600-yard dot crosses the top of the target if the gun is moving downward, or as the 600-yard dot crosses the bottom of the target if the gun is moving upward. If the range of the upward and downward motion is so small that the 600-yard dot does

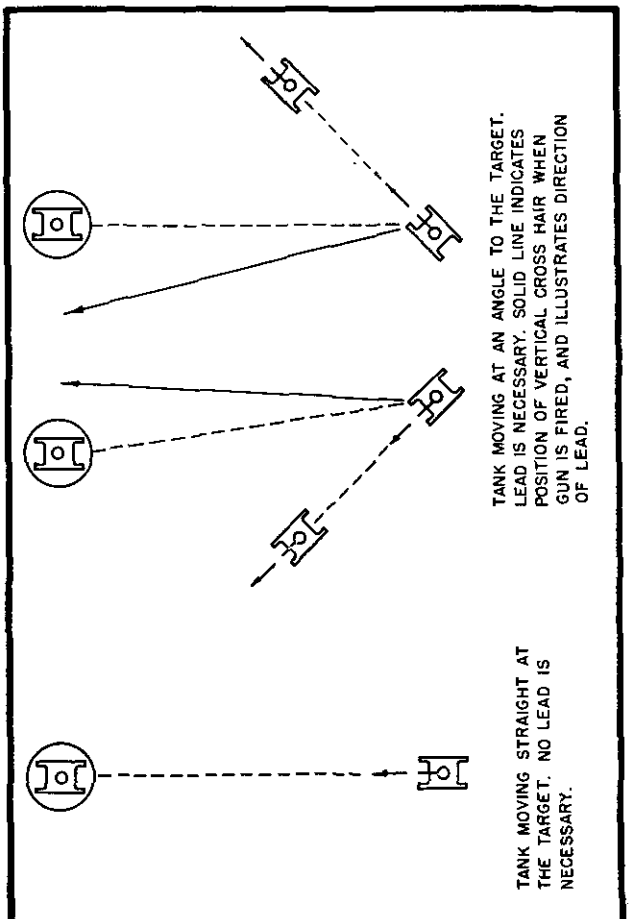


FIGURE 29.—Firing while moving.

not fall below the bottom or above the top of the target, fire as the 600-yard dot crosses the center of the target.

(2) *Firing to the side.*—When firing over the corner of the tank or to the side, use a lead to compensate for the fact that the tank is moving at an angle to the target (fig. 29). Remember that the direction of the lead is opposite from that used in firing from a stationary tank at a moving target. When firing from a tank moving to the right, the lead is established on the left side of the target. In other words, when firing at a stationary target from a moving tank, establish the lead on the side of the target opposite the direction in which the tank is moving.

c. Moving targets.—If the target is moving, its fire will be inaccurate. Therefore, halt the vehicle, destroy the target, then continue the advance.

d. Gyro-stabilizer.—The accuracy of moving fire depends on the gyro-stabilizer. This is a delicate mechanism, so a thorough understanding of its operation and adjustment is necessary. Watch for the following common mistakes:

(1) The gyro-stabilizer turned on and allowed to run indefinitely when not in use runs down the battery.

(2) The gyro-stabilizer not turned on soon enough to allow the gyroscope to attain its maximum speed before using the stabilizer.

(3) "Stiffness" not properly adjusted, thereby causing either a continuous hunting when adjusted too stiff, or a lack of pressure when not stiff enough.

(4) Guns not properly balanced.

(5) Recoil adjustment not made. This results in air entering the system which adversely affects the action of the stabilizer.

(6) Gunners using the elevating handwheel too much, thereby offsetting the effect of the stabilizer.

(7) Homelite charging systems not in operation. Drivers will insist that the tank battery is fully charged from normal running, yet in many cases it will be low. This materially affects the action of the stabilizer. Correct the reluctance of drivers to run the Homelite by making them aware of the importance of a fully charged battery.

(8) Improperly lubricated trunnions which cause too much friction and affect the operation of the stabilizer.

(9) Air not bled from the system.

■ 56. EXAMPLES OF FIRE ORDERS.—*a. Tank gun, stationary target.*

GUNNER
ANTITANK
HE
TRAVERSE RIGHT
STEADY_____ON
ONE TWO HUNDRED
FIRE

b. Tank gun, moving target.

GUNNER
TANK
SHOT
TRAVERSE LEFT
STEADY_____ON
EIGHT HUNDRED
LEAD ONE ZERO
FIRE

c. Coaxial machine gun, stationary target.

GUNNER
TRUCK
CALIBER THIRTY
TRAVERSE RIGHT
STEADY_____ON
FIVE HUNDRED
FIRE

d. Bow machine gun, stationary target.

BOG
DOUGHS
RIGHT FRONT
FIRE

e. Platoon commander concentrating fire of section on stationary target.

FIRST SECTION
ANTITANK
WATCH MY BURST

The platoon commander's tank then fires until the target is plainly indicated to the others, after which he commands:

FIRST SECTION
ONE EIGHT HUNDRED
FIRE

SECTION VII

INDIRECT LAYING

■ 57. GENERAL.—*a.* Indirect laying occurs whenever the gunner cannot see the target. Battle experience has shown that indirect laying is extremely common with modern medium tanks. Antitank guns are often attacked at ranges of 3,000 to 4,000 yards, and even higher, with the tanks defiladed from enemy view.

b. The first step in indirect laying training is clear cut explanation that indirect laying requires only that someone who can see the target transmit to the gunner changes the elevation and in direction which he applies to the gun in order to hit the target. Make the men realize that indirect laying is easy to understand and to use.

c. Before training the men in any type of indirect laying, explain its employment (par. 58). Drill the crews in indirect laying by means of simulated firing exercises. After the men understand the mechanics of indirect laying, have simulated firing from tactical positions. Conduct terrain walks and have the crews select defiladed positions. Comment on their selections, keeping in mind the problem of minimum elevation (par. 60).

■ 58. TYPES.—Three types of indirect laying employed in tank units are:

a. One tank in defilade.—The tank is placed in a defiladed position. The tank commander places himself where he can observe the target. He then lines in the gun and target, and adjusts fire on the target. Communication between the tank commander and the gunner is ordinarily by voice. The purpose of placing a tank in a defiladed position and firing by indirect laying is to enable it to destroy targets without exposing itself to enemy fire.

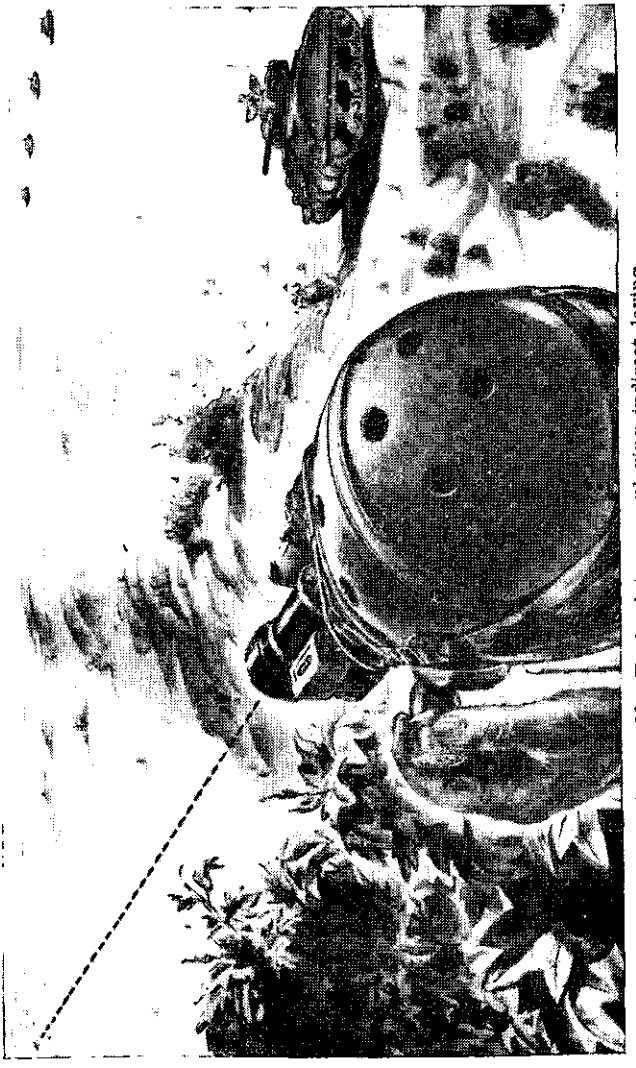


FIGURE 30.—Tank platoon employing indirect laying.

b. Two or more tanks in defilade.—Where two or more tanks are placed in a defiladed position, each tank commander may line in his tank and the target. Usually, where there are more than two tanks, an observer (the platoon commander or platoon sergeant) lays them parallel. (See fig. 30 and par. 63.) One observer (usually the platoon commander or platoon sergeant) always adjust the fire of all the tanks. Communication may require voice relay or radio.

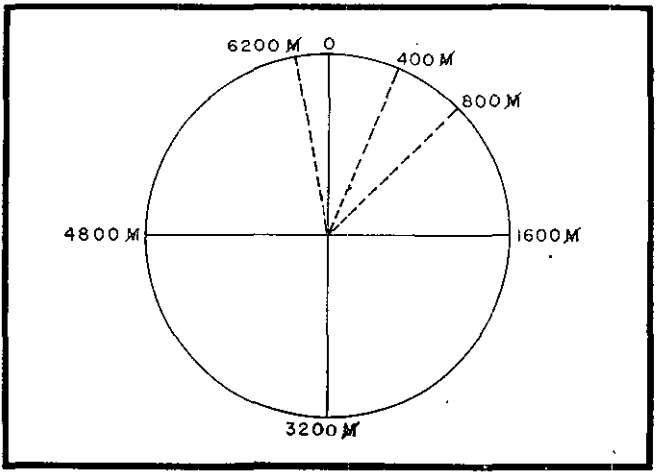


FIGURE 31.—Measuring gunnery angles in mils.

A platoon commander might use this method of indirect laying to establish a base of fire with part of his platoon while the remainder outflanks the target. A company commander might use it to establish a base of fire with one platoon while the remainder of his company maneuvers to attack the objective.

c. Tanks as auxiliary artillery.—The most advanced type of indirect laying occurs when tanks are used as auxiliary field artillery. Examples: forcing a river crossing, passage of defiles, passages of defended mine fields, and like operations. One or more companies of tanks are placed in position and their fires massed on a target. The division artil-

lery command selects the positions, completes the survey, and prepares data for each tank platoon so employed (considering the tank platoon approximately equivalent to a battery of 75-mm artillery). Extra ammunition required is supplied at the firing position by truck. The organic ammunition load of the tanks is left intact for use in later stages of the operation.

■ 59. THE MIL.—*a.* In gunnery, angles are measured in "mils." The full circle contains 6,400 mils. That is:

360°=6,400 mils
1°=18 mils approximately (actually 17.8)

Gunnery angles are measured clockwise (fig. 31).

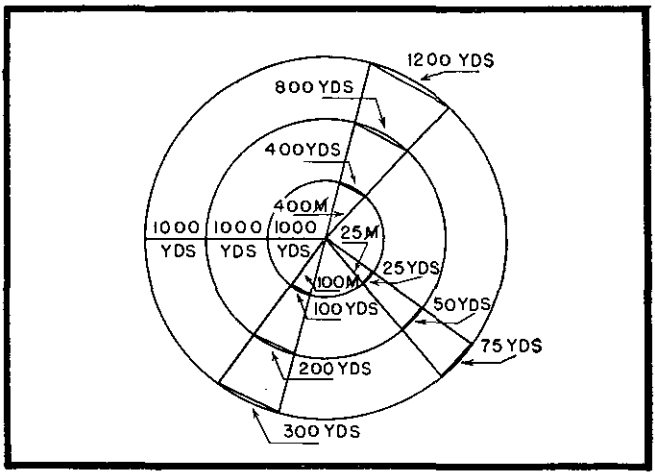


FIGURE 32.—Relation of mils to width (in yards) and distance (in 1000s). (Not drawn to scale.)

b. It is also true that 1 mil is subtended by 1 yard at a distance of 1,000 yards (fig. 32). That is—

1 mil is subtended by 1 yard at 1,000 yards
is subtended by 1½ yards at 1,500 yards
is subtended by 2 yards at 2,000 yards
is subtended by 5 yards at 5,000 yards, etc.

Similarly—

150 mils is subtended by 150 yards at 1,000 yards
is subtended by 225 yards at 1,500 yards
is subtended by 300 yards at 2,000 yards, etc.

These relationships are accurate enough for gunnery calculations for any angle less than 400 mils.

c. Knowing any two of the figures involved, the third can be computed by the mil formula as shown in figure 33.

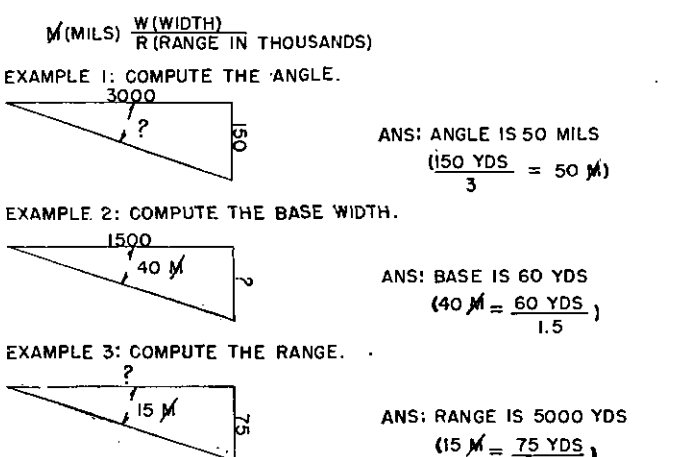


FIGURE 33.—Using the mil formula.

■ 60. PLACING TANKS IN DEFILADED POSITIONS.—*a. To insure clearing the crest determine minimum elevation.* Elevate the gun until the line of sight along the bottom of the bore clears the crest or mask. Measure this elevation by placing the gunners quadrant on the breech ring. Center the bubble by moving the quadrant arm. Add to the measured elevation the elevation for the ammunition to be used corresponding to the range to the crest plus 4 mils. This sum is the minimum elevation.

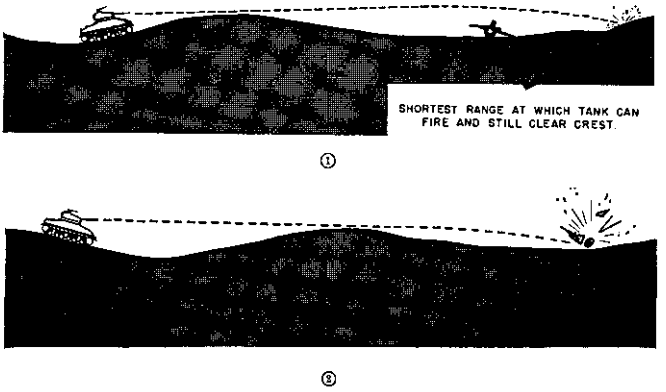


FIGURE 34.—Do not place tanks on a reverse slope behind a crest. You may not be able to hit the target. Go a little farther back in order to get on a forward slope.

b. Using the firing table for the ammunition to be fired, convert the minimum elevation into range. This range is the shortest at which the gun can be fired from that position.

c. Do not place tanks close to a mask of trees or on a reverse slope behind a crest (fig. 34). When either of these things is done, the range corresponding to the minimum elevation required to clear the crest is so great that you may not be able to hit the target. As soon as each tank is placed in position, determine the minimum elevation and announce it to the observer. Do not fire at an elevation less than your minimum elevation.

d. To facilitate adjusting fire, number the tanks, starting from the right flank (No. 1, No. 2, No. 3, and No. 4). Thus,

the tank on the right, facing in the direction of fire, is always designated No. 1 when using indirect laying, regardless of its permanent number in the platoon.

■ 61. INSTRUMENTS FOR INDIRECT LAYING.—*a. Gunner's quadrant.*—Each medium tank is equipped with a gunner's quadrant (figs. 35, 36). This device contains a bubble and a mil scale which permits the gun to be laid accurately for elevation.

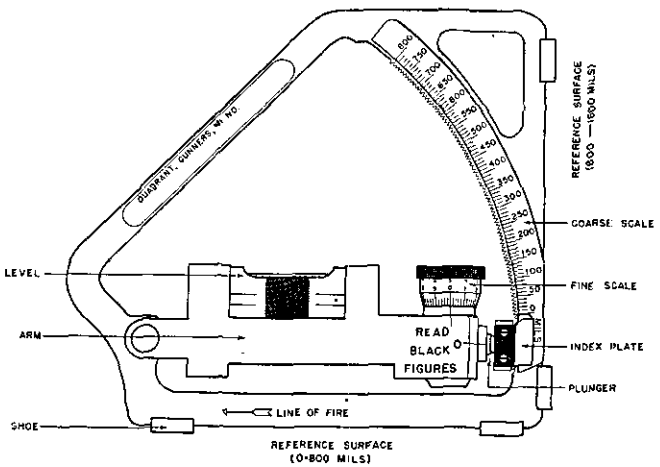


FIGURE 35.—Gunner's quadrant.

b. Graduated elevating handwheel.—Medium tanks M4 are equipped with a graduated elevating handwheel (fig. 37). Each graduation represents a change of 1 mil in the elevation of the gun. The elevating handwheel has 25 one mil graduations.

NOTE.—When using the graduated elevating handwheel it is essential that the gunner hold on to the wheel throughout an adjustment. If he does not, the wheel will turn and the accuracy of the adjustment will be lost.

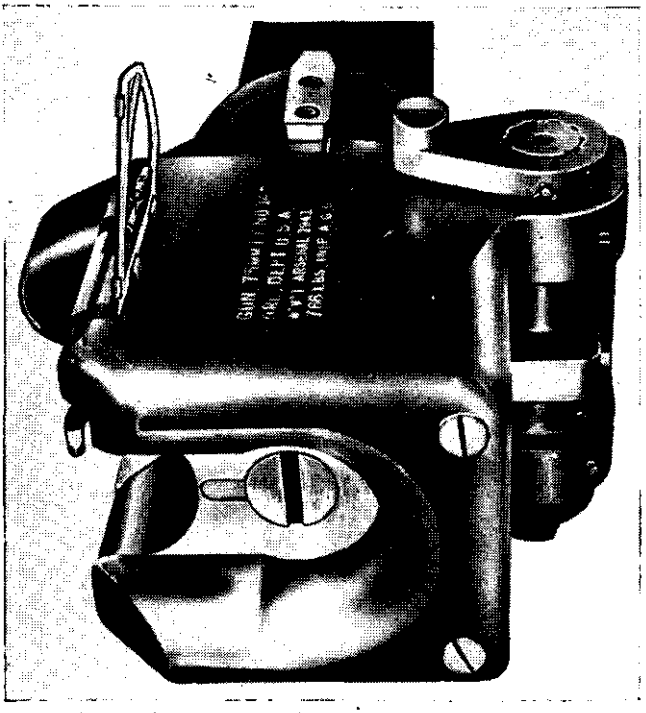


FIGURE 36.—Position of gunner's quadrant on breech ring. 75-mm tank gun M3.

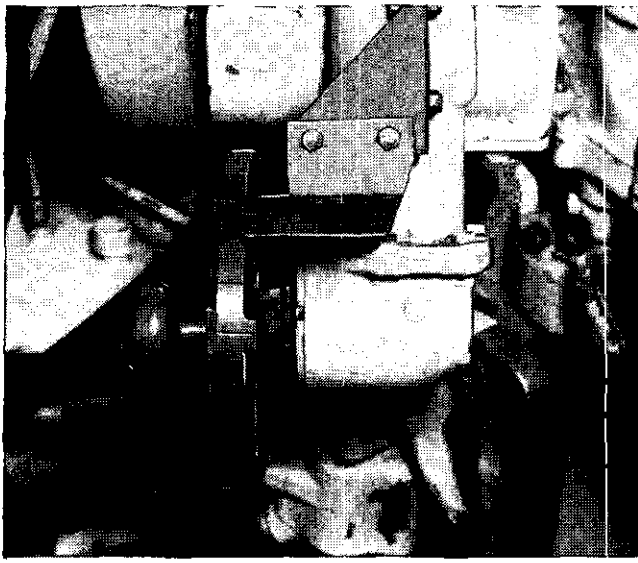


FIGURE 37.—Graduated elevating handwheel, medium tank M4.

c. *Azimuth indicator.*—The medium tank M4 is equipped with an azimuth indicator (figs. 38 and 39). This is a dialed instrument with two systems of pointers. The first system indicates the number of mils which the turret has been traversed from the longitudinal axis of the tank. Thus, when the gun points straight forward, the bottom pointer reads zero; at right angles to the right, 1,600; straight to the rear, 3,200; at right angles to the left, 4,800. The second system (top set of pointers) can be set at zero for any position of the gun and thereafter reads the number of mils which the gun has been traversed right or left from this position.

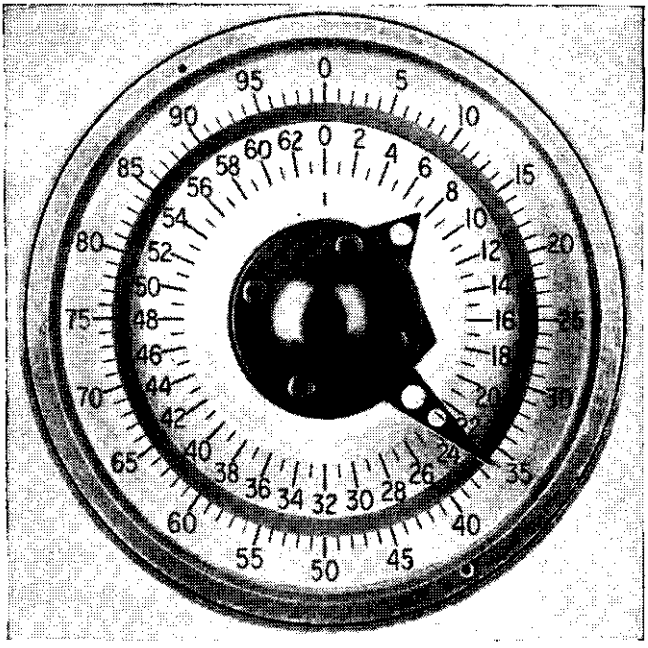


FIGURE 38.—Azimuth indicator.

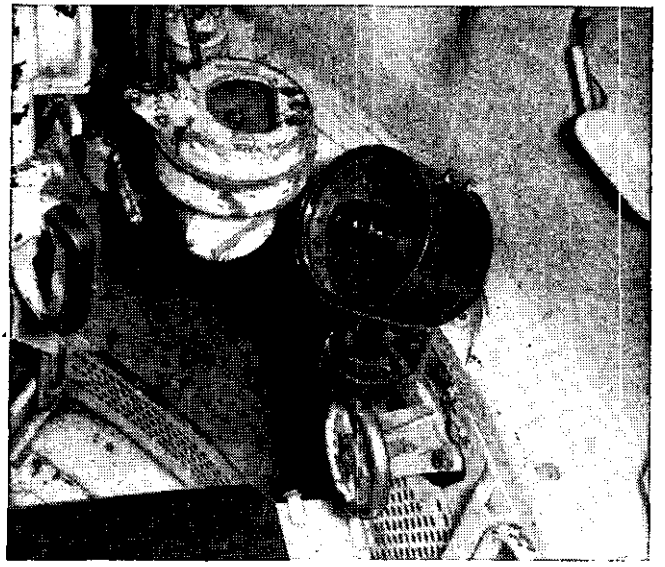


FIGURE 39.—Position of azimuth indicator in medium tank M4.

d. Panoramic machine-gun sight.—This instrument consists of a low power telescope mounted on a horizontal turntable graduated in mils (fig. 40). Each M4 medium tank platoon will be equipped with two of these sights mounted on tripods to be used like aiming circles for laying the guns.

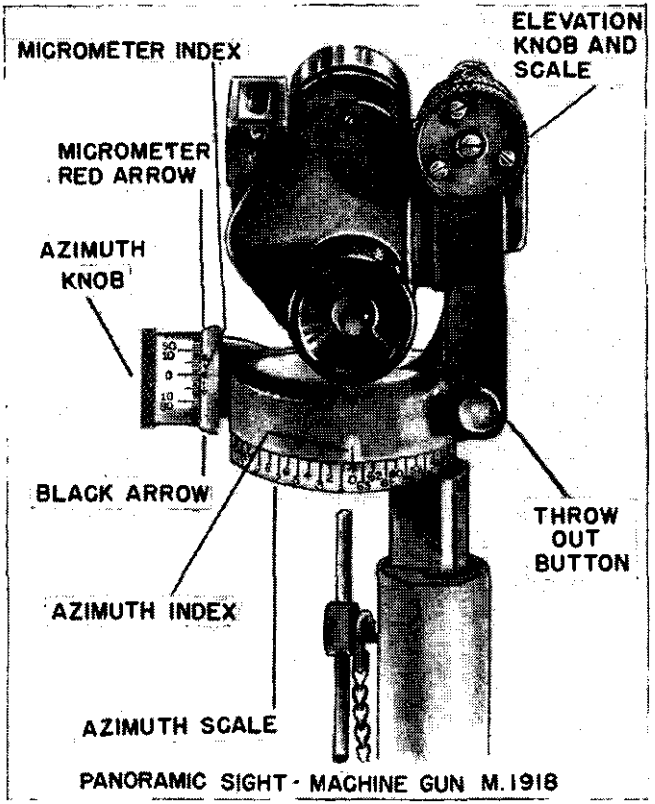


FIGURE 40.—Panoramic machine-gun sight M1918.

■ 62. LINING IN TANK AND TARGET.—To line in his tank and the target, the tank commander places himself on the line between gun and target and commands: LAY ON ME. The gunner then traverses the gun as indicated by the tank commander.

■ 63. LAYING GUNS PARALLEL.—*a.* The observer sets up his machine-gun sight and tripod where he will not be seen by the enemy.

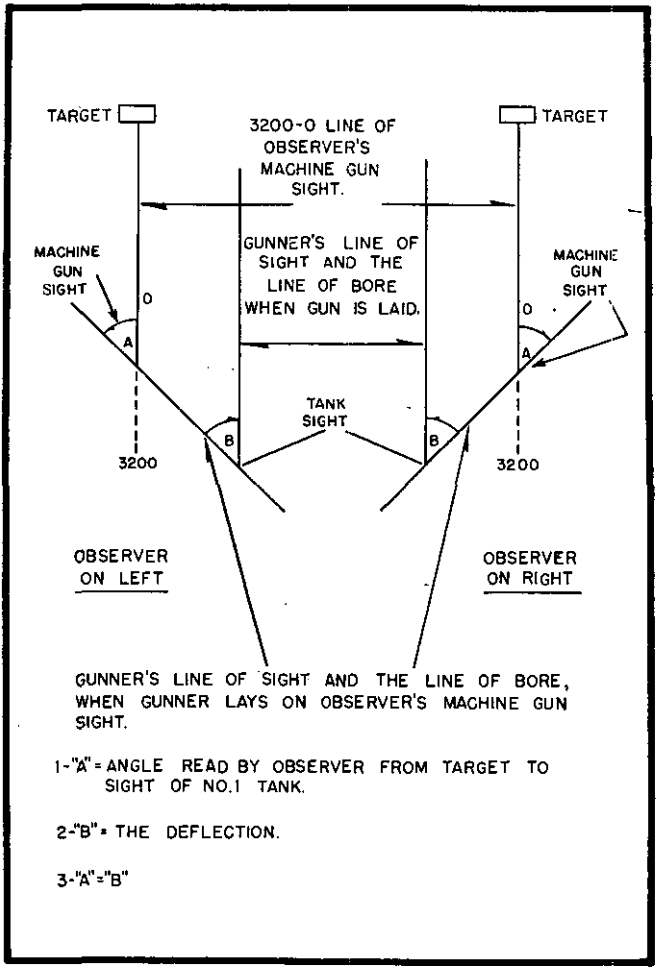


FIGURE 41.—Laying tanks parallel.

b. With the sight scales set at 3,200, lays the vertical cross-hair on the target.

c. Tightens the lower locking screw in order to lock the sight and mount in this position.

d. Commands: AIMING POINT, THIS INSTRUMENT. Each gunner then lays on the machine-gun sight and sets the pointers of his azimuth indicator at zero.

e. Using the upper motion, the observer rotates the head of the sight until the vertical crosshair is laid on the center of the gunner's periscope on No. 1 tank.

f. Reads the setting on the sight scales. (Always read the black numbers on the "tens" scale.) This is the deflection.

g. Commands: DEFLECTION NO. ONE (so much).

h. Determines and announces the deflection for the other tanks in the same manner.

i. Each gunner sets the announced deflection on his azimuth indicator and traverses the turret until the azimuth indicator reads zero.

j. The guns are now laid parallel (fig. 41).

k. One tank can lay the others parallel by use of the azimuth indicator. Lay one tank on the target. Set the indicator pointers at 3,200. Then traverse until the sight is laid on one of the other tanks. Read the azimuth indicator. This is the deflection for that tank. Proceed as above.

■ 64. REFERRING TANKS TO AIMING STAKE.—If the observer expects to move from the position from which he laid the guns parallel, the gunner uses an aiming stake as an aiming point. The command is: AIMING POINT, AIMING STAKE, REFER. *Without disturbing the position of the gun,* the gunner sets the azimuth indicator at zero and has the aiming stake lined in with his sight.

■ 65. CORRECTING FOR POSITION OF OBSERVER.—If the observer is on the line of fire, laying the tanks parallel lays them on the target. If the observer is not on the line of fire, it is necessary to correct for his position. He estimates his distance from the line of fire. Next he estimates the distance from the observation point to the target. By means of the mil formula, he determines the amount necessary to shift the guns (fig. 42). He shifts the guns as soon as he has laid them parallel. The shift is right if the observer is to the right of the tanks, and vice versa.

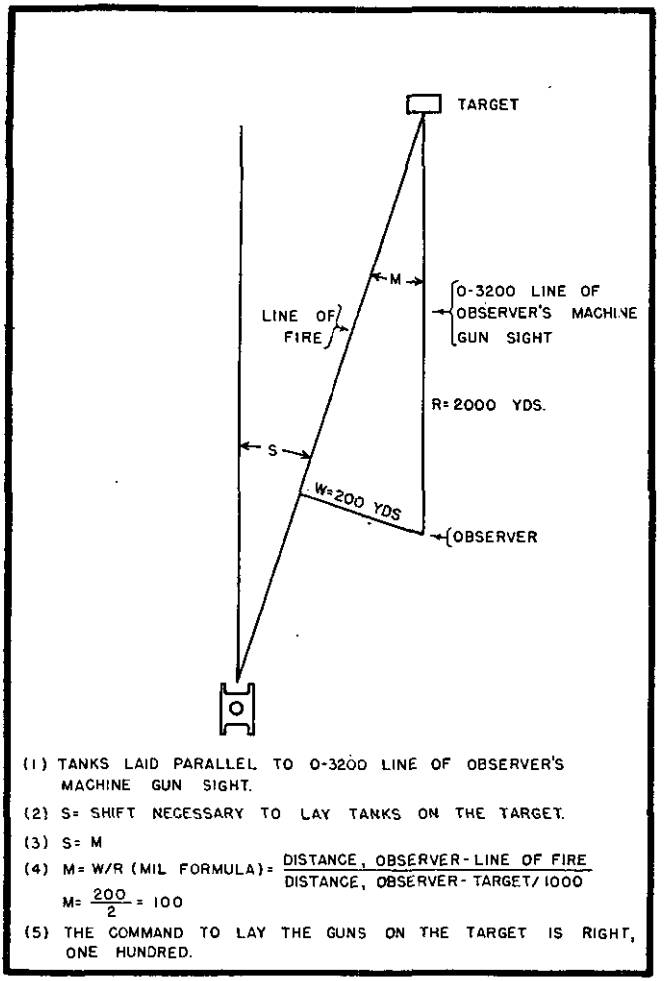


FIGURE 42.—Correcting for position of observer.

■ 66. LAYING FOR DIRECTION USING A STAKED LINE.—When tanks are used as auxiliary artillery, the artillery command

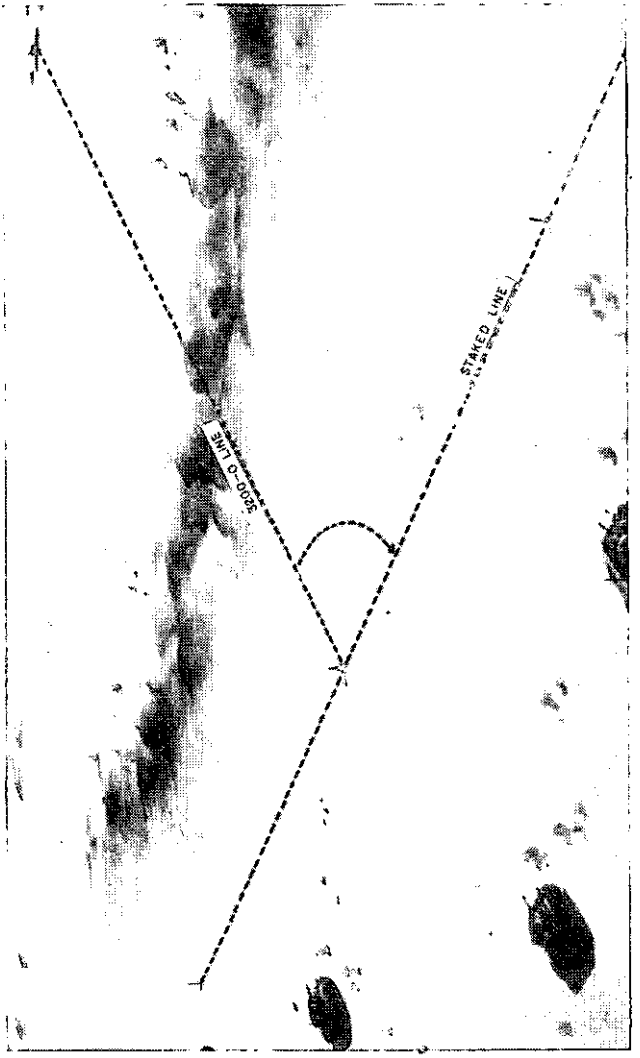


FIGURE 43.—Laying for direction using a staked line.

will frequently stake out a line on the ground near the firing position. The artillery officer then gives the platoon commander an angle to use in laying the tanks for direction. The method used is as follows (fig. 43):

a. Set up the machine-gun sight or aiming circle accurately on the line.

b. Set off on the sight or aiming circle the angle supplied by the artillery officer.

c. Sight down the line at the most distant stake. The 3,200–0 line of the instrument now points either to the front or the rear. If it points to the front, it is laid on the target.

d. If the 3,200–0 line points to the rear, leave the angle set on the instrument but sight down the line in the opposite direction. Sight on the most distant stake in the new direction. The 3,200–0 line is now laid on the target.

e. The instrument is now laid in the direction of fire. Lay the tanks parallel to it by method already learned.

■ 67. LAYING FOR RANGE.—The observer estimates the range from the tanks to the target. Using the firing table, he converts the range into mils. Use the gunner's quadrant for initial laying. Use the graduated handwheel for range changes.

■ 68. CHANGING DEFLECTION.—If the command is RIGHT TWO ZERO, the gunnner merely traverses the turret to the right until the top pointer of the azimuth indicator has moved 20 mils. Shift to the left by traversing to the left.

■ 69. ADJUSTING FIRE.—*a. General.*—(1) The observer stays as close to the line of fire as the terrain permits. Moving to the flank distorts his sensings of range and deflection errors.

(2) First, have the gunner fire a round where you can see it burst. Then, measure the deviation of this round from the target and give commands for changes in direction and elevation which will bring the next round on or near the target for deflection and which will bracket it for range. Split your bracket until the correct range is obtained. Then, fire a salvo (par. 70*e*) with all guns to check the deflection of each. When effective fire is obtained, change to volley fire (par. 70*e*).

(3) When firing one tank in the preliminary adjustment of a section or platoon, the other tanks must follow the deflection and elevation changes given to the adjusting gun.

b. Direction.—(1) In correcting direction, measure the deviation of the round from the target by means of the mil scale in the field glasses, or else by measuring it in mils using the hand or finger, the hand being held an arm's length from the eye (fig. 44). Everyone must determine and memorize the width of his hand, fist, and finger in mils. Having determined the deviation, have the gunner traverse his gun the proper number of mils. When adjusting two or more guns, measure the deviation of the center of the group of bursts.

(2) The "sheaf" consists of the planes of fire of several guns handled as a group (fig. 45). A *converged sheaf* is one in which the fire is converged at the target. A *parallel sheaf* is one in which the guns are laid parallel. An *open sheaf* is one which is spread beyond parallel. Any gun badly out of place in the sheaf is corrected individually.

(3) Use a converged sheaf for point targets (antitank guns, pill boxes) accurately located. When firing at area targets use a sheaf approximating 100 yards. The burst of a 75-mm shell covers an area 30 yards wide. Therefore, the maximum front which can be covered with fire with four tanks is 120 yards, the distance between flank bursts being 100 yards.

c. *Range.*—These principles have been outlined in paragraph 54c. They are repeated here because of their great importance.

(1) When the first round is sensed for range, change the range in the proper direction by an arbitrary amount of 400 yards, unless you *know* the round was near the target. When the round is far from the target, the change is greater than 400 yards. Make range and deflection changes bold enough to insure the next round appearing in the opposite sense. "Creeping" is an error of all inexperienced observers and is a thief of time and ammunition. After a bracket is obtained, further adjustment consists in splitting the bracket successively until effective fire is obtained. If you obtain a salvo giving both overs and shorts, change to fire for effect (volley

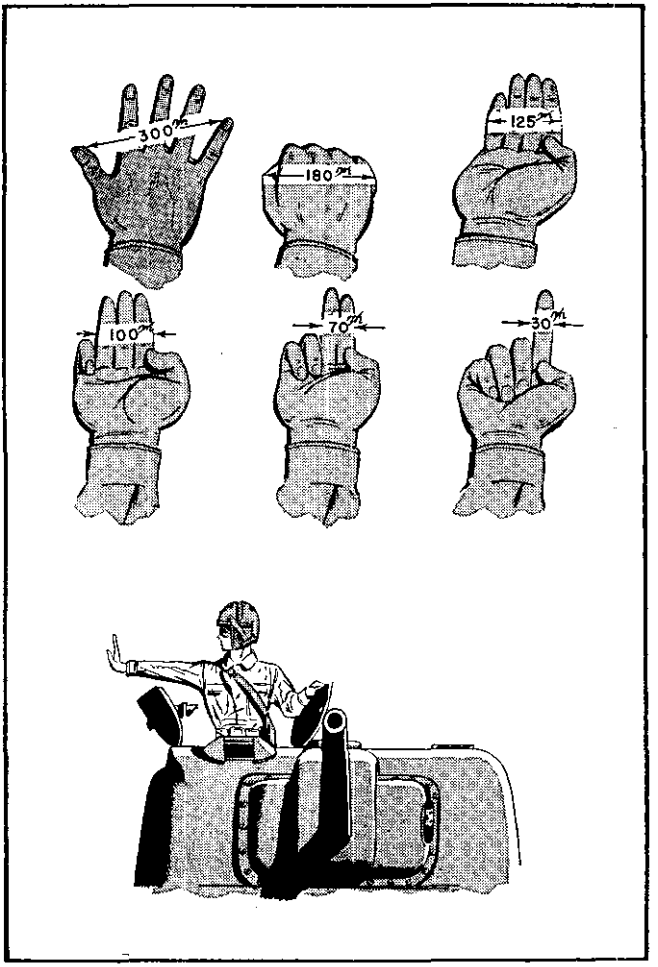


FIGURE 44.—Measuring angles with the hand.

fire) immediately. During volley fire, the range of each volley as a whole is sensed.

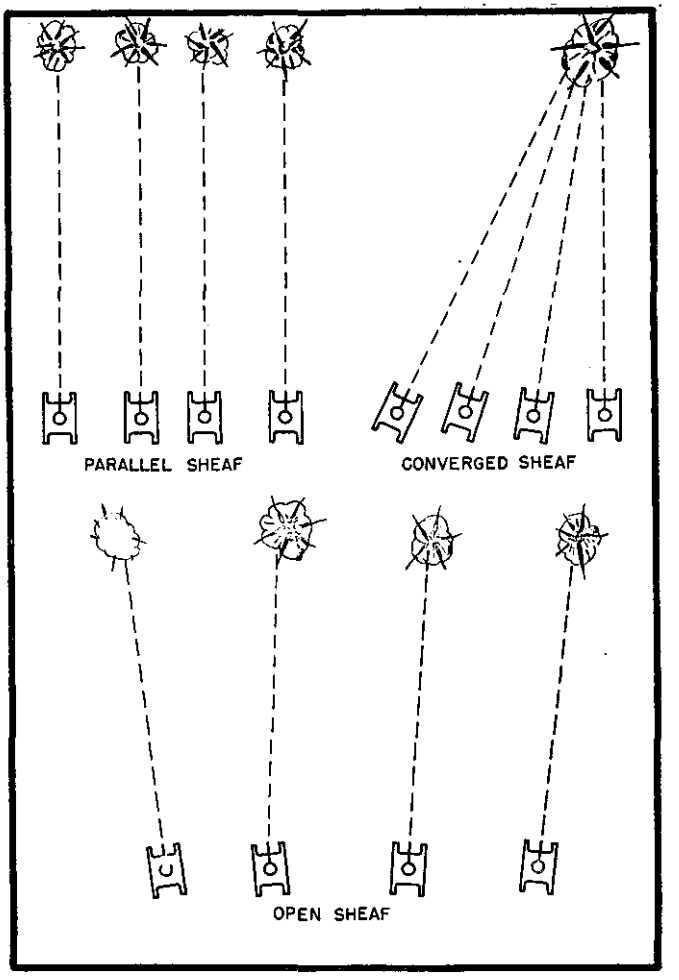


FIGURE 45.—Types of sheafs.

(2) Fire for effect is generally conducted at a single range. Range dispersion gives depth to the beaten zone. Fire sev-

eral volleys initially. If this range gives a decided preponderance of overs or shorts, make an appropriate range change to center fire on the target.

■ 70. FIRE ORDERS.—*a. General.*—The sequence of orders is the same as for direct laying. Necessary additional information is shown below.

(1) Target description. No change.
(2) Type of ammunition to fire. No change.
(3) Direction to traverse turret. See *b* below.
(4) Stopping traverse. Not used.
(5) Range. See c below.
(6) Guns to fire. See *d* below.
(7) Method of fire. See *e* below.
(8) Fire. See *f* below.

b. Direction.—Initial orders are LAY ON ME or, for example, AIMING POINT, THIS INSTRUMENT, DEFLECTION NO. ONE, THREE ZERO NINE ONE. Subsequent commands are the deflection shifts, as RIGHT FIVE or LEFT ONE ZERO.

c. *Range.*—The command for using the gunner's quadrant is, for example, QUADRANT THREE ZERO. The orders for range changes are, for example, UP FOUR or DOWN SIX.

d. Guns to fire.—To fire all the guns, preface the method of fire by "Platoon" or "Section." If you desire to fire one gun, *say,* for example, NO. ONE, ONE ROUND, FIRE.

e. Method of fire.—When more than one gun is to fire, there are two methods of fire:

(1) *Salvo fire.*—The command is: PLATOON RIGHT (LEFT), FIRE. This indicates the flank from which the guns fire successively. Fire is opened by the tank commander on the designated flank as soon as he is ready. Each gun follows in sequence 2 seconds after the adjacent gun has fired. If the wind is from the right, use salvo left, and vice versa.

(2) *Volley fire.*—Change to volley fire as soon as you get effect. The order is: PLATOON (SO MANY) ROUNDS, FIRE. Each gun fires the specified number of rounds as soon as it is ready without regard to the other guns.

f. Command to fire.—The command FIRE, given by the observer, is the authority for the tanks to open fire.

■ 71. EXAMPLES OF INDIRECT LAYING.—*a. Single tank.*—Target: Antitank gun. Range: 2,000 yards. Ammunition: HE, M48 (supercharge). c=2.

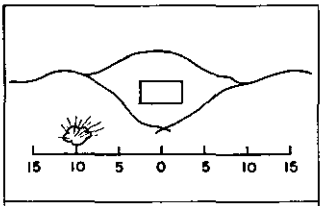
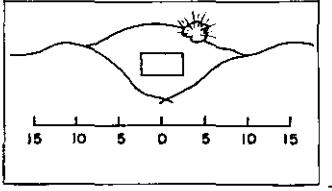
Commands	Results	Sensings
GUNNER, ANTITANK, HE, LAY ON ME. QUADRANT THREE ZERO, FIRE.		One zero left, short
RIGHT ONE ZERO, UP EIGHT, FIRE.		Three right, over

FIGURE 46.

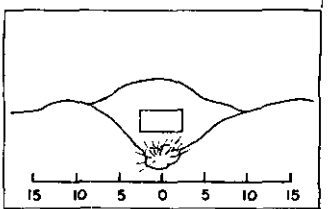
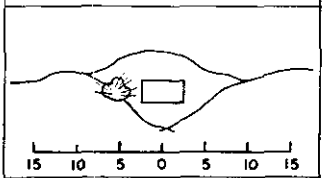
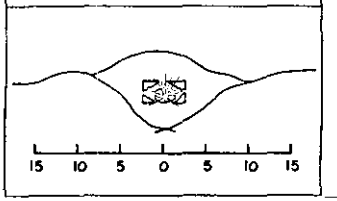
Commands	Results	Sensings
LEFT THREE, DOWN FOUR, FIRE.		Short
UP TWO, FIRE.		Doubtful
RIGHT ONE, REPEAT RANGE, FIRE.		Hit

FIGURE 47.

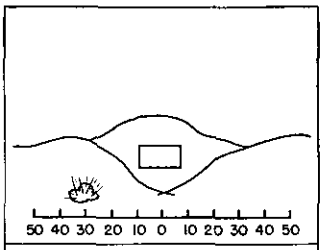
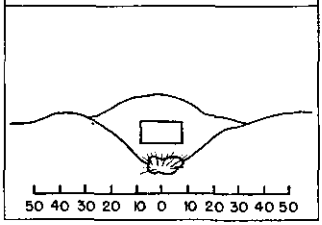
Commands	Results	Sensings
SECOND SECTION, ANTITANK, HE, AIMING POINT THIS INSTRUMENT, DEFLECTION NO. ONE SIX ZERO THREE ZERO. DEFLECTION NO. TWO FIVE NINE NINE FIVE (When using indirect laying, the tank on the right is always designated No. 1, par. 60*d*). RIGHT ONE FIVE ZERO (Correcting for position of the observer, par. 65). QUADRANT THREE NINE. NO. ONE, ONE ROUND, FIRE.		Three zero left, doubtful
RIGHT THREE ZERO. REPEAT RANGE, FIRE.		Short

FIGURE 48.

b. Two tanks.—Target: 88-mm AT gun accurately located. Range: 2,500 yards. Ammunition: HE, M48 (supercharge). c=2.

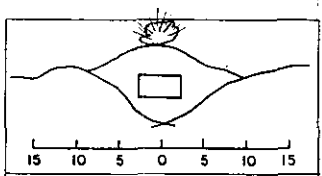
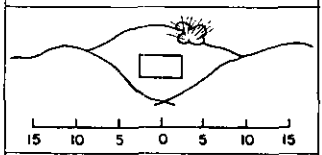
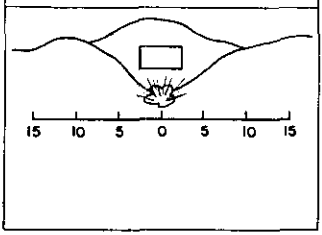
Commands	Results	Sensings
UP EIGHT, FIRE.		Over
DOWN FOUR.		Three right, over
LEFT THREE, DOWN TWO, FIRE.		Short
NO. TWO, RIGHT TWO ZERO (Accurately located point target, use converged sheaf. Tanks are about 50 yards apart and laid parallel. Therefore there will be about 50 yards between bursts. 50 yards = 20 m at 2,500 yards.)		

FIGURE 49.

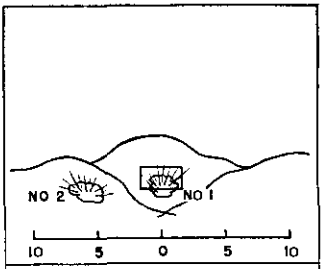
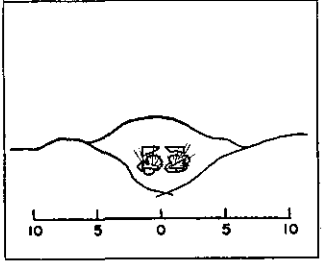
Commands	Results	Sensings
UP ONE, SECTION RIGHT (Splitting a 2-mil or 100-yard bracket, effective fire will probably be obtained on next round. Therefore, fire both guns. Use salvo fire to check the deflection). FIRE.		(Senses each burst as it appears.) Range correct. Five left, doubtful.
NO. TWO, RIGHT FIVE, REPEAT RANGE, SECTION, ONE ROUND. (Fire volleys to completely destroy the target) FIRE.		

FIGURE 50.

c. Platoon.—Target: Antitank guns located along edge of wood. Range: 3,500 yards. Ammunition: HE, M48 (supercharge). c=2 Distance from observer to target, 3,000 yards. Width of a 100-yard sheaf at 3,000 yards. $\frac{100}{3}=33$ ㎜

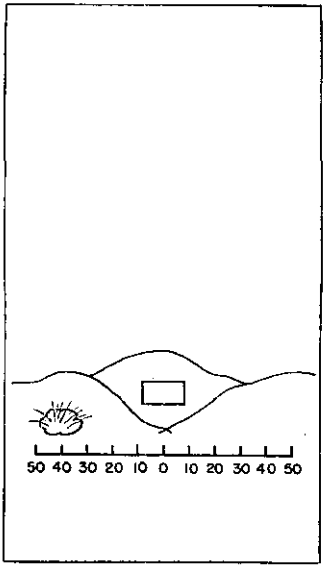
Commands	Results	Sensings
PLATOON, ANTITANK, HE, AIMING POINT, THIS INSTRUMENT. DEFLECTION NO. ONE, TWO ONE TWO FOUR, DEFLECTION NO. TWO, TWO ONE SIX SIX, DEFLECTION NO. THREE, TWO TWO ZERO ONE, DEFLECTION NO. FOUR, TWO TWO FOUR SEVEN. LEFT TWO HUNDRED (Correcting for position of observer) QUADRANT, SIX TWO. NO. TWO, ONE ROUND, FIRE.		Four zero left, doubtful.

FIGURE 51.

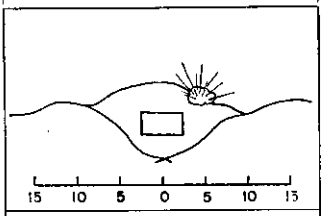
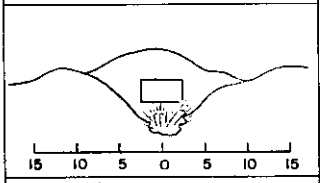
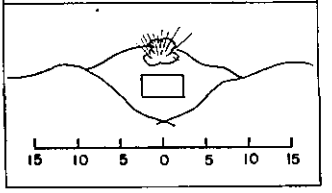
Commands	Results	Sensings
RIGHT, FOUR ZERO REPEAT RANGE, FIRE.		Three right, over
LEFT THREE DOWN EIGHT, FIRE.		Short
UP FOUR, FIRE.		Over

FIGURE 52.

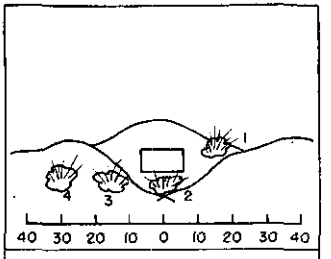
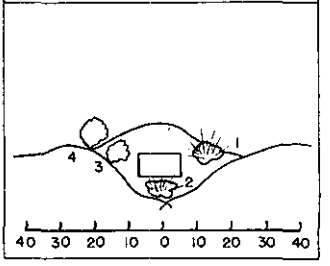
Commands	Results	Sensings
DOWN TWO, PLATOON RIGHT (Target not accurately located point, splitting 200-yard bracket places fire in area where target is thought to be. Therefore, fire all guns). FIRE.		Over Short Doubtful Doubtful Deflection correct (Deflection of salvc sensed as a whole). 45 mils between flank burst. (Measured to determine if sheaf is more than 100 yds. wide.)
NO. ONE, LEFT FOUR. NO. THREE, RIGHT FOUR. NO. FOUR, RIGHT EIGHT (Correcting deflection to close sheaf to 100 yards). UP ONE, (majority of rounds short; increase elevation) PLATOON, ONE ROUND, FIRE.		

FIGURE 53.

SECTION VIII

FIRING

■ 72. GENERAL.—*a.* Study FM 17–15 in conjunction with this section.

b. Plan all firing in every detail in order that officers and men will obtain the maximum benefit from it.

c. Use tactical firing positions and simulate battle conditions.

d. Carry out care and maintenance of weapons during and after firing in order to accustom crews to performing these duties in the field. Whether the weapons are in the field or in garrison the bores must be cleaned with sal soda and boiling water on each of the three days immediately following firing.

e. Men must know the results of their firing if they are to acquire confidence in their weapons and improve their technique. Massed firing at unmarked targets accomplishes nothing toward improving individual marksmanship. During individual marksmanship firing, only one gun will fire at a given target at one time. Score the target before another gun is permitted to shoot at it.

f. Hold a critique on each problem immediately after it has been fired.

g. Keep unessential personnel, both officers and men, at least 25 yards from the vehicles.

h. Do not permit unnecessary talking in the immediate vicinity of the vehicles.

■ 73. TARGETS AND RANGES FOR FIELD FIRING.—Represent tanks by full-size silhouettes painted field-gray or brown, and placed both in the open and in "hull down" positions. Often it will be impracticable to have full-size silhouettes for moving targets, but whatever is used paint it gray or brown. Represent personnel by standard drab silhouette targets, E, F, and M (commonly called "bobbing" targets). Represent antitank guns by small panel targets, painted olive drab and placed in camouflaged positions. Ranges on which targets move continuously over the same path have limited value for training gunners; first, because the men soon learn

where to ambush the target, and second, it is rarely possible to mark the targets properly.

■ 74. CHECK LIST FOR FIRING.—Before leaving the park, do the following:

a. Obtain all the necessary information about the firing. In particular, this includes location of firing positions, observation posts, if any, type of firing, amount and kinds of ammunition, and safety limits.

b. Leave the park in time to permit the guns to be in position and *ready to fire* at least 15 minutes ahead of the scheduled time.

c. Check recoil mechanisms. Test firing mechanisms, breech mechanisms, elevating and traversing mechanisms for proper operation and functioning.

d. Adjust the sights. In every park, have a convenient place where the sights can be adjusted with precision. Check the sight adjustment again on reaching the firing position.

e. Check the gunners' quadrants. These get out of adjustment, owing to rough handling and failure to keep them clean. The quadrant is the basis of all adjustments of range scales, range quadrants, and bubbles; it must, therefore, be right.

f. Check range quadrants, elevation scales, and bubbles, if installed on the matériel. Check other sighting equipment.

g. Inventory ammunition to see that it meets the requirements as to quantity and type. Also, spot check it for condition.

h. Check tools and accessories for completeness.

i. Fully stow the vehicles.

■ 75. SAFETY MEASURES.—*a. Responsibility.*—The officer in charge of firing is responsible for all safety measures. He is assisted by an officer called the safety officer, who has no other duty than that of safety officer.

b. Safety officer.—The duties of the safety officer are to—

(1) Verify that the safety limits are established on the ground and are understood by all tank commanders and gunners.

(2) Verify that the red flag is displayed at the control point before firing.

(3) Check that the visible portion of the range is clear before firing.

(4) Notify the officer in charge of firing when he is satisfied that it is safe to fire.

(5) Be familiar with local range regulations.

c. *Safety data.*—Prior to firing, the safety officer is provided with data pertaining to safety by the officer in charge of firing. Data should include the date of firing, gun position, right and left limits of fire, minimum and maximum ranges, and any special information necessary to insure safety.

d. Safety precautions.—(1) Unnecessary accidents are as harmful in battle as in training. The purpose of safety precautions is to prevent them.

(2) The officer in charge or safety officer should have radio communication with the platoon commanders in order to control the firing.

(3) An overheated machine gun will often fire itself without intention of the gunner, due to heating of the cartridge in the gun. Always have tank cannon and coaxially mounted machine guns elevated after firing, in order that any accidental discharge of the machine gun will go above personnel moving about outside the tank. This procedure does not remove the necessity for clearing the guns.

(4) Do not permit smoking in the vicinity of ammunition.

(5) Caution crew members to stay clear of the path of recoil.

(6) When tanks are firing on maneuver areas rather than on prepared ranges, the platoon commander, before giving the command to open fire, will take time to note whether any tank is liable to fire into a tree, fence post, or other obstruction.

(7) Firing will not begin until the officer in charge has ascertained that the range is clear and given his authority to commence fire.

(8) In emergencies, anyone may give the command CEASE FIRING. Firing will cease immediately, regardless of the source of the command.

(9) Place a red flag on each vehicle firing. Remove the red flag and raise a white one to indicate that firing has ceased.

(10) Prior to permitting personnel in front of vehicles or to moving any vehicle from firing line, weapons will be unloaded.

e. To remove a jammed fuzed round from gun.—Whenever possible, remove a round from the gun by shooting it out. When this cannot be done, the round may be removed by forcing it from the chamber. This operation must be under the direct *supervision of an officer.* Use great care not to strike the fuze and that personnel do not place portions of their bodies in front of the bore. Use a rammer with head of such a shape that the fuze is not touched.

■ 76. ADVANCE PLANNING FOR COMBINED WEAPONS FIRING.—Draw up all tactical and firing problems to simulate battle conditions. Take reasonable precautions to avoid unnecessary or foolhardy risks, but the first consideration is battle training. *Firing over the heads of troops from a moving vehicle is dangerous and will not be done.* In order to take full advantage of firing problems, thorough advance planning and supervision is necessary. Where there is to be firing over the heads of troops, all gun positions and observation posts must be surveyed in, limits of fire computed, and individual safety cards or graphical sketches made with the data checked by a competent officer before issuing these cards to the safety officers. Prior to the problem, a careful reconnaissance of all positions must be made by the problem director, safety officer, and safety noncommissioned officers. At this time, instructions for the control of the problem are issued. The detailing of competent safety personnel and their instruction ahead of time, is the responsibility of the problem director. With so many dangerous factors involved, precautions to avoid serious accidents cannot be shuffled off at the last moment on junior lieutenants.

APPENDIX I

GUNNERS' PROFICIENCY TEST, TANK GUNS

Introduction

■ 1. OBJECT OF THE PROFICIENCY TEST.—The object of the test is to—

a. Provide a means of determining the proficiency of the individual crew member in gunnery.

b. Provide the men with an additional incentive to excel in their work.

■ 2. RESPONSIBILITY FOR TEST.—The determination that a high standard of training has been attained before the crews are permitted to fire service ammunition is a command responsibility. The gunners' test is the means of determining the state of training. Training for gunners' test is an important part of unit training.

■ 3. CONDUCT.—The test will be conducted as prescribed by regimental and separate unit commanders. Conducting a test and preparing his men to take it is the finest type of training for a junior officer.

■ 4. RECORD.—The organization commander is responsible that a record is kept of the results of the examination.

■ 5. OTHER WEAPONS.—Similar tests should be conducted for machine guns, mortars, antitank guns, and assault howitzers.

Part I—Practical

■ 6. GENERAL.—*a.* The time for any trial is the time from the last word of the command to the soldier's report or signal "Ready."

b. To obtain maximum credit, trials must be performed promptly and without hesitation. The size of the cut for time should be proportional to the amount of the delay.

■ 7. DISASSEMBLY OF BREECH MECHANISM (ONE TRIAL).—*a.* The soldier is in the turret. The examining officer commands: DISASSEMBLE BREECH MECHANISM. The soldier performs the operations as described in—

(1) FM 23–81.

(2) FM 17–66.

b. Mark the soldier on the general merit of his work.

■ 8. ASSEMBLY OF BREECH MECHANISM (ONE TRIAL).—*a.* The soldier is in the turret. The examining officer commands: ASSEMBLE BREECH MECHANISM. The soldier performs the operations as described in—

(1) FM 23–81.

(2) FM 17–66.

b. Mark the soldier on the general merit of his work.

■ 9. FUNCTIONING (ONE TRIAL).—The examining officer selects at least five groups, or parts, such as the firing pin guide assembly (percussion mechanism). He then asks, for example, "Explain the functioning or operation of the firing pin guide assembly." The soldier explains the functioning as described in—

a. FM 23–81.

b. FM 17–66.

■ 10. CARE AND MAINTENANCE OF WEAPONS (ONE TRIAL).—*a.* The piece is prepared for action. The examining officer commands: DAILY LUBRICATION TEST INCLUDING FILLING RECOIL CYLINDER(S). The soldier selects the proper lubricating devices and lubricants. He demonstrates the lubrication of each place requiring daily lubrication, but does not perform the actual operation. The soldier (and assistant) demonstrate filling the recoil cylinder(s) as described in—

(1) FM 23–81.

(2) FM 17–66.

b. Assess a penalty of ½ point for—

(1) Each place *missed* or *improperly lubricated.*

(2) Each time the proper lubricating device or proper lubricant is not selected.

(3) Each improper procedure in filling the recoil cylinder(s).

■ 11. CREW DRILL (FIVE TRIALS).—Conduct the test by crew. Assign each crew member a position. The entire crew executes five of the movements prescribed in the appropriate crew drill. Have some of the movements executed through the hatches and some through the bottom escape hatch. After each trial assign each man a new position. Grade the crew as a whole in its performance of each trial. The grade given each individual is the crew grade less cuts for individual deficiencies. Examples of movements for the test are as follows:

a. Action.
b. Fight on foot.
c. Abandon tank.
d. Out of action.
e. Secure equipment.
f. Engine fire.
g. Hull fire.

■ 12. DIRECT LAYING (TWELVE TRIALS).—*a. General.*—Place targets at ranges of 300, 500, 800, 1,000, 1,500, 2,000, and 3,000 yards. The gun is prepared for action. The examining officer checks the laying for range and deflection after each trial. Allow no credit if the laying is not precisely correct.

b. Stationary targets (four trials).—(1) The soldier takes his position. The examining officer commands, for example:

GUNNER	GUNNER	GUNNER
TANK	ANTITANK	MACHINE GUN
SHOT	HE	CALIBER THIRTY
TRAVERSE RIGHT	TRAVERSE RIGHT	TRAVERSE RIGHT
STEADY_____ON	STEADY_____ON	STEADY_____ON
FIVE HUNDRED	TWO THOUSAND	FOUR HUNDRED
FIRE	FIRE	FIRE

(2) On the command FIRE, the soldier lays the gun, calls "Ready," and moves his head clear of the sight.

c. Setting leads (four trials).—(1) Use stationary targets.

The soldier takes his position. The examining officer commands, for example:

GUNNER	GUNNER	GUNNER
TANK	ARMORED CAR	TRUCK
SHOT	HE	CALIBER THIRTY
TRAVERSE LEFT	TRAVERSE LEFT	TRAVERSE LEFT
STEADY . . . ON	STEADY . . . ON	STEADY . . . ON
EIGHT HUNDRED	ONE FIVE HUNDRED	FIVE HUNDRED
LEAD FIVE	LEAD ONE ZERO	LEAD FIVE
FIRE	FIRE	FIRE

(2) On the command FIRE, the soldier lays the guns, calls "Ready," and moves his head clear of the sight.

d. Tracking moving targets (four trials).—The soldier takes his position. On signal from the examining officer, a vehicle starts across the line of observation. The examining officer gives appropriate orders. On the command FIRE, the soldier lays with the prescribed range and lead and tracks the target. On signal from the examining officer, the soldier stops tracking and the target halts. Blow a whistle to stop the tracking and *at the same time* wave a flag to stop the target. Have a man in the target vehicle constantly watching for the flag. This insures the target halting at the instant the signal is given.

■ 13. RANGE, SPEED, AND LEAD ESTIMATION (FIVE TRIALS).—*a.* Select a varied piece of terrain. Place tanks, half-tracks, antitank guns, etc., at various unannounced, predetermined ranges (300 to 3,000 yards) from the observer. When commanded, vehicles are driven across the range at prearranged speeds, at right angles to the line of observation.

b. The soldier takes his position. The examining officer designates one of the moving targets and asks:

(1) What is the range? (Wt. 2 points.)

(2) What is the speed? (Wt. 2 points.)

(3) What is the lead? (Wt. 1 point.)

c. The soldier records his estimates for range, speed, and lead for each trial. This test can thus be conducted for a considerable group. Cut one point if the error in range esti-

mation is over 10 percent; two points if it is over 20 percent. Cut two points if the speed is not estimated correctly as slow, medium or fast. Cut one point if the lead is not correct for the estimated speed.

■ 14. SELECTION OF WEAPON AND AMMUNITION (THREE TRIALS).—*a.* Select a varied piece of terrain. Place tanks, half-tracks, antitank guns, etc., at various ranges (300 to 3,000 yards) from the observer.

b. The soldier takes his position. The examining officer designates one of the targets and asks:

(1) Which weapon is to be used?

(2) What type of ammunition is to be used?

c. The soldier records the weapon, and type of ammunition to be used.

Part II—Written

NOTE.—For crews using other sights, the appropriate reticle will be used.

Question	*Answer*
1. If your gun and sight are perfectly adjusted, where will the lines through the sight and gun cross each other? (Circle the correct answer). At 500 yards 1,000 yards 10,000 yards Never (they are parallel)	1. Never (they are parallel).
2. To adjust the sight and gun accurately, what is the minimum range to a distant object which will give satisfactory results? (Circle correct answer). 500 yards 1,000 yards 10,000 yards Infinity.	2. 1,000 yards.

Question	*Answer*
3. In the sight picture (fig. 54), show which ranges correspond to each line (or dot).	3.

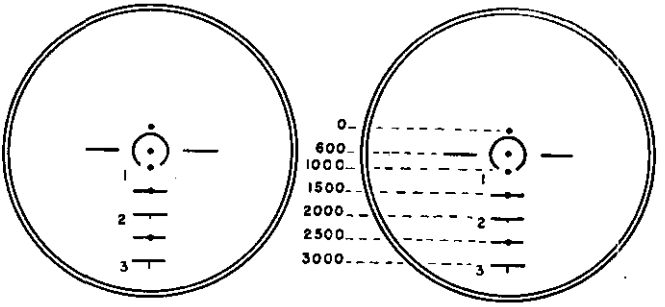


FIGURE 54.

4. When laying a gun on a stationary target, on what part of the target do you put—	4.
a. The range line (or dot) corresponding to the gun-target range?	*a.* On the *center* of the target.
b. The center (deflection) line or dot?	*b.* On the *center* of the target.
5. You are adjusting your sight, using the target shown in figure 55. Mark in the sight picture where the target will appear when the gun and sight are correctly adjusted.	5.

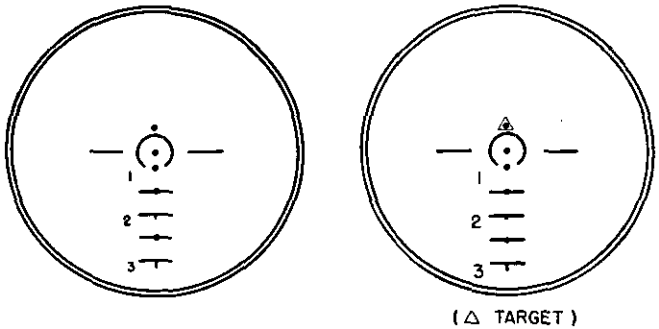


FIGURE 55.

Question	*Answer*
6. In direct laying, what two methods do we have for adjusting fire on the target?	6. *a.* Put the burst on the target. *b.* Bracket the target.
7. Which of the above methods is best when the range is short and the target is clearly visible?	7. Put the burst on the target.
8. Why is the foregoing method best?	8. It is faster and saves ammunition.
9. At what ranges may this method be successfully used?	9. Generally at ranges less than 1,000 yards.
10. Which method of adjustment is best when the target is at a great range and/or is not clearly visible?	10. The bracketing method.
11. What is the usual initial range change when adjusting by the bracketing method?	11. Four hundred yards at ranges greater than 1,500 yards. 200 yards at ranges less than 1,500 yards.

Question	*Answer*
12. While adjusting by bracket methods, you get a short at 1,200 and an over at 1,400. The burst at 1,200 appears much closer to the target than the one at 1,400. *a.* What is your next range? *b.* Why?	12. *a.* 1,300. *b. Always* split brackets.
13. You are a platoon commander. A German 88-mm AT gun is visible under three low trees to your right front. Your position is under cover 50 yards to your rear. Two of your tank commanders are with you. You estimate the range as 1,500 yards. Give your commands as necessary to employ the fire of two tanks.	13. ANTITANK RIGHT FRONT, THREE LOW TREES, UNDER MIDDLE TREE ONE FIVE HUNDRED TANK POSITIONS THERE (POINTING) UNDERSTOOD.
14. You are a tank commander. A German AT gun is clearly visible to your right front. Your tank is under cover. You estimate the range as 800 yards. Give your commands.	14. GUNNER ANTITANK HE TRAVERSE RIGHT STEADY . . . . . ON EIGHT HUNDRED PUT BURST ON TARGET FIRE
15. Show how the AT gun appears in the sights when your gun is laid and ready to fire.	15.

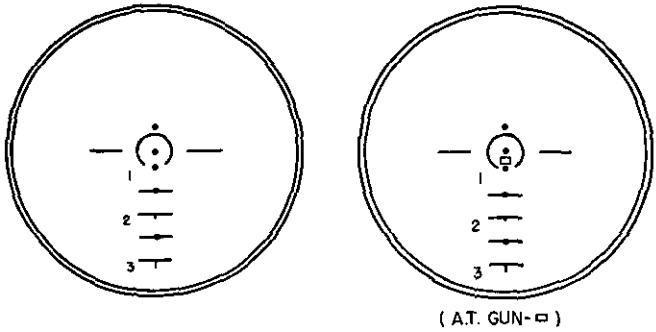


FIGURE 56.

Question

16. The burst appears as shown in the sight picture (fig. 57). What does the gunner do?

Answer

16. Immediately relays the gun, then picks up the base of the burst in the sight, traverses and elevates the gun until the target occupies the same place in the sight as the base of the burst did.

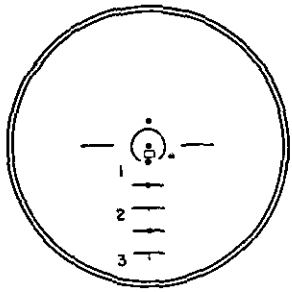


FIGURE 57.

Question	*Answer*
17. How does the target appear in the sight when your gun is laid for the second round?	17.

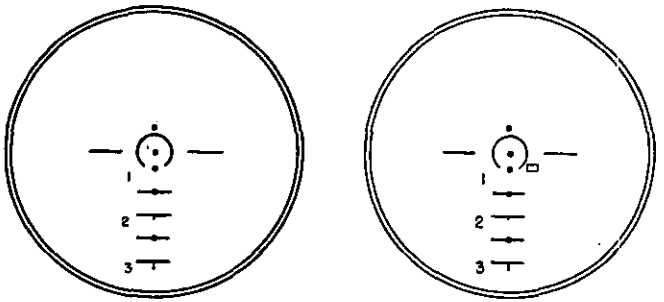


FIGURE 58.

18. The smoke from the second burst completely hides the target, as shown in the sight-picture (fig. 59). Was the target hit?	18. No. This round is certainly short.

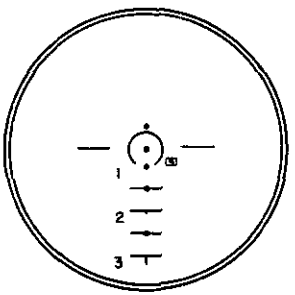


FIGURE 59.

Question	*Answer*
19. When can you be certain that you have hit the target?	19. When the strike of the projectile or the explosion of the shell *moves* any part of the target.
20. How should the target appear when your third round is fired?	20.

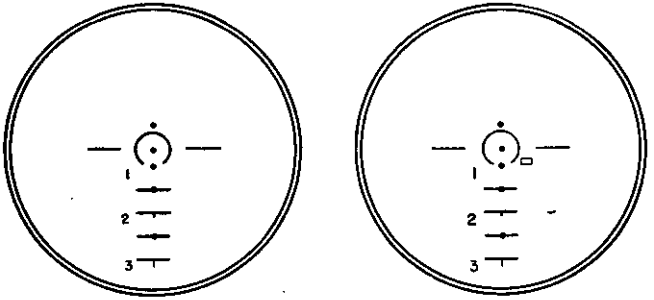


FIGURE 60.

21. You are a tank commander. Your tank has halted in a good firing position. From the turret you see a Japanese self-propelled gun go into position to your left front. You estimate the range as 2,500 yards. Give your commands.	21. GUNNER ANTITANK HE TRAVERSE LEFT STEADY . . . . . ON TWO FIVE HUNDRED FIRE
22. Your first burst is beyond and 10 mils to the left of the target. Assume that the elevation change for 100 yards range change is 2 mils. Give your commands.	22. RIGHT ONE ZERO DOWN FOUR HUNDRED or DOWN EIGHT (graduated handwheel) FIRE

Question

23. Your second burst is "line-short." Give your commands.

24. Your third round is "line-over." Give your commands.

25. Your fourth round knocks a wheel off the target.

a. Give your commands.

b. Explain why.

26. You are tank commander and are opening fire on a German scout car traveling at medium speed from left to right across your front at a range which you estimate as 1,200 yards. Give your commands.

27. How does the car appear in the sight when your gun is laid? Assume gun with M/V 2,000 f/s.

Answer

23. UP TWO HUNDRED
or
UP FOUR
FIRE

24. DOWN ONE HUNDRED
or
DOWN TWO
FIRE

25. *a.* REPEAT RANGE
FIRE

b. I want to finish that gun and its crew with fewest rounds possible.

26. GUNNER
ARMORED CAR
HE
TRAVERSE LEFT
STEADY . . . . . ON
ONE TWO HUNDRED
LEAD ONE ZERO
FIRE

27. Lead is 10 mils.

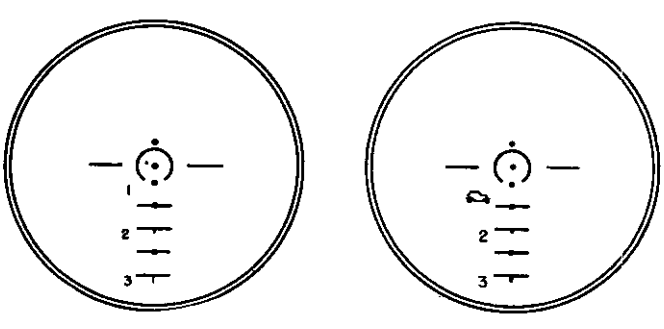


FIGURE 61.

Question	*Answer*
28. The first round strikes ahead of and a little below the target, as shown in the sight-picture (fig. 62). Give your commands.	28. UP TWO HUNDRED or UP FOUR LEAD FIVE FIRE

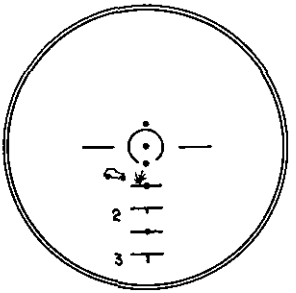


FIGURE 62.

29. How should the target appear when the second round is fired? 29.

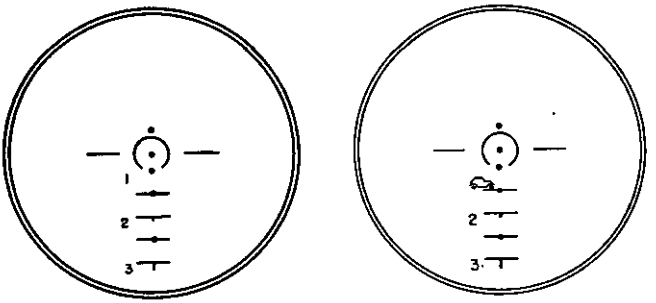


FIGURE 63.

Question	*Answer*
30. The second round appears to strike just to the left of the target, as shown on the sight-picture. Give your commands.	30. REPEAT RANGE LEAD SEVEN FIRE

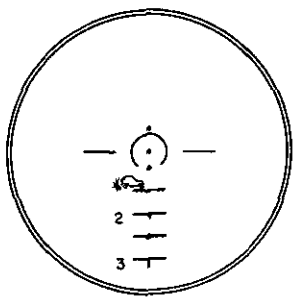


FIGURE 64.

31. *a.* What is the best unit of measure for leading a moving target?	31. *a.* The mil.
b. What initial leads are used if the target is moving at right angles to line of fire at slow, medium and fast speeds? (75-mm gun, M3).	*b.* Five mils. Ten mils. Twenty mils.
32. What is meant by the expression, "Adjustment of sights"?	32. Placing the line of sighting and the center line (axis) of the gun parallel.

Question	*Answer*
33. *a.* You have correctly adjusted your sight. Then you lay accurately and fire on a target which you estimate as 1,000 yards distant. The shot falls short. Why is this?	33. *a.* The range is greater than 1,000 yards.
b. In direct fire at a stationary target, what single element of the initial data do we not generally know?	*b. The exact range.*
c. In firing at a moving target what two elements must we find out in order to hit it?	*c.* The range and the speed.

TABULATION

PRACTICAL TEST	No. of trials	Points each	Maximum credit
Operation and functioning	3	3	9
Care and maintenance	1	10	10
Crew drill	5	4	20
Direct laying: Stationary targets	4	4	16
Direct laying: Setting leads	4	3	12
Direct laying: Tracking targets	4	4	16
Range, speed, and lead estimation	5	5	25
Weapons and ammunition	3	3	9
Total			117

WRITTEN TEST	No. of questions	Points each	Maximum credit
	33	1	33
GRAND TOTAL			150

APPENDIX II

REFERENCES

■ 1. DESCRIPTION.—*a. Field Manuals (FM).*—Field Manuals pertaining to particular weapons cover duties of crew members in the service of the piece, mechanical training, operation, and maintenance. Field Manuals are obtained by requisition direct to The Adjutant General of the Army. Distribution is governed by FM 21–6.

b. Technical Manuals (TM).—Technical Manuals are of two general classes:

(1) Manuals containing all the essential technical information required by the using arms for the use and care of the particular equipment described. These manuals are distributed to companies using the equipment. Requisition is the same as for Field Manuals.

(2) Manuals containing detailed instructions for maintenance and repair by ordnance personnel. These manuals are distributed only to ordnance units.

c. Table of Basic Allowances (T/BA) and Tables of Equipment (T/E).—T/BA (T/E) No. 17 contains the allowances of all types of equipment to which units of the Armored Force are entitled. Ammunition allowances for mobilization are also shown in this table. The T/BA or T/E is the authority for the requisition and issue of all items shown herein.

d. Ordnance standard nomenclature lists (SNL).—SNL supplement the T/BA. The SNL for a particular weapon shows the tools, spare parts, accessories, sighting equipment, and articles for instructional purposes which an organization armed with that weapon should obtain. It is the authority for the requisition and issue of these items.

e. Monthly digest of War Department directives.—This shows Field Manuals and Technical Manuals issued during a particular month and not shown in FM 21–6. To obtain complete coverage of training publications, check the digest for each month since the date of the latest edition of FM 21–6 and 21–7. The digest is distributed to headquarters of regiments and separate battalions.

f. Index to Ordnance Publications for Supply (OPSI).—The OPSI lists the SNL's and is used to determine whether the SNL for a particular item of ordnance equipment has been published. It is distributed to all organizations receiving SNLs.

g. War Department circulars.—Changes and amendments to the Army Regulations governing range regulations, training ammunition allowances, etc., are published in the War Department circulars which are distributed to headquarters of regiments and separate battalions.

h. War Department training circulars.—These supplement the Field and Technical Manuals. Recently issued Training Films and Film Strips, not shown in FM 21–7, are listed in training circulars which are distributed to headquarters of regiments and separate battalions.

i. Lubrication guides.—Ordnance Field Service Bulletin, 6-series, Instructions for Lubrication of Matériel, will be distributed. War Department Lubrication Guides, which are lubrication check charts printed on heavy cardboard and metal bound may be obtained by requisition through the local ordnance officer, on the basis of one per weapon.

j. Ordnance field service publications.—Ordnance field service bulletins, ordnance field service technical bulletins, and ordnance field service circulars often contain technical information of value to gunnery officers. These publications are distributed to division ordnance officers and ordnance maintenance personnel.

■ 2. GENERAL REFERENCES.—*a.* AR 35–6620, Expendable Property.

b. FM 9–5, Reports of Accidents, Prematures, etc.

c. AR 750–10, Range Regulations for Firing Ammunition.

d. AR 775–10, Qualifications in Arms and Ammunition Training Allowances.

e. FM 17–5, Armored Force Drill.

f. FM 17–15, Combat Practice Firing, Armored Force Units.

g. FM 17–62, Fire Control and Coordination.

h. FM 21–5, Military Training.

i. FM 21–6, List of Publications for Training.

j. SNL F–69, Firing Tables.

k. SNL K–1, Cleaning, Preserving and Lubricating Materials.

l. TM 9850, Cleaning, Preserving and Lubricating Materials

m. TM 9–1900, Ammunition, General.

n. TM6–220, Fire Control Instruments. (Includes compass M2 and field glasses.)

o. Vehicle Stowage Lists.

■ 3. 37-MM ANTITANK GUNS.—*a.* FM 23–70, 37-mm Gun, Antitank, M3.

b. SNL–A44. 37-mm Antitank Gun, M3.

c. SNL F–184, Telescope, M6, and Telescope Mount, M19.

d. SNL R–1, Ammunition, Fixed, All Types, for Tank, Light and Medium Artillery.

e. TM 9–1245, 37-mm Gun M3, and Carriage M4, Ordnance Maintenance.

f. TM 9–1940 (when printed), Tank and Antitank Cannon Ammunition, General.

■ 4. 37-MM TANK GUNS, M6.—*a.* FM 23–81, 37-mm Gun, Tank, M6.

b. Firing tables and Sight Diagrams for 37-mm and 75-mm Tank Guns, published by Ordnance Department.

c. SNL A–45, 37-mm Gun, M5 and M6.

d. SNL G–103, Light Tank, M3, M3A1, M5.

e. SNL R–1, Ammunition, Fixed, All types, for Tank, Light and Medium Artillery.

f. TM 9–725, Light Tanks.

g. TM 9–732, Light Tank M5.

h. TM 9–1940 (when printed), Tank and Antitank Cannon Ammunition, General (being published).

■ 5. 60-MM MORTAR.—*a.* FM 23–85, 60-mm Mortar, M2.

b. SNL A–43, 60-mm Mortar, M2.

c. SNL F–148, Sight, M4 (for 60-mm and 81-mm Mortars).

d. SNL R–4, Ammunition, Trench Mortar, Including Fuzes, Propelling Charges and Other Components.

e. TM 9–1535, Sights, M4. M3 (for 60-mm and 81-mm Mortar Matériel), Ordnance Maintenance.

■ 6. 75-MM ASSAULT GUN.—*a.* FM 17–25, Assault Gun, Section and Platoon.

b. Field Manual—Crew Drill, 75-mm Howitzer Motor Carriage, M8.

c. FT 75–I–2, Firing Tables—75-mm Ammunition.

d. SNL C–26, 75-mm Howitzer (Pack), M1 and M1A1.

e. SNL F–214, Panoramic Telescope, M12 Series.

f. SNL R–1, Ammunition, Fixed, All types, for Tank, Light and Medium Field Artillery.

g. SNL R–3, Service Fuzes and Primers, for Tank, Light and Medium Artillery.

h. TM 9–320, 75-mm Howitzer Matériel.

i. TM 9–732B, 75-mm Howitzer Motor Carriage, M8.

j. TM 9–1320, 75-mm Howitzer, Matériel, Ordance Maintenance.

k. TM 9–1551, Panoramic Telescope, M12 Series, Ordnance Maintenance.

l. TM 9–1945, 75-mm Howitzer Ammunition.

■ 7. 75-MM TANK GUNS, M2 AND M3.—*a.* FM 17–66. 75-mm Tank Gun, M3, Mounted in Medium Tank, M4.

b. Firing Tables and Sight Diagrams for 37-mm and 75-mm Tank Guns, published by the Ordnance Department.

c. SNL C–34, 75-mm Gun, M2 and M3, and Recoil Mechanisms (Tank).

d. SNL G–104, Medium Tank, and M4 Series.

e. SNL R–1, Ammunition, Fixed, All Types, for Tank, Light and Medium Field Artillery.

f. SNL R–3, Service Fuzes and Primers, for Tank, Light and Medium Field Artillery.

g. TM 9–1940 (when printed), Tank and Antitank Cannon Ammunition, General.

■ 8. 81-MM MORTAR.—*a.* FM 17–27, 81-mm Mortar Squadron and Platoon.

b. FM 23–90, 81-mm Mortar, M1.

c. FM 23–91 (when printed), 81-mm Mortar, Mounted in Combat Vehicles.

d. SNL A–33, 81-mm Mortar, M1.

e. SNL F–148, Sight, M4 (for 60-mm and 81-mm Mortars).

f. SNL G–102, 81-mm Mortar Carrier, M4.

g. SNL R–4, Ammunition, Trench Mortar, Including Fuzes, Propelling Charges and Other Components.

h. TM 9–1535, Sights, M4, M3 (for 60-mm and 81-mm Mortar Matériel), Ordnance Maintenance.

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