TM 4-315

WAR DEPARTMENT



TECHNICAL MANUAL

# COAST ARTILLERY GUNNERS' INSTRUCTION
# MOBILE SEACOAST ARTILLERY
# FIRST AND SECOND CLASS GUNNERS

January 22, 1942

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TECHNICAL MANUAL No. 4-315

WAR DEPARTMENT,
WASHINGTON, January 22, 1942.

# COAST ARTILLERY GUNNERS' INSTRUCTION, MOBILE SEACOAST ARTILLERY, FIRST AND SECOND CLASS GUNNERS

Prepared under direction of the
Chief of Coast Artillery



430792°—42——1

## Chapter 1

# GENERAL



1. **Purpose and scope.**—*a. Purpose.*—This manual is designed primarily for use by organization commanders in the instruction of enlisted men of mobile seacoast artillery units of the Coast Artillery Corps. It may be used also by officers conducting examinations of enlisted men for qualification as gunners, as contemplated by FM 4-150. The questions and answers are intended merely as a guide and should be supplemented by the extensive use of other questions and answers and by practical demonstrations.

*b. Scope.*—The topics included are those prescribed in FM 4-150 for qualification of enlisted men as first and second class gunners in mobile seacoast artillery units.

2. **Assignment of topics.**—The following is the general assignment of topics. Each organization should omit those portions of the assigned chapters, sections, and paragraphs that do not pertain to the particular equipment in use by the organization.

SECOND CLASS GUNNER

| Subjects | 155-mm gun batteries | 14-inch railway gun batteries | 8-inch railway gun batteries | 12-inch railway mortar batteries |
|---|---|---|---|---|
| Service of the piece | Secs. I and II, ch. 2. | Secs. I and III, ch. 2. | Secs. I and IV, ch. 2. | Secs. I and V, ch. 2. |
| Nomenclature of the various parts of the gun, carriage, and emplacement matériel. | Par. 15. | Par. 16. | Par. 17. | Par. 18. |
| Action, care, and minor adjustment of the various parts of the gun and carriage. | Sec. I, ch. 4. | Sec. II, ch. 4. | Sec. III, ch. 4. | Sec. IV, ch. 4. |
| Powders, projectiles, primers, and fuzes, to include precautions in handling. | Sec. I, ch. 8. | Sec. I, ch. 8. | Sec. I, ch. 8. | Sec. I, ch. 8. |
| Motor transportation | Secs. I and II, ch. 10. | ---------- | ---------- | |
| Nomenclature, action, and maintenance of the small arm with which the organization is equipped and its ammunition. | Sec. II, ch. 14. | Sec. II, ch. 14. | Sec. II, ch. 14. | Sec. II, ch. 14. |
| Cordage and mechanical maneuvers | Sec. IV, ch. 14. | Sec. IV, ch. 14. | Sec. IV, ch. 14. | Sec. IV, ch. 14. |
| Nomenclature of railroad track matériel, practical knowledge of packing journal boxes, brake mechanisms, buffers, and couplings. | ---------- | Sec. V, ch. 14. | Sec. V, ch. 14. | Sec. V, ch. 14. |

SECOND CLASS GUNNER—Continued

| Subjects | Headquarters batteries, 155-mm gun regiment (less supply platoon) or brigade | Headquarters batteries, railway battalion, regiment (less supply platoon), or brigade | Supply platoons, mobile gun regiments |
|---|---|---|---|
| Service of the piece | Secs. I and II, ch. 2. | Sec. I and sec. III, IV, or V, ch. 2. (See note 1.) | Sec. I and sec. II, III, IV or V, ch. 2. (See note 1.) |
| Nomenclature of the various parts of the gun, carriage, and emplacement matériel. | Par. 15. | Par. 16, 17, or 18. (See note 1.) | Par. 15, 16, 17, or 18. (See note 1.) |
| Action, care, and minor adjustment of the various parts of the gun and carriage. | Sec. I, ch. 4. | Sec. II, III, or IV, ch. 4. (See note 1.) | Sec. I, II, III, or IV, ch. 4. (See note 1.) |
| Powders, projectiles, primers, and fuzes, to include precautions in handling. | Sec. I, ch. 8. | Sec. I, ch. 8. | Sec. I, ch. 8. |
| Motor transportation | Secs. I and II, ch. 10. | | Secs. I and II, ch. 10. |
| Supplies | | | Ch. 13. |
| Nomenclature, action, and maintenance of the small arm with which the organization is equipped and its ammunition. | Sec. II, ch. 14. | Sec. II, ch. 14. | Sec. II, ch. 14. |
| Cordage and mechanical maneuvers | Sec. IV, ch. 14. | Sec. IV, ch. 14. | Sec. IV, ch. 14. |
| Nomenclature of railroad track matériel, practical knowledge of packing journal boxes, brake mechanisms, buffers, and couplings. | | Sec. V, ch. 14. | |

NOTE 1.—Candidates will be required to pass in the subjects prescribed in FM 4-150 for a firing battery of the same organization.

| Subjects | Headquarters battery, 155-mm gun battalion (less ammunition trains) | Ammunition trains, 155-mm gun battalion | Searchlight battery, 155-mm regiment |
|---|---|---|---|
| Service of the piece | Secs. I and II, ch. 2 | Secs. I and II, ch. 2 | |
| Nomenclature of the various parts of of the gun, carriage, and emplacement matériel. | Par. 15 | Par. 15 | |
| Action, care, and minor adjustment of the various parts of the gun and carriage. | Sec. I, ch. 4 | Sec. I, ch. 4 | |
| Powders, projectiles, primers, and fuzes, to include precautions in handling. | Sec. I, ch. 8 | Sec. I, ch. 8 | |
| Motor transportation | Secs. I and II, ch. 10 | Secs. I and II, ch. 10 | Pars. 54-56, incl. |
| Drill of the searchlight section | | | Sec. I, ch. 12. |
| Nomenclature of various parts of the searchlight. | | | Sec. II, ch. 12. |
| Nomenclature of various parts of the control system. | | | Sec. III, ch. 12. |
| Nomenclature, action, and maintenance of the small arm with which the organization is equipped and its ammunition. | Sec. II, ch. 14 | Sec. II, ch. 14 | Sec. II, ch. 14. |
| Cordage and mechanical maneuvers | Sec. IV, ch. 14 | Sec. IV, ch. 14 | Sec. IV, ch. 14. |

## FIRST CLASS GUNNER

| Subjects | 155-mm gun batteries | 14-inch railway gun batteries | 8-inch railway gun batteries | 12-inch railway mortar batteries |
|---|---|---|---|---|
| Duties of the range section | Ch. 5. | Ch. 5. | Ch. 5. | Ch. 5. |
| Use, orientation, and adjustment of observation instruments. | Ch. 6. | Ch. 6. | Ch. 6. | Ch. 6. |
| Pointing methods and instruments | Ch. 7. | Ch. 7. | Ch. 7. | Ch. 7. |
| Elementary definitions for SCA | Sec. I, ch. 9. | Sec. I, ch. 9. | Sec. I, ch. 9. | Sec. I, ch. 9. |
| Motor transportation | Secs. III to VI, incl., ch. 10. | ---------- | ---------- | |
| Use and care of telephones | Sec. I, ch. 11. | Sec. I, ch. 11. | Sec. I, ch. 11, | Sec. I, ch. 11. |
| Indication, identification, and characteristic features of warships. | Sec. I, ch. 14. | Sec. I, ch. 14. | Sec. I, ch. 14. | Sec. I, ch. 14. |
| Nomenclature, action, service, and drill of antiaircraft machine gun; its mount, ammunition, and targets. | Sec. III, ch. 14. | Sec. III, ch. 14. | Sec. III, ch. 14. | Sec. III, ch. 14. |

| Subjects | Headquarters batteries, 155-mm gun regiment (less supply platoon) or brigade | Headquarters batteries, railway regiment (less supply platoon) or brigade | Supply platoons, mobile gun regiments |
|---|---|---|---|
| Use, orientation, and adjustment of observation instruments. | Ch. 6. | Ch. 6. | |
| Elementary definitions for SCA | Sec. I, ch. 9. | Sec. I, ch. 9. | |
| Definitions for coast artillery, and particular definitions pertaining to supplies and supply functions. | ---------- | ---------- | Pars. 54, 55, and 57. |
| Motor transportation | Secs. III to VI, incl., ch. 10. | Secs. III to VI, incl., ch. 10. | Secs. III to VI, incl., ch. 10. |
| Use and care of telephones | Sec. I, ch. 11. | Sec. 1, ch. 11. | Sec. I, ch. 11. |
| Installation and operation of the brigade, regimental, or battalion telephone system and net, to include the duties of switchboard operators. | Sec. II, ch. 11. (See note 2.) | Sec. II, ch. 11. (See note 2.) | |
| Radio communication | Sec. III, ch. 11. (See note 2.) | Sec. III, ch. 11. (See note 2.) | |
| Indication, identification, and characteristic features of warships. | Sec. I, ch. 14. | Sec. I, ch. 14. | Sec. I, ch. 14. |
| Map reading | ---------- | ---------- | Sec. VI, ch. 14. |
| Orientation and reconnaissance | Sec. VII, ch. 14. | Sec. VII, ch. 14. | |

NOTE 2.—Section III, chapter 11, may be substituted for section II, chapter 11, in appropriate cases.

FIRST CLASS GUNNER—Continued

| Subjects | Headquarters batteries, 155-mm gun battalion (less ammunition train) | Ammunition trains, 155-mm gun battalion | Searchlight batteries, 155-mm gun regiment | Headquarters batteries, railway battalion |
|---|---|---|---|---|
| Use, orientation, and adjustment of observation instruments. | Ch. 6. | ---------------- | Ch. 6. | Ch. 6. |
| Transporting, handling, and storing ammunition. | ---------------- | Sec. II, ch. 8. | ---------------- | |
| Elementary definitions for SCA | Sec. I, ch. 9. | ---------------- | Sec. I, ch. 9. | Sec. I, ch. 9. |
| Definitions for coast artillery, and particular definitions pertaining to ammunition supply. | ---------------- | Secs. I and II, ch. 9. | ---------------- | Sec. II, ch. 9. |
| Motor transportation | Secs. III to VI, incl., ch. 10. | Secs. III to VII, incl., ch. 10. | Secs. III to VI, incl., ch. 10. | |
| Use and care of telephones | Sec. I, ch. 11. | ---------------- | Sec. I, ch. 11. | Sec. I, ch. 11. |
| Installation and operation of the brigade, regimental, or battalion telephone system and net, to include the duties of switchboard operators. | Sec. II, ch. 11. (See note 2.) | ---------------- | ---------------- | Sec. II, ch. 11. (See note 2.) |
| Radio communication | Sec. III, ch. 11. (See note 2.) | ---------------- | ---------------- | Sec. III, ch. 11. (See note 2.) |
| Care and operation of power plant | ---------------- | ---------------- | Sec. IV, ch. 12. | |
| Care and operation of searchlight | ---------------- | ---------------- | Sec. V, ch. 12. | |
| Care and operation of the control system | ---------------- | ---------------- | Sec. VI, ch. 12. | |
| Indication, identification, and characteristic features of warships. | Sec. I, ch. 14. | Sec. I, ch. 14. | Sec. I, ch. 14. | Sec. I, ch. 14. |
| Map reading | ---------------- | Sec. VI, ch. 14. | ---------------- | |
| Orientation and reconnaissance | Sec. VII, ch. 14. | ---------------- | ---------------- | Sec. VII, ch. 14. |

## CHAPTER 2

# SERVICE OF THE PIECE

NOTE.—The service of the piece as given in this chapter is intended only as a guide in the assignment of individuals and duties.



## SECTION I

## GENERAL



3. **Organization of gun section.**—*Q*. What is the manning detail for the emplacement of a mobile gun or mortar? *A*. The gun section, consisting of a gun (or mortar) squad, an ammunition squad, a staff sergeant (electrician) (14-inch guns only), and an artillery mechanic (in gun section for 14-inch guns only).

*Q*. What are the strengths of the gun sections for various types of mobile armament? *A*.

| | *Total of gun section* | *Numbered personnel in gun or mortar squad* | *Cannoneers in ammunition squad* |
|---|---|---|---|
| 155-mm guns | 20 | 8 | 5 |
| 14-inch railway guns | 40 | 14 | 13 |
| 8-inch railway guns | 26 | 10 | 7 |
| 12-inch railway mortars | 26 | 13 | 5 |

*Q*. What is the organization of the 155-mm gun squad? *A*. Gun commander, gun pointer, elevation setter, and 8 cannoneers numbered consecutively from 1 to 8, inclusive.

*Q*. What is the organization of gun (or mortar) squads manning railway artillery? *A*. Gun commander (chief of section), gun pointer, elevation setter, aiming rule operator, two display board operators, recorder (14-inch gun squad only), chief of breech, battery commander's telephone operator (except mortar squad), and the cannoneers numbered consecutively from 1.

*Q.* What is the organization of the ammunition squad? *A.* A chief of ammunition, and the prescribed number of cannoneers, numbered consecutively starting with the first number after those used for the gun or mortar squad. The squad is divided by its chief into details for the service of powder and projectiles.

*Q.* What is the formation of the gun section? *A.* Each section assembles in two ranks with 4 inches between files and 40 inches between ranks. The post of the chief of section (gun commander) is in the front rank, 1 pace to the right of his section. The artillery mechanics take post in the front rank on the left of the gun sections to which they have been assigned.

NOTE.—Except in the case of the 14-inch gun section artillery mechanics are not members of the gun sections.

**4. Duties of personnel.**—*Q.* What are the duties of the chief of section? *A.*

(1) The chief of section (noncommissioned officer) is in command of a gun section. He is responsible to the officer in charge of the emplacement for the—

(*a*) Training and efficiency of the personnel of his section.

(*b*) Condition of the matériel and ammunition under his charge.

(*c*) Emplacement of the gun and its preparation for firing, including camouflage discipline and gas discipline when necessary.

(*d*) Firing the piece.

(*e*) Observance of all safety precautions pertaining to the service of the piece.

(*f*) Police of the emplacement.

(2) He supervises the preparation of the firing position, the emplacement of the mount, removing the gun and mount from position, the loading of equipment, the service of the piece, and the service of ammunition. He personally directs the work of care and preservation of all matériel.

(3) The gun (or mortar) being emplaced for firing, he commands: 1. DETAILS, 2. POSTS, when the section arrives at the emplacement, and supervises the procuring of equipment. After all details have reached their posts, he commands: EXAMINE GUN. He then makes an inspection of the gun, carriage, and other matériel, paying particular attention to the recoil system, the recuperator system, the firing mechanism, all safety devices, the oiling of the various bearings, the condition of the emplacement, and the air compressor and the power plant (14-inch guns). He receives the reports of the chief of ammunition and of the chiefs of the various details of the gun

(or mortar) squad, and reports to the officer in charge of the emplacement, "Sir, No. ——— in order," or any defects he is unable to remedy without delay.

(4) When necessary to verify the section he commands: CALL OFF. The cannoneers of his section call off their titles or number, beginning with the unnumbered members, followed by the numbered members in order.

(5) He informs the chief of ammunition as to the projectile, fuze, and powder charge to be used.

(6) At the command TARGET he repeats the command and target designation. As soon as the gun pointer is on the target, he reports to the officer in charge of the emplacement, "Sir, No. ——— on target."

(7) At the command LOAD he repeats the command and supervises the loading. After the piece is loaded and pointed, he sees that all personnel are clear and then calls "No. ——— ready." The piece is not fired until the command COMMENCE FIRING has been given and the proper firing signal received.

(8) At the command COMMENCE FIRING, if the piece is unloaded, he commands: LOAD, and supervises the work of his section. He commands: LOAD, before each shot of a series. Upon receipt of the firing signal, he commands: 1. No. ———, 2. FIRE, unless this duty is performed by the gun commander.

(9) When the number of shots to be fired has been designated, he commands: CEASE FIRING, when the specified number of shots has been fired. In any case, he repeats the command CEASE FIRING when it is given by the battery commander. At the conclusion of a series of shots, he reports to the officer in charge of the emplacement, "Sir, No. ——— (so many) rounds fired."

(10) During firing he stations himself in such a position as best to observe the functioning of the gun squad and the gun. He pays particular attention to the action of the gun in recoil and counterrecoil in order that a loss of oil by leakage may be immediately corrected.

(11) In case of a misfire, he reports to the officer in charge of his emplacement, "No. ——— misfire," and sees that the prescribed safety precautions are observed.

(12) He keeps a record of the number of rounds fired by his gun, showing the date and approximate time in order that the emplacement book may be kept posted accurately and up to date.

(13) At the command REPLACE EQUIPMENT, he supervises the replacing of all equipment, sees that matériel and ammunition are

properly secured, and that the emplacement is properly policed. Then, unless otherwise directed, he forms his section.

*Q*. What are the duties of the gun commander? *A*.

(1) The gun commander (noncommissioned officer) is in command of a gun squad. If no chief of section is designated, the gun commander will, in addition to his other duties, perform the duties prescribed for the chief of section. He is responsible to the chief of section for the—

(*a*) Efficiency of the personnel of his squad.

(*b*) Condition of matériel under his charge.

(*c*) Observance of all safety precautions pertaining to the service of the piece.

(*d*) Police of the emplacement to which assigned.

(2) He supervises the preparation of the firing position, the emplacement of the mount and its removal from firing position, and the loading of the equipment.

(3) At the command EXAMINE GUN, given by the chief of section, he personally makes an inspection of the gun, carriage, and other matériel, paying special attention to the recoil cylinders, firing mechanism, safety devices, and the oiling of all movable parts. He also gives special attention to those parts most likely to cause trouble and to which special attention is directed by the pertinent Field Manuals and Technical Manuals.

(4) He receives the reports of the chiefs of the various details of the gun squad and reports to the chief of section, "No. ——— in order," or any defects he is unable to remedy without delay.

(5) At the command LOAD, he supervises the work of his squad.

(6) After the piece is loaded and pointed, the gun commander verifies the pointing as far as practicable, considering the mount or emplacement, the time allowed before firing, and the method of pointing being used. He receives the reports "Set" or a signal from the elevation setter and the gun pointer. He sees that all personnel are clear of the piece and have taken cover posts or firing posts. Thereafter, he either reports his piece ready and waits for the command or signal to fire or himself commands: 1. No. ———, 2. FIRE, when the proper firing signal is given, according to the system prescribed for his particular battery.

(7) When firing by case II and when the gun is ready to be fired, the gun commander calls or signals "No. ——— ready." The gun is then fired by the gun pointer or at the command of the gun pointer.

(8) When firing by case III, he is responsible that the piece is fired immediately upon receipt of the proper signal, safety precautions permitting.

(9) He commands: RELAY, in case the time-interval signal fails to sound at the gun or in case his gun is not ready to fire. He repeats the command RELAY when it is given by the chief of section.

(10) In case of a misfire, he calls "No. ——— misfire," and sees that the prescribed safety precautions are observed.

(11) At the command CEASE FIRING, when dummy ammunition is used, he sees that the piece is unloaded.

(12) At the command REPLACE EQUIPMENT, the gun commander supervises the replacing of equipment, sees that all matériel is properly secured, and then, unless otherwise directed, forms his squad and reports to the chief of section.

*Q*. What are the duties of the chief of ammunition? *A*.

(1) The chief of ammunition (noncommissioned officer) is responsible to the chief of section for the efficiency of the personnel of his squad, for the care of the ammunition and ammunition handling apparatus, for the uninterrupted service of ammunition, for the observance of all safety precautions in the care and service of ammunition.

(2) He keeps a record of all ammunition received, exercising particular care that the projectiles, fuzes, and powder charges are listed under proper name and type. He keeps the chief of section informed regarding the ammunition on hand and reports any defects found.

(3) At the command DETAILS, POSTS the chief of ammunition posts the members of his squad.

(4) At the command EXAMINE GUN he inspects the matériel under his charge, gives the necessary instruction for preparing ammunition and equipment for drill or firing, and reports to the chief of section "Ammunition service in order" or defects that he is unable to remedy without delay.

(5) At the command LOAD he directs and supervises the service of ammunition.

(6) At the command CEASE FIRING, when dummy ammunition is used, he causes the dummy projectiles and dummy powder charges to be put in their proper place.

(7) At the command REPLACE EQUIPMENT he supervises the replacing of equipment, sees that all ammunition and other matériel are properly secured, forms his squad, and reports to the chief of section.

*Q*. What are the duties of the display board operators? *A*.

(1) They are responsible to the gun commander (or chief of section) for the proper operation of the display boards and recording of all data received from the plotting room.

(2) At the command DETAILS, POSTS they procure chalk, blackboard erasers, forms for recording data, and the telephones, and take post at the display boards.

(3) At the command EXAMINE GUN, they clean the display boards if necessary, put on the telephone headsets, test the communication to the plotting room, and report to the gun commander (or chief of section), "Deflection (azimuth) display board in order" or "Range (elevation) display board in order," or report any defects they are unable to remedy without delay.

(4) At the command TARGET, they receive deflections (azimuths) or ranges (elevations) from the plotting room, post them on the display boards, and record them on the data forms.

(5) At the command CEASE FIRING, they continue posting and recording data received from the plotting room.

*Q.* What are the duties of the artillery mechanics? *A.* The artillery mechanics, assisted by members of the gun sections, make such minor repairs and adjustments as can be made with the means available. The chief artillery mechanic is the custodian of the supplies pertaining to the gun emplacements to which his battery is assigned. He is responsible for the condition of the storerooms pertaining to the gun emplacements and the supplies contained therein. The chief mechanic or his assistant issues such equipment, tools, oils, paints, and cleaning materials to the members of the gun sections as are necessary for the service and care of the guns and accessories.

**5. Notes on service of the piece.**—*Q.* How should service of the piece be conducted? *A.* The service of the piece should be conducted with dispatch and precision and with as few orders as possible. Commands should be given in the prescribed forms. Except for the necessary orders, reports, and instructions, no talking will be permitted. Cannoneers change position at a run.

*Q.* What use of signals may be made? *A.*

(1) Signals may be substituted for commands whenever desirable. Verbal commands should be kept to the minimum. During continuous firing no verbal commands should be necessary except in the case of accident or unforeseen emergency.

(2) Signals with whistles or bugles are authorized.

(3) The following visual signals may be used if desired:

(*a*) ELEVATE. Raise either hand to the height of the head, fingers pointing upward. Move the hand in short upward movements by flexing the hand at the wrists.

(*b*) DEPRESS. Raise either hand to the height of the head, fingers pointing downward. Move the hand in short downward movements by flexing the hand at the wrist.

(*c*) RIGHT or LEFT. Motion with either hand, palm turned and fingers pointing in the desired direction.

(*d*) READY. Raise and fully extend either arm vertically, hand and fingers open and in prolongation of the arm.

(*e*) CEASE FIRING. Raise the forearm in front of the forehead, palm to the front, and swing it up and down several times in front of the face.

NOTE.—The commands or signals ELEVATE, DEPRESS, RIGHT, LEFT, given in pointing, refer to the direction of motion of the muzzle.

*Q*. What is the purpose of the command STAND FAST? *A*. To halt all movements of matériel and personnel.

*Q*. Who normally gives the command? *A*. The battery executive (assistant battery executive), the chief of section, or the gun commander (chief of squad).

*Q*. What is the purpose of the command RELAY? *A*. When firing on time-interval signal, if it becomes apparent that a piece will not be pointed in time, the battery executive (or assistant battery executive) commands: RELAY.

*Q*. What is done at the command RELAY? *A*. Display board operators post new data on their display boards. The lanyard, if used, is slacked. The gun pointer and range setter continue to point the piece in direction and elevation as at the command TARGET.

**6. Safety precautions.**—*Q*. What is the purpose of the safety precautions prescribed in this paragraph? *A*. They are prescribed for peacetime conditions. They indicate as well the principles to be followed under war conditions but should be interpreted by the personnel concerned according to the circumstances existing at the time of any particular emergency.

*Q*. Who may give the command CEASE FIRING? *A*. Any individual in the military service will command or signal CEASE FIRING if he observes any condition which makes it unsafe to fire. At the command given when the piece is loaded, lanyards will be detached if firing by lanyard or the safety switch will be opened if firing electrically.

*Q*. What tests of the firing mechanism will be made before firing? *A*.

(1) The firing mechanism will be inspected and tested frequently and immediately before firing to insure proper operation and functioning of the safety features.

(2) To test the safety features of a mechanism using separate primers a friction primer will be inserted before the breech is rotated. A strong pull will be exerted on the lanyard while the block is being rotated to ascertain if it is possible to fire the primer before the breech is closed and locked. The mechanism will also be tested in a similar manner with an electric primer, the magneto being operated continuously while the breechblock is being closed.

(3) Previous to firing, each primer to be used will be inserted in turn in the obturator spindle in order to test the proper fit of each primer, and the firing leaf and slide will be lowered to their firing position in order to demonstrate that these parts will function properly with each primer.

*Q.* What precautions should be taken in the handling of primers? *A.*

(1) Prior to firing, the primer pouch will be examined to make certain that it contains live primers only.

(2) Care will be taken not to drop primers.

(3) Primers will not be inserted until after the breechblock has been completely closed and locked in its recess except to test the safety features of the firing mechanism as described in the preceding answer.

(4) Primers will never be inserted or removed by means of the button or wire.

(5) The greatest care will be exercised in lowering the leaf of the firing mechanism.

(6) Fired primers will be discarded as soon as they are removed from the firing mechanism.

(7) Primers that have failed will be handled with great care, due to the possibility of a primer hangfire, and will be turned in to the ordnance officer for inspection.

*Q.* How should the lanyard be pulled? *A.* The lanyard should be pulled with a quick, strong pull (not a jerk) from a position to the right of and as near the rear of the piece as conditions of safety will permit.

*Q.* What are the special precautions relative to the handling of fuzes? *A.*

(1) Projectiles equipped with base detonating fuzes normally will be received properly fuzed for firing. Projectiles equipped with point detonating fuzes normally will be received unfuzed and will be fuzed as required in the following manner:

(*a*) Unscrew the plug from the fuze socket.

(*b*) Insert the fuze, being careful to see that it is fitted with its felt or rubber washer, and screw it home by hand.

(*c*) Screw up the fuze with the fuze wrench but without using any great force.

(*d*) If there is any difficulty in screwing home the fuze, it should be removed and another inserted. If the same trouble is experienced with the second fuze, the shell should be rejected.

(2) The alteration of fuzes is forbidden except when specifically authorized by the Chief of Ordnance.

*Q*. What precautions are required in the handling of powder charges? *A*. All powder charges will be kept in their containers except the charge which is to be served to the piece for the next succeeding round. The powder charge for any given round will not be brought near the breech until the preceding round has been fired, the powder chamber sponged, and the face of the mushroom head wiped.

*Q*. What are the precautions concerning the sponging of the powder chamber? *A*. After each shot the powder chamber will be sponged and the face of the mushroom head wiped with the liquid prescribed for this purpose.

*Q*. What are the precautions concerning cover for the gun section? *A*. When cover is prescribed, each member of the gun section will be required to take adequate shelter each time the piece is fired.

*Q*. What precautions must be observed in case of misfire? *A*. A misfire occurs if the piece fails to fire when desired. In case of a misfire all personnel remain clear of the path of recoil, and the piece is kept pointed at the target or at a safe place in the field of fire.

(1) *Primer heard to fire*.—If the primer is heard to fire it will not be removed or the breechblock opened until 10 minutes have elapsed since the primer fired.

(2) *Primer not heard to fire*.—If the primer is not heard to fire, at least three attempts will be made to fire it. If a special device by which the primer can be removed by an individual standing clear of the path of recoil is available, the primer may be removed and examined 2 minutes after the last attempt to fire it. If the primer has not fired, a new one may be inserted and firing continued. If the primer has fired, a new primer will not be inserted nor the breechblock opened until at least 10 minutes have elapsed since the last attempt to fire.

## Section II

## 155-MM GUNS



**7. Drill.**—Instruction in service of the piece should be practical and should include actual drill and emplacement of the matériel assigned to the battery.

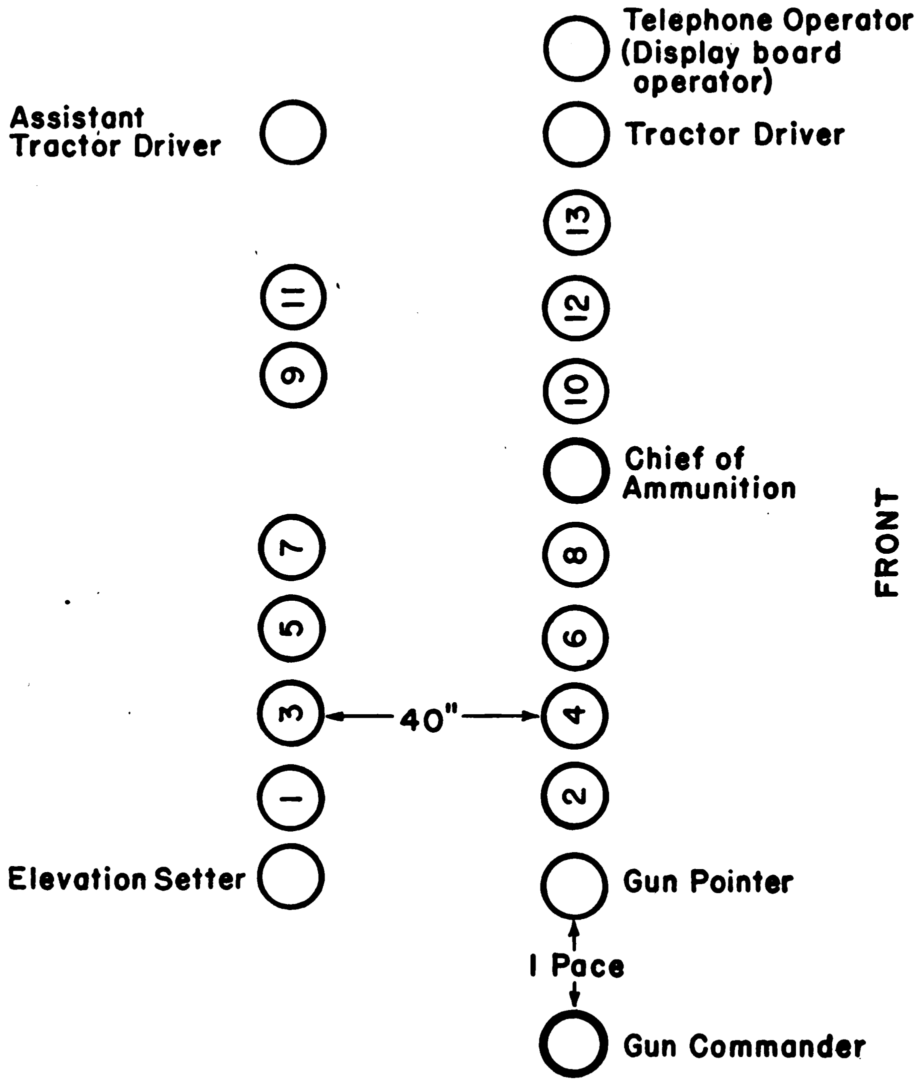


Figure 1.—Formation of 155-mm gun section.

*Q*. Describe the formation of the gun section. *A*. See figure 1.

*Q*. What are the posts of the cannoneers at the command details, posts? *A*. See figure 2 and table I.

*Q*. What is done at the command CALL OFF? *A*. The cannoneers of the section call off their titles or numbers in succession, beginning with the unnumbered members of the section, followed by the numbered members in order.

*Q*. What are the duties of the members of the gun section at the various commands? *A*. See table I.

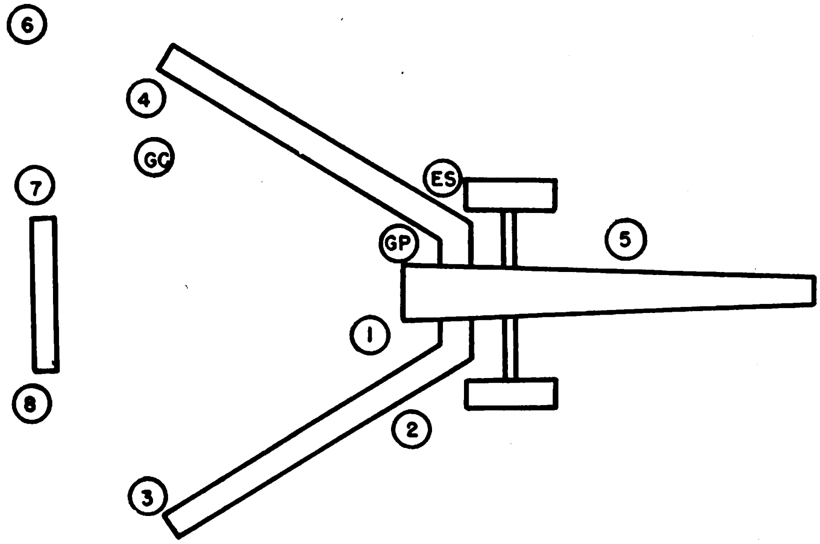


FIGURE 2.—Posts of 155-mm gun section.

TABLE I.—*Service of the piece, 155-mm gun*

| Details | DETAILS, POSTS | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| Gun pointer (noncommissioned officer). | Gets panoramic sight and telephone headset; removes sight bracket cover and places sight in bracket; connects headset to line; takes post on sighting platform facing front. | (a) Examines sight and traversing mechanism; tests telephone to plotting room.<br>(b) Reports to gun commander, "Sight, traversing mechanism, and deflection telephone in order," or defects he is unable to remedy. | Sets deflection (azimuth) received from plotting room and traverses piece to put his line of sight on target (aiming point); when the vertical crosswire is on the target (aiming point), calls, "On target"; continues to set data as received from plotting room and follow the target (point the piece in azimuth). | Repeats deflection (azimuth) received from plotting room and sets sight accordingly; keeps bubble in cross level centered; for case II firing, follows target with vertical cross wire of his sight by traversing piece, and, after hearing "Lanyard" from No. 1 and "Set" from the elevation setter, commands or signals: FIRE: for case III firing, completes the pointing in direction by traversing the piece; when his vertical cross wire is accurately on the aiming point (target) calls "Ready." | Continues receiving and setting data until command CEASE TRACKING is received. |
| Elevation setter. | Gets telephone headset, connects to line; takes post outside left trail, opposite quadrant sight, facing the sight. | (a) Examines sight micrometer and level, quadrant sight, and elevation mechanism; tests telephone to plotting room; verifies accuracy of quadrant sight.<br>(b) Reports to gun commander, "Quadrant sight, elevating mechanism, and elevation telephone in order," or defects he is unable to remedy. | Sets elevation received from plotting room and centers longitudinal bubble by elevating or depressing piece; continues to set data as received from plotting room and keeps longitudinal bubble centered. | Repeats elevation received over telephone; sets elevation on quadrant sight; elevates or depresses piece until bubble is centered, completing the centering operation after breechblock is closed; calls "Set." | Continues receiving and setting data until command CEASE TRACKING is received. |

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| No. 1 (breech detail). | Gets oil can and waste; takes post 1 foot to right and 1 foot to rear of breech, facing to left. | (*a*) Assisted by No. 2, removes breech cover and places it in a convenient position outside trails or in rear of a gun position; opens breech; examines breechblock, vent, bore, and chamber; closes breech, inserts firing mechanism, attaches lanyard, and tests firing mechanism.<br>(*b*) Reports to gun commander, "Breech and firing mechanism in order," or defects he is unable to remedy. | Removes firing mechanism and passes it to No. 2; ***opens breech; locks percussion hammer lock bolt;*** wipes off mushroom head and breech threads. | When piece is loaded, closes breech (if breech does not properly close reports, "Breech out of order"). ***After breech is fully rotated and locked in the closed position,*** receives loaded firing mechanism from No. 2 and inserts it in breechblock; attaches lanyard; unlocks percussion hammer lock bolt; calls "Lanyard"; fires piece at command FIRE of gun pointer (case II) or of gun commander (case III). | Detaches lanyard, removes firing mechanism and passes it to No. 2; opens breech; cleans breechblock, obturator, gas check seat, and vent. (If the piece is loaded with service ammunition the breech will not be opened unless the command UNLOAD is given.) |
| No. 2 (breech detail). | Gets pouch containing reamer, vent cleaner, extra firing mechanism, lanyard, and primers; takes post outside right trail, on line with breech facing to left. | (*a*) Assists No. 1 in removing breech cover; examines firing mechanism; when breech is closed, passes firing mechanism and lanyard to No. 1.<br>(*b*) No duties. | Receives firing mechanism from No. 1. | Inserts primer in firing mechanism; passes loaded firing mechanism to No. 1; inserts primer in extra firing mechanism for next round. | Receives firing mechanism from No. 1; removes primer from firing mechanism; cleans and oils mechanism. |
| No. 3 (rammer detail). | Assists No. 4 in bringing up sponging solution; brings up rammer and places it on rest near right trail, staff to rear; takes post in rear of right trail facing to front. | (*a*) Removes muzzle cover and puts it at the designated place.<br>(*b*) No duties. | No duties. | Places rammer against base of projectile and pushes projectile clear of loading tray; when loading tray has been removed, commands: HOME RAM, and assisted by No. 4 rams projectile; withdraws rammer and falls back to right trail. | If piece is to be unloaded, assisted by No. 4, extracts projectile. |
| No. 4 (sponge detail). | Assisted by No. 3, brings up sponge tub of sponging fluid; places it inside and near end of left trail; brings up chamber sponge and places it in tub; takes post in rear of left trail, facing to front. | (*a*) Sees that fluid is deep enough to cover head of sponge, and that the sponge fits properly in powder chamber of gun.<br>(*b*) No duties. | No duties. | While loading tray is being removed, grasps rammer stave in front of loading detail; assists in ramming projectile; returns to post at sponge tub, and sponges full length of powder chamber immediately after each round is fired. | If piece is to be unloaded, assists No. 3 in extracting projectile. |

TABLE I.—*Service of the piece, 155-mm gun*—Continued

| Details | DETAILS, POSTS | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| No. 5 (replenisher detail). | Gets millimeter scale for measuring position of replenisher piston, oil drain tube, and wrenches for drain plug and drain tube; takes post opposite and facing replenisher. | (*a*) Measures distance of replenisher piston from rear face of replenisher; when recoil or recuperator cylinders require draining or filling, duties as prescribed in FM 4-25.<br>(*b*) Reports to gun commander, in millimeters, the distance of replenisher piston from rear face of replenisher. | No duties. | Measures and reports position of replenisher piston to gun commander after each round. | If piece is to be unloaded, assists in unseating projectile on call from No. 3. |
| No. 6 (powder serving detail). | Takes post at powder pit. | (*a*) Assists ammunition detail in preparing powder charges. When necessary, brings up pump assisted by No. 7, and assists No. 5 in refilling recoil or recuperator cylinders.<br>(*b*) No duties. | No duties. | Receives powder charge from No. 10, and moving at a run carries it to breech; as soon as projectile is rammed and breech clear, inserts powder charge. | If piece is to be unloaded, withdraws powder charge and carries it to No. 10. |
| No. 7 (loading detail). | Gets loading tray and places it on loading tray stand; takes post on left of projectile board, facing piece. | (*a*) When necessary, assists No. 6 in bringing up pump, and assists No. 5 in refilling recoil or recuperator cylinders.<br>(*b*) No duties. | Nos. 7 and 8 carry loading tray to projectile board ready to receive fuzed projectile from No. 9. | Nos. 7 and 8 lift loading tray with projectile thereon, placing it in breech; No. 7 removes loading tray after projectile has been pushed clear of tray and before it is rammed home. | If piece is to be unloaded, Nos. 7 and 8 insert loading tray in breech and receive projectile, No. 7 steadying the backward movement of the projectile with an extra rammer or pick handle. They return tray and projectile to loading tray stand. |

| | | | | | |
|---|---|---|---|---|---|
| No. 8 (loading detail). | Gets loading tray stand and places it in rear of and in line with gun, between trails; takes post on right of projectile board, facing piece. | (a) No duties.<br>(b) No duties. | Duties under No. 7 above. | Duties under No. 7 above. | Duties under No. 7 above. |
| No. 9 (ammunition detail). | Gets fuze wrench; takes post in rear of projectile board, facing piece. | (a) Inspects projectiles on projectile board, cleaning them if necessary.<br>(b) No duties. | Repeats name or type of fuze called by gun commander; fuzes projectile for first round. | Places fuzed projectile in loading tray; fuzes another projectile for succeeding round. | Removes fuze from projectile and returns it to No. 11; removes projectile from loading tray, placing it on projectile board, and removes fuze. |
| No. 10 (ammunition detail). | Takes post at ammunition pit. | (a) Opens powder cases and arranges powder containers in convenient order.<br>(b) Reports "Ammunition in order." | Repeats projectile designation. | Withdraws powder charge from container, removes increment charge if normal charge is ordered, and hands charge to No. 6. | Receives from No. 6 the withdrawn charge and replaces it in container. |
| No. 11 (ammunition detail). | Takes post at ammunition pit. | (a) Opens box containing fuzes to be used.<br>(b) No duties. | No duties. | Assists No. 9 in fuzing projectiles. | Receives from No. 9 the fuzes removed from projectiles and disposes of them as directed. |
| No. 12 (ammunition detail). | Takes post at ammunition pit. | (a) Assists other members of the ammunition squad as required.<br>(b) No duties. | No duties. | Places projectiles on projectile board as needed. | No duties. |
| No. 13 (ammunition detail). | Takes post at ammunition pit. | (a) Assists other members of the ammunition squad as required.<br>(b) No duties. | No duties. | Places projectiles on projectile board as needed. | No duties. |

**8. Emplacement.**—*Q*. What is done at the command PREPARE FOR ACTION given by the executive while the gun is on the road in march order? *A*. The gun commander has the gun placed in the indicated position, the gun is put in firing position, and the emplacement is prepared.

*Q*. What does the ammunition squad do at the command PREPARE FOR ACTION? *A*. They construct ammunition pits or shelters and prepare ammunition for service. They may also be used to clear fields of fire or to relieve members of the gun section who have the heavier jobs.

*Q*. What is done at the command UNCOUPLE, given by the gun commander? *A*. Nos. 7 and 8 take position at the drawbar. No. 7 unlatches the pintle latch and with the assistance of No. 8 raises the drawbar from the pintle and signals the tractor driver to move on.

*Q*. What is done at the command IN FIRING POSITION? *A*. Nos. 1 and 2 line up chocks and chock the wheels. Nos. 3 to 8 remove the spades and place them in rear of the spade hole positions. Nos. 1 and 2 remove the gun translating rack covers and secure the ratchet wrenches. No. 3 removes the breech, muzzle, and piston rod covers and secures the special recoil and recuperator wrench. Nos. 1 and 2 release the traveling clips, attach the ratchet wrenches, and working together under the direction of the gun pointer bring the gun into battery. No. 3 takes position between the trails and screws on the recoil and counterrecoil piston rod nuts, releases the traveling bar, passing it to Nos. 1 and 2, and replaces the special wrench in its chest.

*Q*. What is done at the command UNLIMBER? *A*. Nos. 4 to 8 bring up the jack beam and place it in position, assisted by No. 3 who guides the beam lug into the eye of the maneuvering lug and secures it with the key. Nos. 4, 5, 6, and 7 bring up the jacks and sufficient blocking. No. 8 inserts the vertical drawbar pin. The tractor is backed up to the drawbar which is being held by Nos. 7 and 8, who lower it into the tractor pintle. The limber may be handled by manpower if desirable. Nos. 5 and 6 disconnect the brake cables. Nos. 1 and 2 unfasten and remove the draft rods and seat assembly. Nos. 4, 5, 6, and 7 operate the jacks together under direction of the gun pointer until the ends of the trails are clear of the limber. Nos. 1 and 2 place blocks or half blocks under the trails to keep them from falling should the jacks slip. No. 8 inserts the horizontal drawbar pin, and the limber is moved straight to the rear on signal from the gun commander.

*Q*. How are the spade holes marked? *A*. Nos. 1 and 2 remove the blocking as the trails are lowered. Nos. 4, 5, 6, and 7 operate the blocks and lower the trails until the ends are about 1 foot above the ground. No. 11 removes the trail coupling pin, and Nos. 1 and 2 place blocks in an arc so that the trails are constantly over blocking as they are spread. Nos. 5, 6, 7, and 8 open both trails simultaneously until stopped by the trail locking bolts, and the gun commander marks on the ground the outline of the spade holes, being guided by the spade connecting plates.

*Q*. How are spade holes dug? *A*. The trails are partially closed by Nos. 5, 6, 7, and 8 so as to clear the positions for the spade holes. The entire gun section digs the spade holes in such a way as to leave unbroken ground between the spade faces. This lessens the back slips when the piece is fired.

*Q*. How are the spades attached? *A*. Nos. 1 to 8 place handspikes through the spade maneuvering rings and lower the spades into the spade holes. The trails are then opened, and Nos. 1 and 2 screw down on the trail locking bolts. Nos. 1 and 2 then unscrew the spade locking bolts and swing them outward. Nos. 3 to 8 lift the spades into position under the spade connecting plates, and Nos. 1 and 2 screw up on the spade locking bolts. When the spade locking bolts are screwed up completely Nos. 1 and 2 remove the blocking from under the trails and Nos. 4, 5, 6, and 7 lower the trails completely. Nos. 1, 2, 3, and 4 remove the jacks and jack beam, and the other members of the gun section make the spades secure, tamping the ground around them firmly into place.

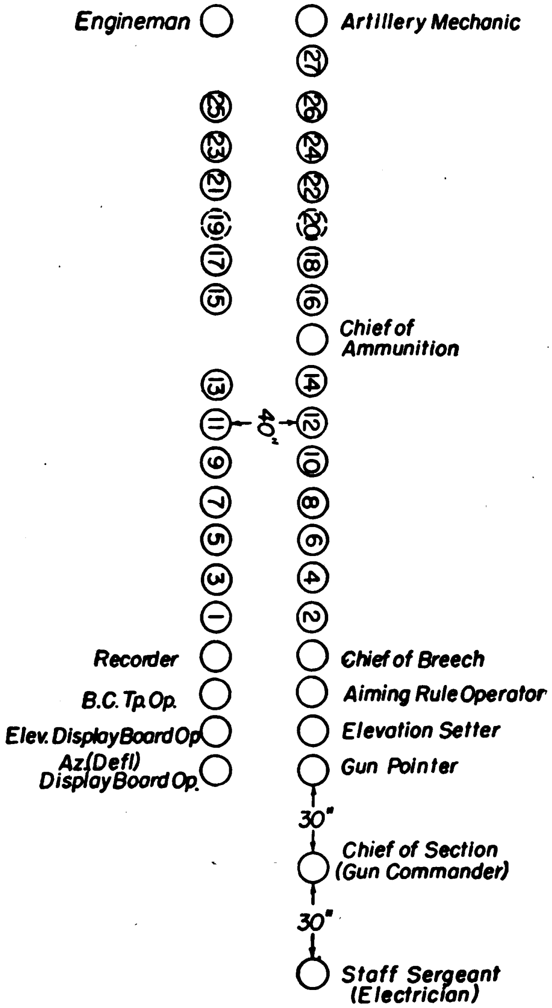
*Q*. How is the weight of the gun taken off the springs? *A*. Nos. 4, 5, 6, and 7 bring up jacks and blocking and adjust the jacks under the front maneuvering lugs. Supervised by the gun pointer they operate the jacks until the spring is relieved of the weight of the carriage. Nos. 1 and 2 then remove the spring shackle bolts, push the shackles outward from the ends of the spring, and replace the bolts in the shackles. Nos. 4, 5, 6, and 7 then lower the jacks until the gun axle is in contact with the two axle centering pins. The gun commander inserts the axle pivot pin and closes the cover. If he has trouble in inserting the pin he directs the operation of the jacks so as to bring the pivot holes in line.

*Q*. Who digs the recoil pit? *A*. The entire gun section, directed by the gun commander.

*Q*. In emplacing the gun and withdrawing it from action is there any general rule as to where the various men work? *A*. Yes. All odd-numbered cannoneers work on the right of the gun and the even numbers on the left.

*Q*. When the executive commands MARCH ORDER, what is the first thing to be done? *A*. The recoil pit must be filled in. The entire gun crew helps in this work.

*Q*. What is the general procedure in limbering the gun? *A*. In general the procedure is the reverse of placing the gun in position, and the men of the gun crew have corresponding duties.




NOTE.—At peace strength Nos. 19 and 20 are eliminated.

FIGURE 3.—Formation of gun section for 14-inch railway gun.

## SECTION III

## 14-INCH RAILWAY GUNS

**9. Drill.**—Instruction in the service of the piece should be practical and should include actual drill and emplacement of the matériel assigned to the battery.

*Q.* How is the gun section formed? *A.* See figure 3.

*Q.* What are the posts of the cannoneers at the command DETAILS, POSTS? *A.* See figure 4.

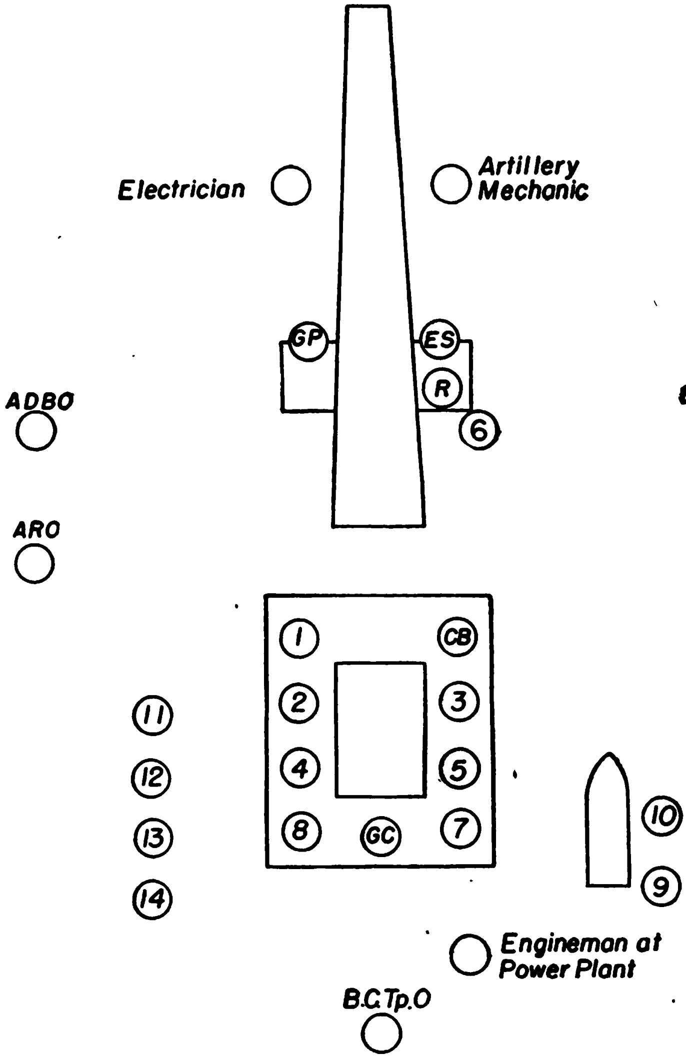



FIGURE 4.—Posts of cannoneers at command DETAILS, POSTS.

*Q.* What is done at the command CALL OFF? *A.* The unnumbered cannoneers call off their designations, beginning with the gun pointer; the numbered cannoneers then call off in succession, beginning with No. 1.

*Q.* What are the duties of the members of the gun section at the various commands? *A.* See table II.

TABLE II.—*Service of the piece, 14-inch railway gun*

| DETAILS | DETAIL, POSTS, | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| Gun pointer (noncommissioned officer). | Procures sight, places it in its seat and takes post on sighting platform or at azimuth index box, facing piece. | (a) Examines and adjusts sight; verifies adjustment of azimuth index; examines and tests traversing mechanism, both hand and power, and electric firing circuit; and supervises and assists in adjustment of aiming rule.<br>(b) Reports to gun commander, "Traversing in order," or any defects he is unable to remedy without delay. | See note 1. | Continues setting data as at command TARGET. When firing by case III, calls or signals, "Azimuth (deflection) set," and if firing by electricity fires piece at command FIRE, given by gun commander. When firing by case II, fires piece or commands: FIRE, to No. 1 after gun commander has called "Ready." | Continues setting data until CEASE TRACKING is received. |
| Elevation setter (noncommissioned officers). | Takes post at quadrant, facing it. | (a) Assisted by No. 6, examines and adjusts quadrant; examines and adjusts elevating mechanism, both hand and power; and checks clearance of trunnions by means of clearance gage.<br>(b) Reports to gun commander, "Elevation in order." or any defects he is unable to remedy without delay. | See note 2. | Continues setting elevations on his quadrant as posted on display board; at the command or signal ELEVATE, given by chief of breech, directs No. 6 to elevate piece until bubbles of quadrant levels are centered; sets elevating brake; and calls or signals "Elevation set." As soon as piece has been fired, directs No. 6 to depress piece to loading position as rapidly as practicable. | Continues setting data until CEASE TRACKING is received. When dummy ammunition is used, directs No. 6 to depress piece to loading position. |

| | | | | | |
|---|---|---|---|---|---|
| Chief of breech (noncommissioned officers). | Assists No. 1 in procuring his cleaning material and equipment and takes post on folding platform to right rear of breech, facing it. | (a) Assists No. 1 in removing breech cover; examines breech mechanism, breechblock, breech recess, chamber and bore, and gives necessary directions for cleaning and preparing them for firing or drill.<br>(b) Reports to gun commander, "Breech in order," or any defects he is unable to remedy without delay. | Stands by. | Assists No. 1 in opening breech; commands HOME RAM, for seating projectile and checks loading of powder charge. As soon as piece is loaded, opens breech closing air valve. If there is no air, assists No. 1 in closing breech by hand. When piece is ready to elevate, commands or signals: ELEVATE, and takes his designated firing post. After piece is fired, assists No. 1 in opening breech, wipes off mushroom head, and as soon as chamber and bore are clear, shuts off gas ejection air valve and calls "Bore clear." If there is no air, assists No. 1 in sponging chamber and breech recess. | When dummy ammunition is used, assists in opening breech and supervises unloading. |
| No. 1 (breech detail). | Procures firing mechanism, lanyard (if required), primer, pouch, primers, drill, reamer, and cotton waste. Takes post on folding platform to left rear of breech, facing it. | (a) Assisted by chief of breech, removes breech cover and places it as directed; cleans and oils breechblock, breech mechanism, and breech recess; examines and cleans firing mechanism, vent, and primer seat; attaches firing mechanism; and places coiled lanyard within reach on left side of platform. If necessary, assists in sponging chamber and bore.<br>(b) Reports to chief of breech any defects of matériel. | Stands by. | As soon as breech is closed and locked, stands clear and inserts primer; raises sliding wedge; and steps off folding platform to left and rear, tripping platform as he does so. If firing by lanyard, fires piece. As soon as piece has been depressed to loading position, pushes down folding platform, pulls breech rotating lever, and assisted by chief of breech lowers breechblock. Assists Nos. 2 and 3 in seating spanning tray in breech recess. If necessary, assists loading tray detail in ramming home powder charge. | Unhooks lanyard, if used, and removes primer. When dummy ammunition is used, assists in withdrawing dummy powder charge and projectile. |

TABLE II.—*Service of the piece, 14-inch railway gun*—Continued

| DETAILS | DETAIL, POSTS, | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
| --- | --- | --- | --- | --- | --- |
| No. 2 (chief) and Nos. 3, 4 and 5 (loading tray detail). | No. 2 procures cotton waste, and assisted by Nos. 11, 12, 13, and 14 brings up vessel containing sponging liquid (if used) and places it at designated position. No. 3 procures hand and power extractors and places them as designated. Nos. 4 and 5 procure chamber and bore sponges and place them in a convenient position: Nos. 2 and 4 take post on left and Nos. 3 and 5 on right of loading tray, all facing tray. | (a) No. 2 examines, cleans, and oils bearings of spanning tray. No. 3 examines, cleans, and oils projectile stop. Both men assist No. 1 on breech mechanism. No. 4 removes stop pin on loading tray and assisted by No. 5 insures that spanning tray will properly enter breech recess. All four men assist in sponging bore and chamber when directed.<br>(b) No. 2 reports to gun commander, "Loading tray in order," or any defects he is unable to remedy without delay. | See note 3. | Nos. 4 and 5 guide projectile and powder tray to proper positions on loading tray. They release shot tongs and signal hoist operators when to raise and clear tongs and tray from loading tray. When chief of breech calls "Bore clear," No. 4 removes stop pin and assisted by No. 5 slides spanning tray forward to Nos. 2 and 3, who guide tray into breech recess. At command HOME RAM, No. 3 releases projectile stop and all four assist in pushing projectile into gun. The powder sections are pushed into chamber. No. 3 being responsible that last section has igniter on rear end. As soon as powder charge has cleared spanning tray, Nos. 4 and 5 slide tray back until No. 4 can secure it with stop pin. | When dummy ammunition is used, they assist in withdrawing dummy powder charge and projectile to their proper positions on loading tray and deliver same to hoists if so directed. No. 3 fixes tackle to projectile for withdrawing it from gun. |
| No. 6 (elevating detail). | Procures oil and cleaning material and takes post at elevating control mechanism, facing piece. | (a) Assists elevation setter in examining, cleaning, and oiling elevating mechanism, both hand and power, and in checking clearance of cradle trunnions.<br>(b) No duties. | Depresses piece to loading position. | Operates elevating control mechanism as directed by elevation setter. As soon as piece is fired, depresses it as rapidly as possible to loading position. | Depresses piece to loading position unless otherwise directed. |

| | | | | | |
|---|---|---|---|---|---|
| Nos. 7 and 8 (hoist detail). | Procure operating levers for hoist controls and place them on their shafts. No. 7 takes post at projectile hoist and No. 8 at powder hoist. | (*a*) Examine, clean, and oil hoists, cables, and controls and test hoists with power to insure that stops are functioning.<br>(*b*) No. 7 reports to gun commander, "Hoists in order," or any defects they are unable to remedy without delay. | See note 4. | No. 8 raises powder charge, swings it over, and lowers it on loading tray. When signaled by No. 4 or 5, raises tray, swings it out, and lowers it for next charge. As soon as piece is fired, No. 7 raises next projectile and places it on loading tray. When signaled by No. 4 or 5, raises tongs, swings them out, and lowers them for next projectile. | When dummy ammunition is used, No. 8 removes dummy powder charge from loading tray and lowers it to powder serving detail. No. 7 lowers dummy projectile to projectile serving detail or places it as directed. |
| Nos. 9 and 10 (projectile serving detail). | Procure cleaning material and take post at position from which projectiles are to be served. | (*a*) Examine projectiles to be used, clean them, see that they are properly marked for tongs and fasten tongs to first projectile.<br>(*b*) No. 9 reports to gun commander, "Projectile service in order," or any defects they are unable to remedy without delay. | See note 5. | Fasten tongs to projectiles when tongs are lowered; No. 9 signals No. 7 when ready to hoist and has projectile stopped and lowered if it is not properly secured. Have next projectile ready for raising as soon as piece is fired. | When dummy ammunition is used, receive dummy projectile from hoist and place it in designated position |
| No. 11 (chief) and Nos. 12, 13, and 14 (powder serving detail). | Procure powder tray; assist No. 2 in procuring sponging liquid; assist in procuring such other material as may be directed; and take posts at powder tray, facing piece. | (*a*) Nos. 11 and 12 examine and clean powder tray. Nos. 13 and 14 remove muzzle cover and place it as directed. Assist artillery mechanic in adding gas and liquid to recuperator and recoil systems if necessary.<br>(*b*) No. 11 reports to gun commander, "Powder service in order," or any defects he is unable to remedy without delay. | No duties. | Receive powder charge from powder detail; place it on powder tray; and No. 11 signals No. 8 to hoist charge. As tray is hoisted, guide it by two ropes attached to each end. No. 11 assures that igniter is placed at one end of powder tray. | When dummy ammunition is used, receive dummy powder charge from hoist and place it in designated position. |

NOTES

1. At command TARGET, gun pointer sets azimuth (deflection) posted on display board on his sight, traverses gun so as to sight on aiming point; centers bubbles on cross levels of sight; checks setting of sight on aiming point and calls or signals "Azimuth (deflection) set." If azimuth circle is used, lays gun at azimuth posted on display board.

2. At command TARGET, elevation setter sets elevations posted on display board on quadrant. Directs No. 6 to depress piece to loading position.

3. At command TARGET, Nos. 2 and 3 stand by. Nos. 4 and 5 guide first projectile onto loading tray, release tongs, and signal No. 7 to raise and clear tongs from loading tray.

4. At command TARGET, No. 7 raises projectile to loading tray, then returns tongs to projectile serving detail. No. 8 lowers powder tray to powder serving detail to receive powder charge.

5. At command TARGET, No. 9 signals No. 7 to hoist first projectile to loading tray.

**10. Emplacement.**—*Q.* How should the track be prepared for field emplacement before the gun arrives? *A.* All ties must be well-bedded and tamped. The spikes must be driven in solidly and all rail joints bolted tightly. If the ground under the roadbed is soft,

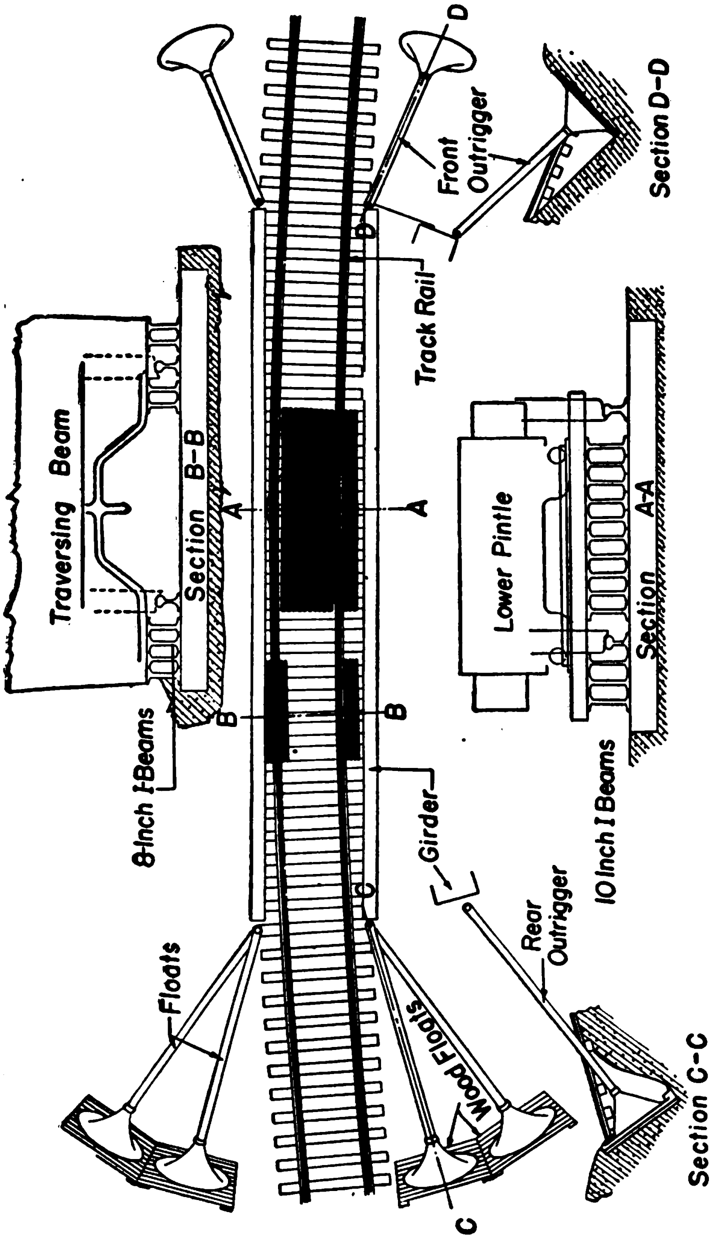



FIGURE 5.—Field emplacement of 14-inch railway gun.

extra ties or bridge timbers should be placed under the rails to give additional bearing surface on the ground for the I-beams.

*Q.* What digging should be done before the gun arrives? *A.* The pits for the outrigger floats should be dug, and plenty of ballast should be on hand for banking. The wooden floats should be placed in position in the pits. (Fig. 5 shows the positions for the outriggers and floats when the track has a curvature of 9½°.)

*Q*. How should the I-beams be placed? *A*. The twelve 10-inch I-beams are centered under the location of the lower pintle base plate. The number placed between and outside of the rails will depend on the curvature of the track, if any. The eight 8-inch I-beams are centered under the location of the mount traversing beam. The I-beams must have a solid bearing on all ties.

*Q*. What means are used to move the mount over the field emplacement? *A*. If it can be done, the locomotive which hauls the mount to the position is used to push or pull the mount onto the field emplacement. If this is not practicable the battalion locomotive or the hand translating mechanism is used.

*Q*. Describe the movement onto the field emplacement. *A*. The movement is made slowly and carefully, and the mount is stopped when the lower pintle base plate is centered over the I-beams. The lower pintle traveling lock is released. The firing wedges are placed under all the journal boxes of the trucks. The power plant, which should have been started as the mount approached the emplacement, is connected to the mount by the short interconnecting cables. All the girder side platforms are unfolded, and the mount is ready to be lowered on the platform.

*Q*. How is the mount lowered when using power? *A*. The traveling stops at both ends of the girders are withdrawn by turning the appropriate handwheels on each body bolster (see fig. 6). The clutch levers which are on the left side of each body bolster are set at the position marked "Motor." The control shaft of the A-end of the hydraulic speed gear, located near the top carriage raising motor, is placed in the neutral position. The top carriage raising motor is started by shifting the clutch lever located at the front of the right raising gear bracket to the position marked "Power raise or lower mount on trucks." The main line switch in the control panel is closed, and the handle of the drum controller is turned in a clockwise direction as far as it will go. The motor and the A-end of the speed gear will now be running at full speed. The control shaft of the A-end of the speed gear is turned in the direction indicated for lowering. It is probable that one end of the mount will be lowered before the other, but the automatic stops will prevent damage to the mechanism.

*Q*. How is the mount lowered by hand? *A*. The cranks are placed on the fast motion shaft on each side of each body bolster. The traveling stops are withdrawn by turning the appropriate handwheels on each body bolster (see fig. 6). The clutch levers which are on the left side of each body bolster are set at the position marked "hand." The cranks are turned in the direction indicated on the direction plate to "lower." Four men are required on each crank.

*Q.* How are the outriggers swung out? *A.* When the mount has been lowered so that the lower pintle base plate and the mount traversing beam are resting on the I-beams (see fig. 5), the top carriage raising motor is stopped by turning the drum controller handle to the "off" position if the mount is being lowered by power. The six outriggers are swung into their positions. The front outriggers are swung into position by means of the 1-ton triplex blocks attached to each hanger. The ammunition cranes are used to swing the rear outriggers into position.

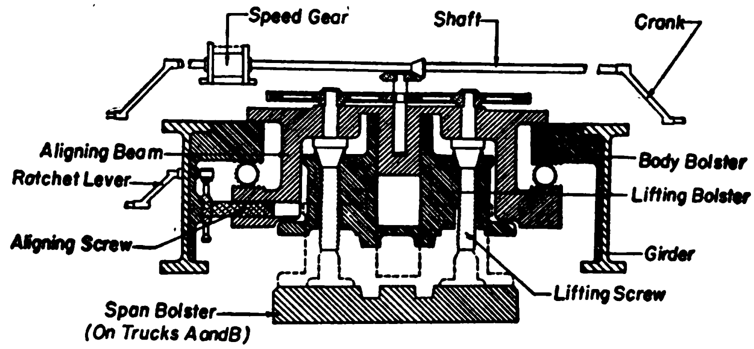



FIGURE 6.—Mount raising and alining mechanism, 14-inch railway gun.

*Q.* Describe the setting of the outriggers. *A.* When the wooden floats have been placed, the six outriggers are swung into position in the sockets of the floats and the ends are screwed to a solid bearing. The wooden floats are banked and tamped. If the ground is soft the outriggers may not hold and it will be necessary to brace them with bridge timbers. When the outriggers have been screwed to a solid bearing in the steel floats the mount is slowly lowered until the lifting bolsters (see fig. 6) are just touching the center plates of the span bolsters. The lifting bolsters are then run down until they just make contact with the span bolsters. The speed gears are stopped by turning the control shaft on the A-end to the neutral position.

*Q.* What becomes of the trucks when the gun is emplaced in the field position? *A.* They are left under the mount but they do not support any of the weight.

*Q.* How may they be moved if desired? *A.* The four cranks are placed on the shafts of the translating mechanism and clamped. Two cranks are placed on the B truck and two on the C truck. The clutch levers on each translating mechanism are pulled out to the position marked "in." If the wheel brakes are on they are released. The trucks without the mount can be moved by one man on each crank, but if the track is not perfectly level the men will probably require the assistance of other cannoneers.

*Q*. What preparations should be made before the top carriage is raised? *A*. The clutch lever at the front of the right raising gear bracket is shifted to the position marked "power raise or lower top carriage." The gun traveling lock bracket and all timbers or blocking which support the muzzle of the gun are removed. The top carriage raising screws are cleaned and well-lubricated. All bolts and other parts which have worked loose and are liable to become caught between the girders and the side frames are tightened or removed.

*Q*. How is the top carriage raised? *A*. The drum controller is turned slowly in the direction for raising the controller handle, being held on each notch for a few moments until the one-half speed position is reached. As the top carriage nears the firing position the controller handle is turned back until the top carriage is rising very slowly, and the handle is held in this position until the motion is stopped by the limit switch.

*Q*. What special precautions have to be taken when raising the top carriage? *A*. Be sure that the cranks for hand raising or lowering the carriages are not on the ends of the cross shaft. A speed higher than one-half should not be used unless it is absolutely necessary. The raising mechanism, especially the raising screws, must be observed continuously for overheating caused by the great weight (140,000 pounds) on each screw. It may be necessary to force grease into the nut housings frequently while the top carriage is being raised.

*Q*. How long does it take to raise the top carriage? *A*. It can be raised in approximately 16 minutes.

*Q*. How may the top carriage be raised by hand? *A*. The clutch lever at the front of the right raising gear bracket is shifted to the position marked "power traverse of mount also hand raising or lowering of the top carriage or of mount on trucks." A crank is placed on each end of the cross shaft and turned in the direction marked "raise." Four men are required on each crank.

*Q*. How is the firing support moved into position? *A*. When the top carriage has been raised to the firing position the bolts which lock the firing support to the raising gear brackets are unlatched. The cranks are placed on the ends of the translating shafts, one on each side of the firing support, and turned in the direction to move the firing support to the rear. Two men are required on each crank.

*Q.* What precautions must be taken when moving the firing support to the rear? *A.* Be sure that the large nut on the bottom of the side frame transom is in the correct position to receive the cross head in the top of the firing support. The nut can be moved by turning the top carriage traversing handwheel.

*Q.* How is the firing support secured in position? *A.* When the firing support has been moved to the rear as far as it will go the latch bolts fastening it to the horizontal girder transom are tightened. The clip lever at the rear of the firing support is moved to a horizontal position. The firing locks located on each side of the firing support are unlatched and thrown outward.

*Q.* In what position are the raising screws left? *A.* When the firing support has been locked in position under the top carriage the raising screws are run down as far as they will go.

*Q.* When are the ammunition cranes set up? *A.* At the same time that the mount is being lowered onto the I-beams, so that they will be ready to swing the rear outriggers to their seats in the floats.

*Q.* How are the ammunition cranes set up? *A.* The clutch levers on each side of the loading platform and below the cranes are shifted to the position marked "hand." Cranks are placed on the fast motion shafts marked "ammunition cranes" and turned in the direction marked "raise." At the same time the tie rods are lifted until the pin which fastens them to the tie rod post can be inserted. The pin is locked by giving it a one-half turn. The toggle pins which lock the boom extension to the boom are removed. The crank is turned, raising the boom extension until it can be locked to the boom at their junction by the lever pins. The pin is inserted and locked by giving it a one-half turn.

*Q.* How is the loading tray set up? *A.* The loading platform which is folded in the loading platform trunk for traveling is set up. The railings are placed about this platform. Using one of the ammunition cranes and a rope sling, the loading tray is raised to its position and the pins at each end are inserted and given a one-half turn.

*Q.* What preliminary preparation is made to place the gun on a fixed emplacement? *A.* A reinforced concrete emplacement will be prepared with a base plate and base ring set in the concrete and bolted down. Before moving the gun into position, this emplacement should be inspected to be sure it is in order, that the bridge rails are in place and bolted down, and that the four hinged rails are in the proper position. All sand and dirt should be cleaned off the emplaced material, especially the cable ducts, and the tapped holes in the base plate and the top surface of the base ring.

*Q.* Should any preliminary work be done on the gun mount? *A.* Yes. The under side of the lower pintle base plate and the holes drilled in it must be thoroughly cleaned. The under surface of the traversing beam must be cleaned and the traversing rollers cleaned and oiled.

*Q.* How is the mount moved onto the emplacement? *A.* It is pushed on the emplacement by a locomotive if possible so that the lower pintle base plate is centered as closely as possible over the base plate. The lower pintle traveling lock is released. The two rear bridge rails are removed, and the rear hinged rails are swung into their recesses in the emplacement. The firing wedges are placed under all the journal boxes of the trucks.

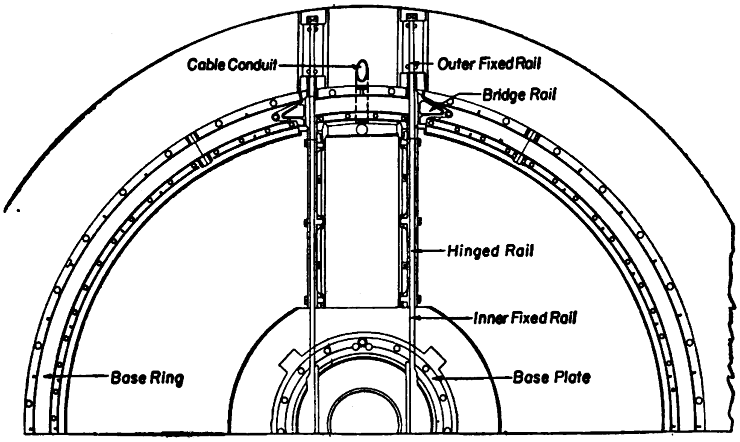


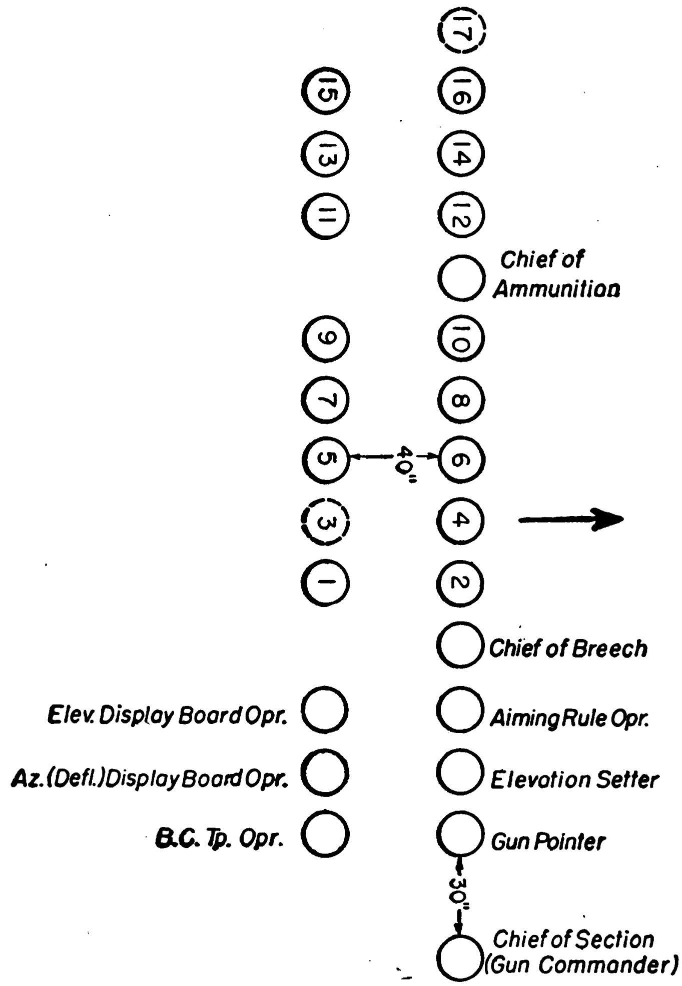

FIGURE 7.—Permanent emplacement, 14-inch railway gun.

*Q.* How is the mount centered over its position? *A.* Lowering is started in the same manner as for the field platform. Lowering of the mount is stopped when the lower surface of the lower pintle base plate is almost flush with the top surface of the base plate. The position is then checked to be sure that the lower pintle base plate will enter the recess in the base plate.

*Q.* If the mount requires movement along the track, how is this done? *A.* In the same manner as described for the field carriage.

*Q.* If the mount requires movement crosswise of the tracks, how is it done? *A.* The mount alining mechanism is used. This mechanism is located in the front body bolster. The locking pin is unscrewed by turning the handwheel at the center of the front end of the body bolster. The ratchet lever is placed in position on its shaft on the right side of the body bolster. When the ratchet lever is turned in a clockwise direction the lower pintle base plate will move to the left and vice versa.

*Q.* How is the carriage lowered into its final position? *A.* When the lower pintle base plate is centered over the base plate, the tap bolts are placed in the holes of the lower pintle base plate and the latter is rotated until all the bolts can be screwed a few threads into the base plate. The mount is then lowered until the mechanism stops. The speed gears are stopped. The tap bolts are screwed solidly into the base plate. The mount traversing clip on the under side of the mount traversing beam is unlatched, let down, engaged with the base ring, and latched in place.




NOTE.—At peace strength Nos. 3 and 17 are eliminated.

FIGURE 8.—Formation of gun section for 8-inch railway gun.

*Q.* Is there any difference in the method of raising the top carriage from the way it is done on the field mount? *A.* No.

*Q.* How is the firing support placed in position? *A.* In the same manner described for the field platform except that the firing locks, located on the top of each side of the firing support, are thrown against the top carriage and securely bolted down to prevent traversing of the top carriage.

*Q*. What becomes of the trucks when the gun is emplaced on the fixed emplacement? *A*. They are usually moved out of the way.

*Q*. How is this done? *A*. Either a locomotive or the hand translating mechanism may be used as described for the field emplacement.

*Q*. How is the gun withdrawn from position? *A*. In a general way the operations are the reverse of emplacement.

## Section IV

## 8-INCH RAILWAY GUNS



**11. Drill.**—Instruction in the service of the piece should be practical and should include actual drill and emplacement of the matériel assigned to the battery.

*Q*. How is the gun section formed? *A*. See figure 8.

*Q*. What are the posts of the cannoneers at the command DETAILS, POSTS? *A*. See figure 9.

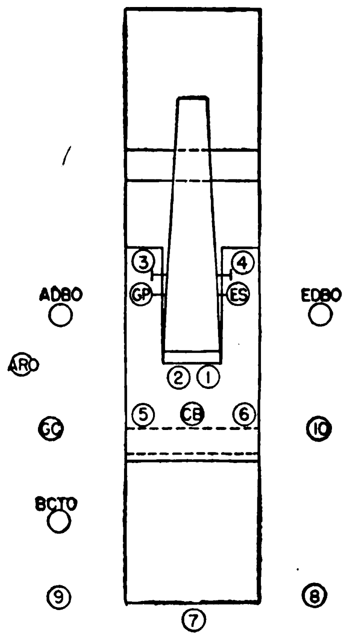



FIGURE 9.—Posts of cannoneers at command DETAILS, POSTS.

*Q*. What is done at the command CALL OFF? *A*. The unnumbered cannoneers call off their designations beginning with the gun pointer; the numbered cannoneers then call off in succession, beginning with No. 1.

*Q*. What are the duties of the members of the gun section at the various commands? *A*. See table III.

TABLE III.—*Service of the piece, 8-inch railway gun*

| Details | DETAILS, POSTS | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| Gun pointer (noncommissioned officer). | Procures sight and telephone headset, places sight in position on sight bracket, and takes post on gun platform in rear of sight, facing it. If azimuth circle is to be used, takes post on ground 2 feet from azimuth index scale, facing it. | (*a*) Examines sight and bracket (azimuth index scale); tests traversing mechanism (assisted by No. 3); supervises and assists in adjustment of aiming rule; and tests his telephone to fire control car. (*b*) Reports to gun commander, "Traversing in order," or any defects he is unable to remedy without delay. | See note. | Continues setting azimuth as received. Keeps gun traversed so as to sight on aiming rule (aiming point). Keeps bubbles on cross level of sight centered. Checks setting of sight on aiming rule. When firing by case III calls or signals "Azimuth set." When firing by case II, commands: FIRE, to No. 7 after gun commander has called "Ready." | Continues receiving and setting data until CEASE TRACKING is received. |
| Elevation setter. | Procures telephone headset and takes post on gun platform, 1 foot in rear of elevation quadrant, facing it. | (*a*) Examines and adjusts quadrant; assisted by No. 4, examines and tests elevating mechanism; tests his telephone to the fire-control car; and makes certain that gun is unlocked from travel position. (*b*) Reports to gun commander, "Elevation in order," or any defects he is unable to remedy without delay. | Sets elevation on quadrant. | Continues setting elevations as received. At command or signal ELEVATE, given by chief of breech, assisted by No. 4, elevates piece until bubbles of quadrant levels are centered, and calls or signals "Elevation set." As soon as piece has been fired, causes it to be depressed as rapidly as possible to loading position. | Continues receiving and setting data until CEASE TRACKING is received. When dummy ammunition is being used, causes piece to be depressed to loading position so dummy powder charge and projectile can be removed. |
| Chief of breech (noncommissioned officer). | Procures firing mechanism, primer pouch containing primers, punch, drill, and reamer, and pair of pliers; posts his detail and takes post 3 feet to rear of breech, facing it. | (*a*) Examines firing mechanism and places it on obturator spindle; cleans vent; and supervises work of breech detail. (*b*) Reports to gun commander, "Breech in order," or any defects he is unable to remedy without delay. | Stands by. | When projectile is ready to be rammed, takes post on rammer behind No. 1 and commands: HOME RAM. When powder has been loaded and breech is rotated and locked, inserts primer, lowers firing leaf, signals or commands: ELEVATE, receives the lanyard thrown by No. 7, hooks it | Removes primer after breech has been opened. Supervises work of unloading and assisted by No. 6 withdraws projectile when dummy ammunition is used. |

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| | | | | after report "Elevation set," calls "Primed," and takes post at right rear of breech. After piece has been fired, unhooks lanyard, and when breech has been opened removes primer, clears vent, and cleans primer seat. He listens for explosion of primer which may be audible if powder charge fails to explode. | |
| No. 1 (breech detail). | Procures cotton waste and can containing lubricating oil, places them convenient to breech, and takes post 1 foot to rear and 1 foot to right of breech, facing it. | (*a*) Assisted by No. 2, removes breech cover and places it on car platform. Examines, cleans, and oils breechblock and breech mechanism.<br>(*b*) Reports to chief of breech any defects of matériel. | Stands by. | After breechblock has been rotated by No. 2, translates it and swings it back until it is engaged by tray back latch. Takes post on right side of rammer near head and assists in ramming. After breechblock has been translated, he rotates it until closed. Assisted by No. 2, folds back hinged floor plate. As soon as piece is fired, assisted by No. 2, replaces hinged plate. Assists in opening breech and sponging chamber. Wipes off mushroom head. | Assists in opening breech for purpose of removing dummy ammunition or cleaning gun. |
| No. 2 (breech detail). | Procures cotton waste and translating crank, places crank in position and takes post 1 foot to rear and 1 foot to left of breech, facing it. | (*a*) Assists No. 1 in removing breech cover. Examines, cleans, and oils breech recess, gas check seat, chamber, and bore.<br>(*b*) Reports to chief of breech if chamber or bore need cleaning. | Stands by. | Unlocks rotating crank and rotates breechblock. Takes post on left side of rammer and assists in ramming. Receives powder charge from designated number of ammunition squad and inserts it in powder chamber so that it will be pushed into place by mushroom head when breech is closed. Releases tray back latch, swings breechblock into breech recess, and translates block. Assists No. 1 in folding back hinged floor plate. After piece is fired, assists No. 1 in replacing hinged floor plate and assists in opening breech. | When dummy ammunition is used, assists in opening breech, withdraws dummy powder charge and passes it to designated number of ammunition squad, and holds projectile tray. |

TABLE III.—*Service of the piece, 8-inch railway gun*—Continued

| Details | DETAILS, POSTS | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| No. 3 (traversing detail). | Takes post on gun platform in front of and facing traversing handwheel. | (*a*) Traverses piece as directed by gun pointer.<br>(*b*) No duties. | Traverses piece as directed by gun pointer. | Traverses piece as directed by gun pointer. As soon as piece has been fired, traverses it as rapidly as possible to loading position when necessary. | Traverses piece as directed by gun pointer. |
| No. 4 (elevating detail). | Assists No. 5 in procuring latter's equipment and placing it on gun platform. Takes post on gun platform in front of and facing elevating handwheel. | (*a*) Assists elevation setter in testing elevating mechanism.<br>(*b*) No duties. | Depresses piece to loading position. | Elevates piece at command of chief of breech as rapidly as possible to approximate elevation posted on display board. As soon as piece is fired, depresses it as rapidly as possible to loading position. | Depresses piece to loading position unless otherwise directed. |
| No. 5 (hoist detail). | Assisted by No. 4, procures cotton waste, can containing light recoil oil, recoil filling devices, wrenches necessary in filling recoil cylinder, a shot tray, two triplex blocks, can containing grease for projectiles, and a brush. Places this equipment in convenient place and takes post on gun platform near crane masts. | (*a*) Assisted by No. 6, inspects and fills recoil cylinder, places triplex blocks on crane masts, examines, tests, and oils triplex blocks.<br>(*b*) Reports to gun commander, "Recoil system and hoists in order," or any defects he is unable to remedy without delay. | No duties. | With grease brush places rim of grease in front of rotating band on projectile; places projectile in shot tray, and with triplex blocks raises and moves projectile to breech, guiding nose into breech for ramming; as soon as projectile is rammed, revolves crane masts and makes another projectile ready for service on next round. | When dummy ammunition is used, moves dummy projectile to floor of gun platform or to overhead rail of the ammunition car by means of triplex blocks and crane masts. |
| No. 6 (rammer detail). | Procures rammer, placing it on clips provided on railing on right side of gun platform. If dummy ammunition is used, also procures hand extractor and places it on gun platform | (*a*) Assists No. 5 in filling recoil cylinder and returns filling device, wrenches, and oilcan to tool car.<br>(*b*) No duties. | No duties. | Brings up rammer, places head against base of projectile and, assisted by chief of breech and Nos. 1 and 2, pushes projectile slowly forward to a position just inside chamber. Takes post on rammer in rear of No. 2 and assists in ramming. As soon as pro- | When dummy ammunition is used, inserts hand extractor in base of projectile and assists chief of breech in withdrawing dummy ammunition. |

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| | beneath rammer. Takes post on right side of gun platform, facing front. | | | jectile is seated, assisted by chief of breech, removes rammer and returns it to clips. As soon as piece has been fired, receives sponge from No. 10, and assisted by No. 1 sponges powder chamber, withdraws sponge, and returns it to No. 10. | |
| No. 7. | Procures lanyard, assists aiming rule operator in securing his equipment, and takes post on ground in line with breech, facing it. | (*a*) Coils lanyard; removes muzzle cover and places it at designated place.<br>(*b*) Reports to gun commander, "Lanyard in order," or any defects he is unable to remedy without delay. | No duties. | Throws end of lanyard containing hook to chief of breech and stands ready to pull lanyard at command FIRE. | Coils lanyard after it is unhooked by chief of breech. |
| Nos. 8 and 9 (outrigger detail). | Procure tommy bar each and assist No. 10 in procuring sponge and tub containing sponging liquid, take post on ground at rear outriggers on side of piece to which assigned by gun commander, facing toward piece. | (*a*) Examine outriggers on side of piece to which assigned and adjust them so that each has a firm bearing on its footplate.<br>(*b*) Report to gun commander, "Outriggers in order," or any defects they are unable to remedy without delay. | No duties. | Inspect and adjust their outriggers after each shot. | Duties as directed. |
| No. 10 (sponge detail). | Assisted by Nos. 8 and 9, procures sponge and tub containing sponging liquid and places them on ground near right rear of gun platform, takes post beside sponge, facing to front. | (*a*) Examines sponge.<br>(*b*) Reports to gun commander, "Sponge in order," or any defects he is unable to remedy without delay. | No duties. | After each shot he passes sponge fully saturated with sponging liquid, but drained, to No. 6 who returns it to him after chamber has been sponged. | Duties as directed. |

NOTE.—At command TARGET, gun pointer sets azimuth on sight; (assisted by No. 3) traverses gun so as to sight on aiming rule (aiming point); centers bubbles on cross levels of sight; checks setting of sight on center of aiming rule sight; and calls or signals "Azimuth set." If azimuth circle is to be used, lays gun to azimuth received from fire-control car.

**12. Emplacement.**—*Q.* How is the matériel for the ground platform prepared for installation? *A.* The beam lashing is unfastened from the side clip angle by unbolting the end from the wire clamps. (The clamps should be left attached to the lashing for safekeeping and the lashing swung out of the way but left attached to the loading box.) The jack blocks are removed from the top of the H-beams and placed to one side on the car platform.

*Q.* How are the H-beams installed? *A.* The odd-numbered cannoneers, under the direction of the elevation setter, throw off two H-beams. These they place on the right side of the position, end to end, parallel with and outside the rails, with the junction of the two opposite the center of the firing position. They connect them together with two connecting plates and twelve 0.75 by 2.75 inch-bolts. The even-numbered cannoneers under the direction of the gun pointer similarly place the other two H-beams on the left side of the position. The H-beams are lined up so that they are parallel to the track, equidistant from the center line of the track, and so that their center lines are 6 feet 10 inches apart. The ends of the beams are directly opposite each other.

*Q.* How are the jack blocks placed? *A.* Under the direction of the elevation setter Nos. 9, 10, 11, and 12 unload and place a jack block under the two forward screw jacks. Under the direction of the gun pointer Nos. 13, 14, 15, and 16 do the same thing for the two rear screw jacks.

*Q.* Describe how the car is jacked up. *A.* Nos. 1 and 2 take post at the right front jack, the elevation setter (or No. 3) and No. 4 at the right rear, display board operators at the left front, and the aiming rule operator and battery commander's telephone operator at the left rear jack, with ratchet levers and cranks. The gun commander personally directs the jacking up so that all details work together.

*Q.* How are the cross ties placed? *A.* The cross ties are unloaded by Nos. 5, 6, 7, and 8 and are placed under the car by Nos. 9 to 16 after the car has been jacked up.

*Q.* Is the car left supported on the jacks? *A.* No. After the cross ties have been placed the jack details lower the car until the car sills rest on the ties. This operation must be coordinated by the gun commander the same as that of raising the car.

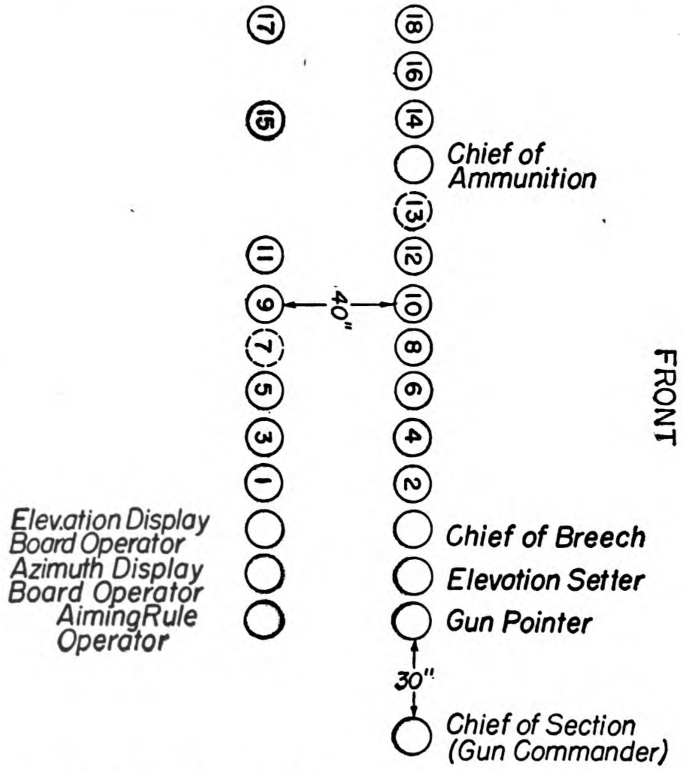
*Q.* What men set the outriggers? *A.* All cannoneers, working in reliefs, dig the holes for the floats, assist in unloading the floats and shoes, place them in position, and set the outriggers.

*Q*. In general how is the gun prepared for traveling? *A*. The members of the gun section handle the same elements in preparing the gun for traveling as they do in preparing it for firing. Float holes should be filled and the roadbed left in good condition.

## Section V

## 12-INCH RAILWAY MORTARS






NOTE.—Nos. 7 and 13 are not included in peace strength organization.

FIGURE 10.—Formation of 12-inch railway mortar section.

**13. Drill.**—Instruction in the service of the piece should be practical and should include actual drill and emplacement of the matériel assigned to the battery.

*Q*. How is the mortar section formed? *A*. See figure 10.

*Q*. What are the posts of the cannoneers at command DETAILS, POSTS? *A*. See figure 11.

*Q.* What is done at the command CALL OFF? *A.* The unnumbered cannoneers call off their designations, beginning with the gun pointer;

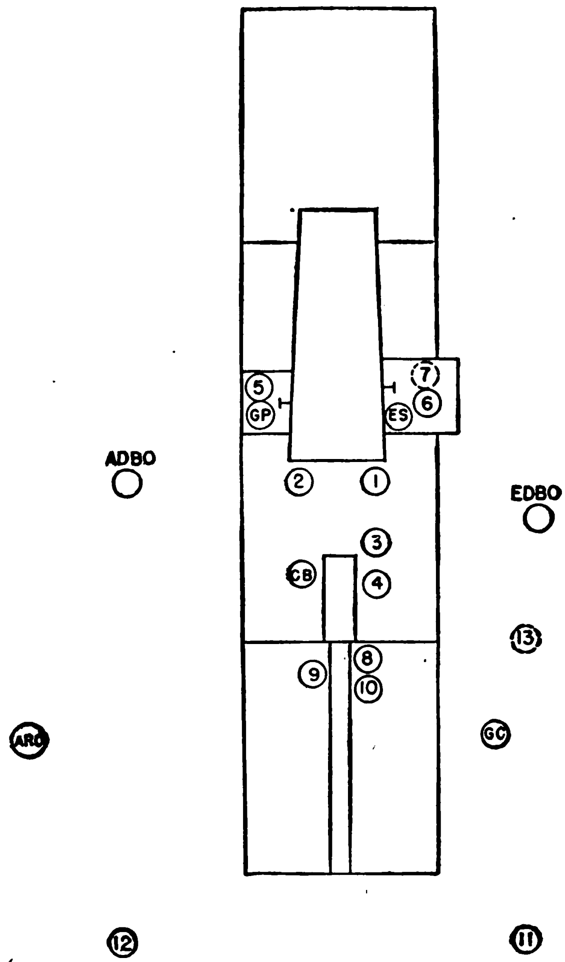



FIGURE 11.—Posts of cannoneers at command DETAILS, POSTS.

the numbered cannoneers then call off in succession, beginning with No. 1.

*Q.* What are the duties of the members of the mortar section at the various commands? *A.* See table IV.

TABLE IV.—*Service of the piece, 12-inch railway mortars*

| Details | DETAILS, POSTS | (a) EXAMINE GUN<br>(b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| Gun pointer (noncommissioned officer). | If sight is to be used, gets panoramic sight, assisted by No. 5, places it in position on sight standard, and takes position on traversing platform in rear of sight, facing it. If azimuth circle is to be used, takes position where he can best see azimuth pointer. | (a) Assisted by No. 5, examines and tests panoramic, sight, sight bracket, level bubbles, traversing mechanism, and azimuth pointer.<br>(b) Reports to gun commander, "Sight and traversing mechanism in order," or any defects that he is unable to remedy without delay. | See note 3. | Assisted by No. 5, lays piece at azimuth posted on display board. As soon as piece is accurately laid in direction and he has heard elevation setter call "Elevation set," he calls "Azimuth set." | Continues to lay piece at azimuth posted on azimuth display board. |
| Elevation setter. | Takes post on elevation platform, facing quadrant. | (a) Assisted by Nos. 6 and 7, examines and tests quadrant and elevating mechanism.<br>(b) Reports to gun commander, "Quadrant and elevating mechanism in order," or any defects that he is unable to remedy without delay. | See note 3. | Sets on quadrant the elevation posted on display board, and at command or signal ELEVATE, given by chief of breech, causes piece to be elevated until bubbles of quadrant cross levels are centered. He then calls "Elevation set." As soon as piece has been fired, he causes it to be depressed as rapidly as possible to loading position. | Continues to lay piece at elevation posted on display board. When dummy ammunition is used, causes piece to be depressed to loading position. |
| Chief of breech (noncommissioned officer). | Posts his detail after assuring himself that they have procured the necessary cleaning material and equipment; takes post on loading platform 4 feet to rear and 2 feet to left of breech, facing it. | (a) Examines breechblock, breech mechanism, firing mechanism, breech recess, chamber, and bore (paying special attention to safety devices), and gives the necessary instructions for cleaning and putting them into condition for service, and supervises this operation.<br>(b) Reports to gun commander, "Breech in order," or any defects that he is unable to remedy without delay. | No duties. | Supervises work of his detail; places shell trough in position; assists Nos. 8 and 4 in placing shell on loading tray; commands: HOME RAM, and assists No. 4 in ramming projectile. After powder charge has been inserted in breech, removes shell trough and, as soon as breechblock has been rotated and locked, commands: ELEVATE. As soon as breech has been opened, assists No. 4 in sponging powder chamber. | When dummy ammunition is being used, receives hand extractor from No. 9. Engages head of extractor in dummy projectile and supervises work of unloading. |

**TABLE IV.**—*Service of the piece, 12-inch railway mortar*—Continued

| Details | DETAILS, POSTS | (*a*) EXAMINE GUN (*b*) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| No. 1 (breech detail). | Gets cotton waste, translating roller crank, and can containing lubricating oil; places them convenient to the breech; takes post 1 foot to rear and 2 feet to right of breech, facing it. | (*a*) Removes breech cover and places it on drop platform, cleans and oils breechblock.<br>(*b*) No duties. | No duties. | Releases rotating crank latch, rotates and translates breechblock, and swings it open until it is engaged by securing latch; after piece is loaded, assisted by No. 2, swings breechblock until tray latch engages. While No. 2 is rotating breechblock, removes translating crank from roller and then hands it to No. 2. With No. 2, turns back folding platform. After piece has been fired, with No. 2 lets down platform. As soon as piece is depressed to horizontal position, opens breech and wipes off mushroom head. | When dummy ammunition is used, opens breech and assists in withdrawing dummy projectile. |
| No. 2 (breech detail). | Gets cotton waste and shell trough; places them convenient to breech and takes post on loading platform 1 foot in rear and 2 feet to left of breech, facing it. | (*a*) Cleans and oils breech recess and gas check seat.<br>(*b*) No duties. | No duties. | Receives powder charge from No. 14 or No. 15 and inserts it in powder chamber until its base barely clears gas check seat, releases securing latch, and assists No. 1 in swinging breechblock until it is engaged by tray latch. Translates and rotates breechblock and assists No. 1 in turning back folding platform. After piece has been fired, unhooks lanyard and removes fired primer; assists No. 1 in letting down folding platform. Places translating crank on roller. When breech has been opened, assists chief of breech in sponging powder chamber. He wipes out breech recess and cleans gas check seat. | When dummy ammunition is used, removes dummy powder charge and passes it back to No. 14. Assists in withdrawing dummy projectile. |

| | | | | | |
|---|---|---|---|---|---|
| No. 3 (breech detail). | Gets cotton waste, lanyard, primers, primer pouch drill, reamer, and firing mechanism; takes post on loading platform 2 feet in rear of No. 1, facing breech. | (*a*) Examines firing mechanism and places it on obturator spindle, clears vent, cleans primer seat, examines lanyard, and places it in convenient position.<br>(*b*) No duties. | No duties. | After breechblock has been fully rotated and locked, inserts primer. After piece has been elevated to 25°, lowers firing leaf and hooks lanyard. Then takes position on ground, straightens lanyard, and stands ready for firing. Fires piece by quick, strong pull (not jerk) on lanyard. As soon as breech has been opened, clears vent, and cleans primer seat. | No duties. |
| No. 4 (ramming detail). | Assists No. 13 in getting sponging tub and chamber sponge; takes post on right side of loading platform opposite chief of breech, facing breech. | (*a*) Examines gravity loading device; cleans and oils tripping lever.<br>(*b*) No duties. | No duties. | Assists No. 8 and chief of breech in placing shell on loading tray; removes shot tongs; at preparatory command HOME, releases tripping lever; at command RAM, assists chief of breech in ramming. After breech has been opened, receives sponge from No. 13 and assisted by chief of breech sponges chamber; passes sponge back to No. 13; levels loading tray. | No duties. |
| No. 5 (traversing detail). | Gets hand extractor and places it beside left truck rail support; mounts to traversing platform and assists gun pointer in placing sight in position; takes post in front of traversing handwheel, facing to rear. | (*a*) Removes muzzle cover and places it in designated place; assists gun pointer in examining and testing sight and traversing mechanism.<br>(*b*) No duties. | No duties. | Traverses piece as directed; when panoramic sight is being used, operates sight bracket leveling screws, keeping cross level bubbles centered. | Continues to traverse piece as directed. |
| No. 6 (elevating detail). | Takes post on elevating platform beside elevating handwheel, facing front. | (*a*) Assists elevation setter in examining and testing quadrant and elevating mechanism.<br>(*b*) No duties. | No duties. | At command ELEVATE, assisted by No. 7, elevates piece approximately as indicated on display board; as soon as piece is fired, depresses it to loading position. | Depresses piece to loading position. If piece is loaded with service ammunition, no duties. |
| No. 7 (elevating detail). | Takes post on elevating platform beside elevating handwheel, facing rear, being in front of and facing No. 6. | (*a*) Assists elevation setter in examining and testing quadrant and elevating mechanism.<br>(*b*) No duties. | No duties. | At command ELEVATE, assists No. 6 in elevating piece approximately as indicated on display board; as soon as piece is fired, assists No. 6 in depressing piece to loading position. | Assists No. 6 in depressing piece to loading position. If piece is loaded with service ammunition, no duties. |

TABLE IV.—*Service of the piece, 12-inch railway mortar*—Continued

| DETAILS | DETAILS, POSTS | (a) EXAMINE GUN (b) REPORT | TARGET | LOAD | CEASE FIRING |
|---|---|---|---|---|---|
| No. 8 (hoisting detail). | Takes post on rear platform on right side of truck, facing front. | (*a*) Examines and tests chain block and overhead loading device. (*b*) Reports to gun commander, "Hoisting mechanism in order," or any defects that he is unable to remedy without delay. | No duties. | At command LOAD, hoists projectile from truck to loading tray; returns empty shot tongs to No. 9. | When dummy ammunition is used, lowers dummy projectile from loading tray to truck. |
| No. 9 (truck detail). | Assisted by No. 10, gets truck rail extension and support and places truck on rails; takes post on left side of truck rails opposite No. 10, facing front. | (*a*) Assisted by No. 10, assembles truck rail extension; examines truck rails and stop, and cleans and oils truck; reports any defects he is unable to remedy. (*b*) No duties. | No duties. | Assisted by No. 10, receives projectile from ammunition car, sees that it is properly placed on truck, and pushes truck up to stop, sees that shot tongs are locked around projectile and hooks tongs to hoisting apparatus; receives empty shot tongs from No. 8. | When dummy ammunition is used, with No. 10 assists No. 8 in lowering dummy projectile; assisted by No. 10, places dummy projectile on truck and pushes it back to ammunition car; passes hand extractor to chief of breech. |
| No. 10 (truck detail). | Assists No. 9 with truck rail extension and in placing truck on rails; takes post on rear platform 2 feet behind No. 8, facing front. | (*a*) Assists No. 9 with truck rail extension and truck. (*b*) No duties. | No duties. | Assists No. 9 in serving projectiles; steadies and guides projectile while No. 8 hoists; alternates with No. 8 in hoisting. | When dummy ammunition is used, assists No. 9 in handling dummy projectile. |
| No. 11 (outrigger detail). | Gets tommy bar and filling plug wrench; takes post on ground near outer end of right rear outrigger, facing front. | (*a*) Removes fillling plug from right recoil cylinder and replaces it at direction of gun commander; examines all right outriggers and tightens up adjusting screws; sees that earth is firmly packed behind each float; reports any defects he is unable to remedy. (*b*) No duties. | No duties. | As soon as piece is fired, inspects all right outriggers and sees that all have tight bearing on footplates. | No duties. |

| | | | | | |
|---|---|---|---|---|---|
| No. 12 (outrigger detail). | Gets tommy bar and filling plug wrench; takes post on ground near outer end of left rear outrigger, facing to front. | (*a*) Removes filling plug from left recoil cylinder and replaces it at direction of gun commander; examines all left outriggers and tightens up adjusting screws; sees that earth is firmly packed behind each float; reports any defects he is unable to remedy.<br>(*b*) No duties. | No duties. | As soon as piece is fired, inspects all left outriggers and sees that all have tight bearing on footplates. | No duties. |
| No. 13 (sponge detail). | Assisted by No. 4, gets sponging tub and chamber sponge; places sponge in tub containing sponging liquid; takes post near sponging tub as directed by gun commander. | (*a*) Sees that tub is filled with sponging liquid.<br>(*b*) No duties. | No duties. | After piece is fired, passes wet sponge to No. 4; receives sponge from No. 4, and places it in sponging solution; sees that sponge is completely covered by solution, and allows excess liquid to run off. | No duties. |

NOTES

1. At command RELAY, No. 3 slacks lanyard, and gun sections perform such of their duties at command LOAD as may be necessary to lay mortar on new data. If new data involve change in zone, command WITHDRAW POWDER CHARGE is given by gun commander, gun section proceed as for command LOAD except that No. 3 unhooks lanyard and removes primer before piece is depressed below 20° and No. 2 withdraws old powder charge and passes it to No. 14 who takes it to ammunition car.

2. At command CEASE FIRING, given when piece is loaded with service ammunition, lanyard is detached and gun section stands clear until further orders are given.

3. As soon after command TARGET is given as data are received, gun pointer and elevation setter set data on panoramic sight (if used) and quadrant, respectively. These data are posted by display board operators.

430792°—42——4

**14. Emplacement.**—The emplacement of the 12-inch mortar is done in the same manner as that of the 8-inch gun. See questions and answers, paragraph 12.

## CHAPTER 3

# NOMENCLATURE OF VARIOUS PARTS OF GUN, CARRIAGE, AND EMPLACEMENT MATÉRIEL



**15. 155-mm guns.**—*Q*. What type and model of gun is assigned to your battery? A. ———.

*Q*. Point out or describe the location of the following parts and explain the purpose of each:

*Gun*

Tube.
Bore.
Grooves (rifling).
Lands (rifling).
Leveling plates.
Muzzle bell.
Breech.
Breech ring.
Powder chamber.
Recoil lug.
Trunnions.

*Breech mechanism*

Breechblock.
Block carrier.
Slotted sectors.
Rack.
Threaded sectors.
Vent.
Breech recess.
Counterbalance cylinder.
Counterbalance spring rod.
Filling-in disk.
Split rings.
Gas check pad.
Gas check seat.
Mushroom head.
Obturator.
Obturator spindle.
Operating lever.
Operating lever handle.
Firing mechanism.
Firing mechanism block.
Firing mechanism block latch and holder.
Firing pin.
Percussion hammer.
Percussion hammer lock bolt.

*Carriage*

Axle pivot pin.
Bottom carriage (chassis).
Counterrecoil (recuperator) cylinder.
Counterrecoil piston rod end.
Control rod gear housing.
Cradle.
Cradle trunnion.
Drawbar.
Elevating handwheel.
Elevating mechanism.
Elevating rack.
Jack beam.
Limber.
Limber stop.
Maneuvering lug.
Pintle.
Recoil cylinder.
Recoil cylinder filling plug.
Recoil cylinder piston rod end.
Recoil regulating arm.
Retracting rack bar.
Recuperator gage.
Replenisher.
Spade.
Top carriage.
Trails.
Trail clamping bolt.
Traveling bar.
Traveling bar lock.
Traversing handwheel.
Traversing mechanism.
Traversing worm.

*A*. (Practical demonstration.)

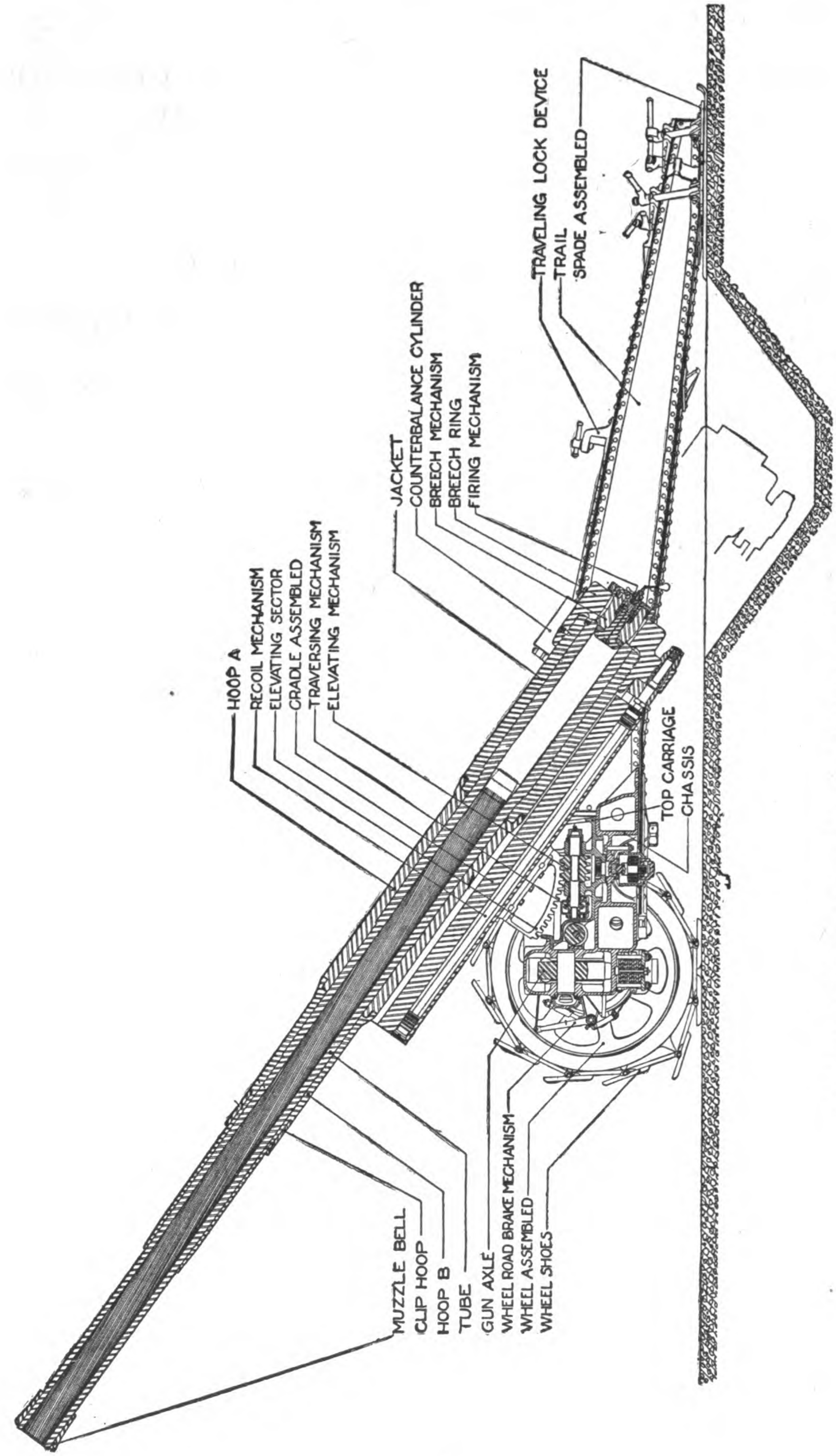
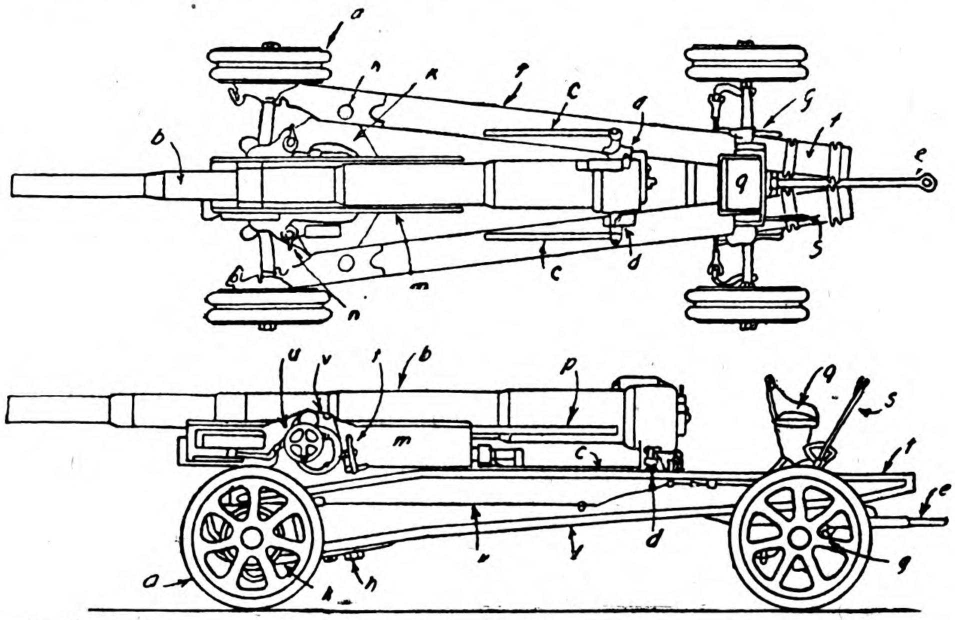



FIGURE 12.—155-mm gun and carriage in firing position (longitudinal section).



a. Wheels.
b. Gun.
c. Retracting rack.
d. Traveling bar clip locks.
e. Drawbar.
f. Trails.
g. Limber.
h. Trail hinge pin.
k. Bottom carriage.
m. Cradle.
n. Trail pin locking nut.
p. Rear clips.
q. Limber seat.
r. Brake operating cable.
s. Brake lever.
t. Traversing handwheel.
u. Elevating handwheel.

FIGURE 13.—155-mm gun and carriage in traveling position (top and side elevation).

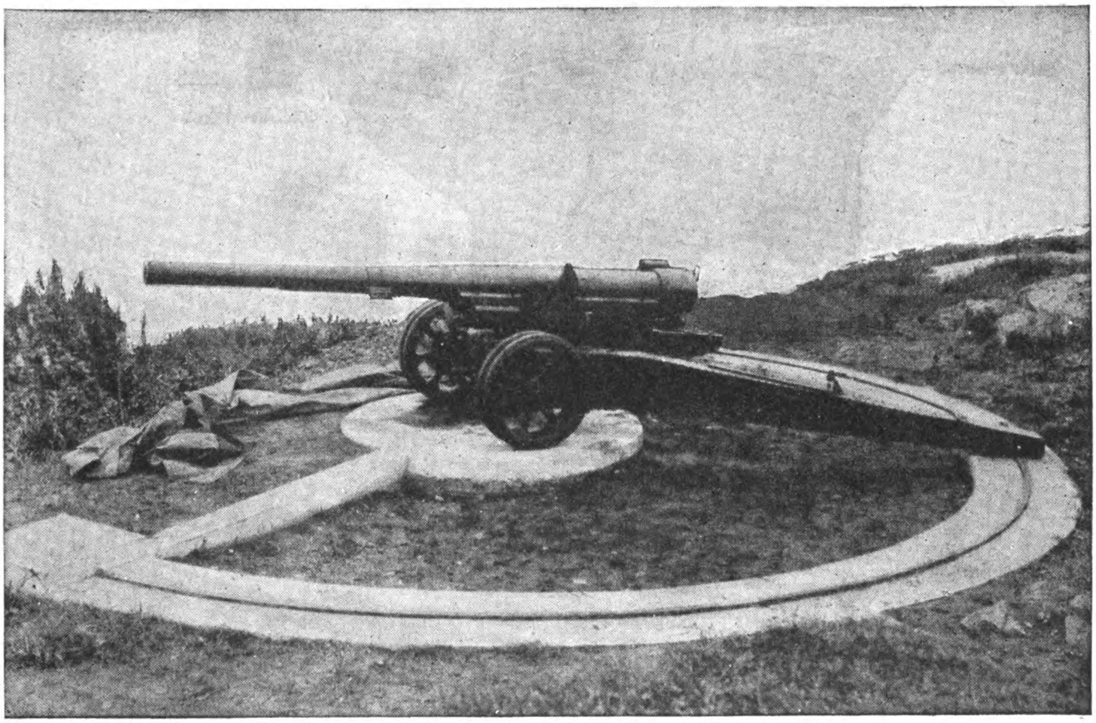


FIGURE 14.—Permanent emplacement for 155-mm gun.

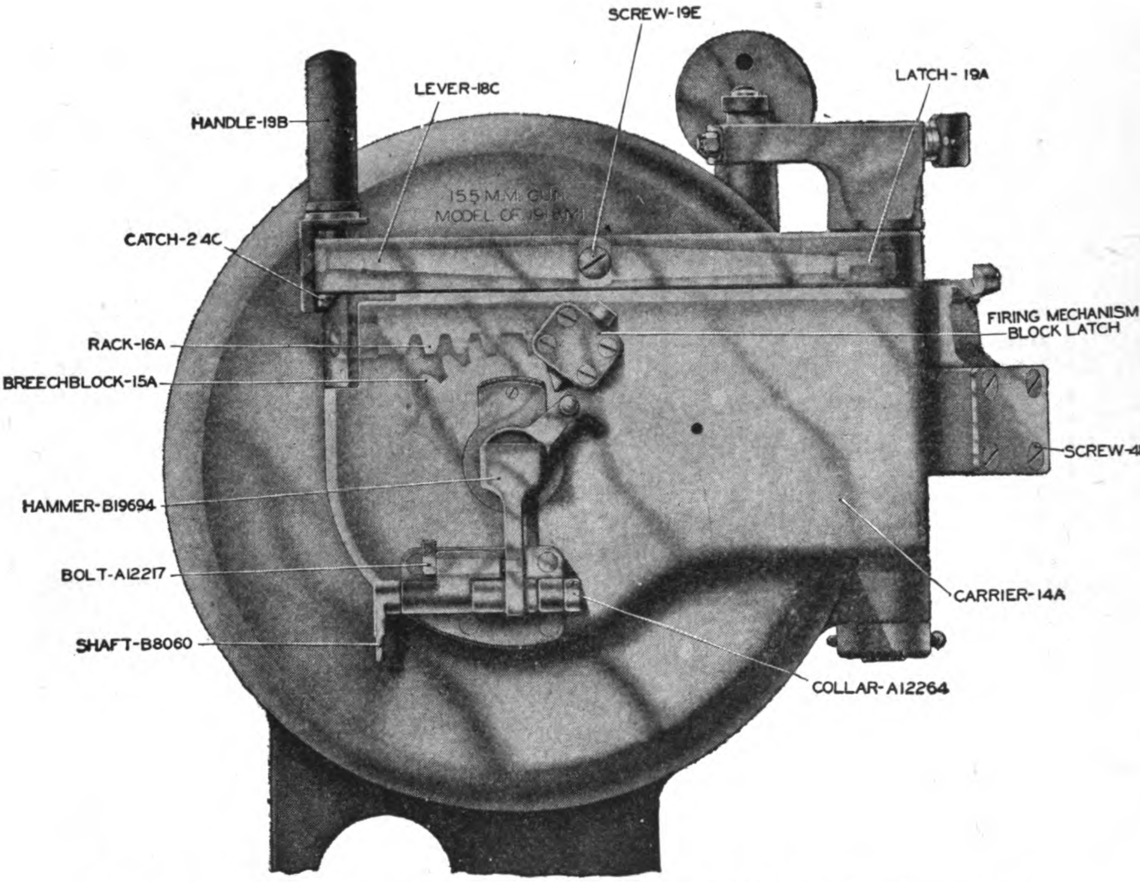
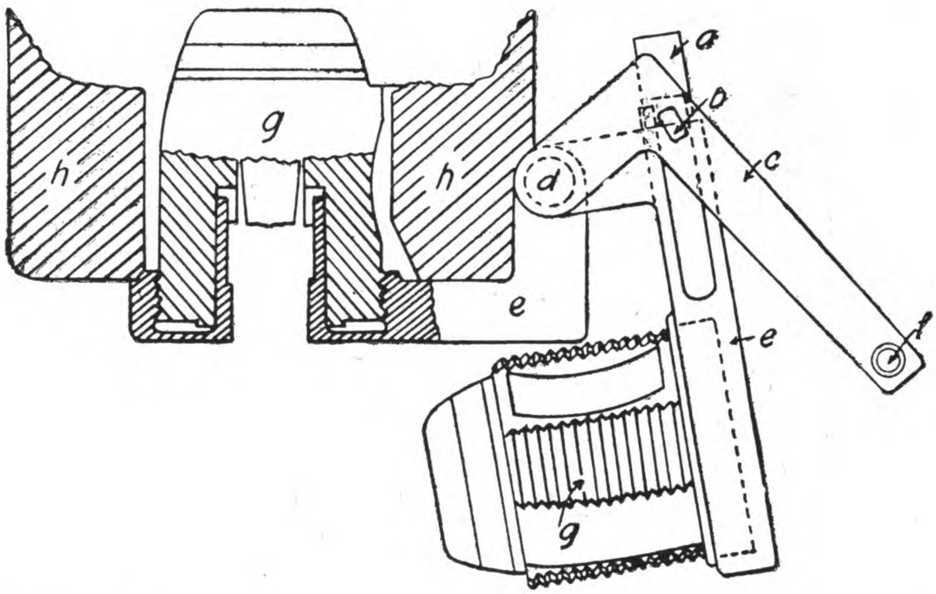
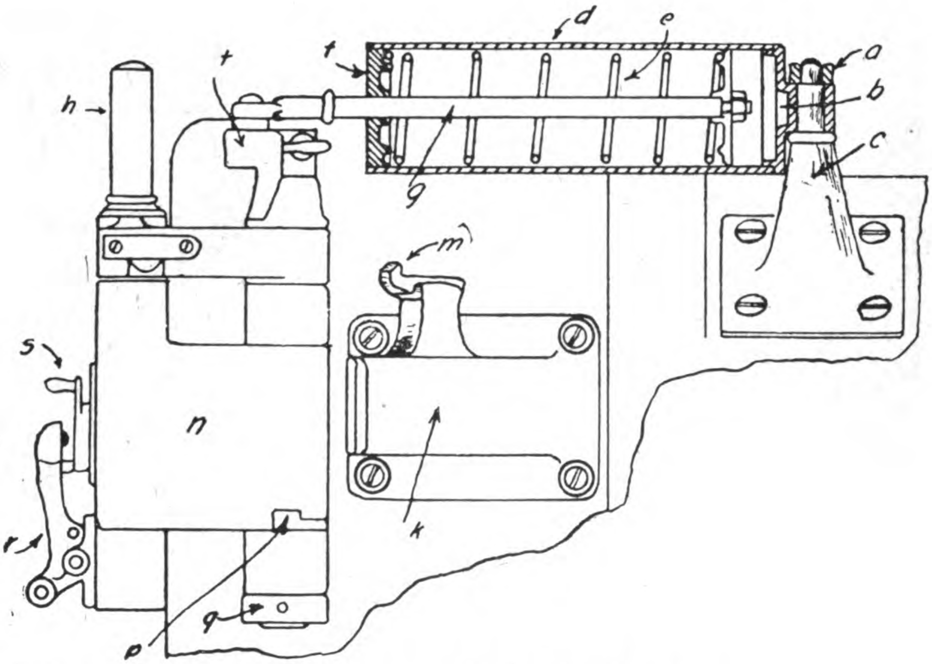



**Figure 15.**—Breech mechanism for 155-mm gun (assembled and sectioned rear views).




a. Rotating rack.
b. Operating lug.
c. Operating lever.
d. Hinge pin.
e. Block carrier.
f. Operating handle.
g. Breechblock.
h. Breech ring.

FIGURE 16.—Lever-pull breech mechanism for 155-mm gun.




a. Bracket collar.
b. Pivoted cylinder head.
c. Counterbalance bracket.
d. Counterbalance cylinder.
e. Counterbalance spring.
f. Cylinder head.
g. Tension rod.
h. Operating lever handle.
k. Lever catch bracket.
m. Lever catch.
n. Block carrier.
p. Hinge pin driving washer.
q. Hinge pin collar.
r. Firing hammer.
s. Firing mechanism.
t. Hinge pin lug.

FIGURE 17.—Sectional view of counterbalance cylinder and right side view of breech mechanism.

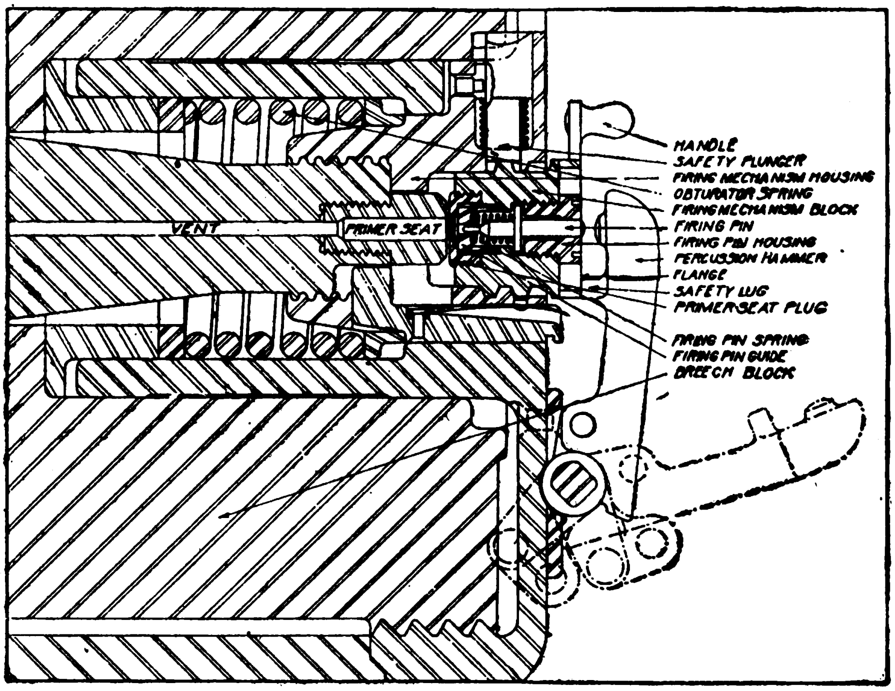



FIGURE 18.—155-mm percussion-type firing mechanism.

**16. 14-inch gun M1920MII on railway mount M1920.**—*Q*. What type and model is assigned to your battery? *A*. 14-inch gun M1920MII.

*Q*. On what type and model of mount is the gun mounted? *A*. Railway mount M1920.

*Q*. Point out or describe each of the following parts and explain the purpose of each:

| *Gun* | *Breech mechanism* | |
|---|---|---|
| Tube. | Breechblock. | Gas check pad. |
| Jacket. | Breechblock control arc. | Obturator. |
| Bore. | Breechblock handle. | Obturator spindle. |
| Grooves (rifling). | Breech recess. | Obturator spindle nut. |
| Lands (rifling). | Cross head. | Operating lever. |
| Muzzle. | Counterbalance spring. | Operating lever buffer assembly. |
| Breech. | Filling-in disk. | Slotted sector. |
| Powder chamber. | Split rings. | Threaded sector. |
| Recoil band. | | |
| Trunnions. | | |

*Firing lock*

Firing lock housing.
Primer retaining catch.
Extractor.
Extractor cam.
Firing pin.
Cocking lever.
Hammer catch.
Hammer.
Lock-operating bar.

*Carriage*

Side frame.
Folding platforms.
Side frame transom.
Raising screw.
Raising gear bracket.
Firing support.
Firing support translating mechanism.
Nut housing.
Trunnion.
Short recoil cylinders.
Long recoil cylinders.
Recuperator cylinders.
Elevating rack.
Elevating brake.
Elevating control handwheel.
Elevating speed gear.
Traversing handwheel.
Traversing shaft.
Translating crank.
Top carriage raising motor.
Top carriage.

*Railway gun car*

Breech platform.
Loading tray.
Girder.
Girder side platforms.
Upper pintle.
Trucks A, B, C, and D.
Truck translating mechanism.
Clip.
Traversing beam.
Traveling lock.
Traveling lock bracket.
Lower pintle base plate.
Power plant.
Air compressor.
Firing wedges.
Outriggers.
Steel floats.
Loading platform trunk.
Control panel.
Drum controller.

*Field platform*

10 inch I-beams.
8 inch I-beam.
Wooden floats.
Girders.

*Permanent emplacement*

Base ring.
Base plate.
Inner fixed rail.
Hinged rail.
Outer fixed rail.
Bridge rail.

*Mount raising and alining mechanism*

Alining beam.
Crank.
Alining screw.
Span bolster.
Lifting bolster.
Lifting screw.
Body bolster.
Ratchet lever.

*Ammunition car*

Chain blocks.
Powder racks.
Stanchions.
Shell racks.
Trolley beam.

*A*. See figures 5, 6, 7, and 19 to 28, inclusive.

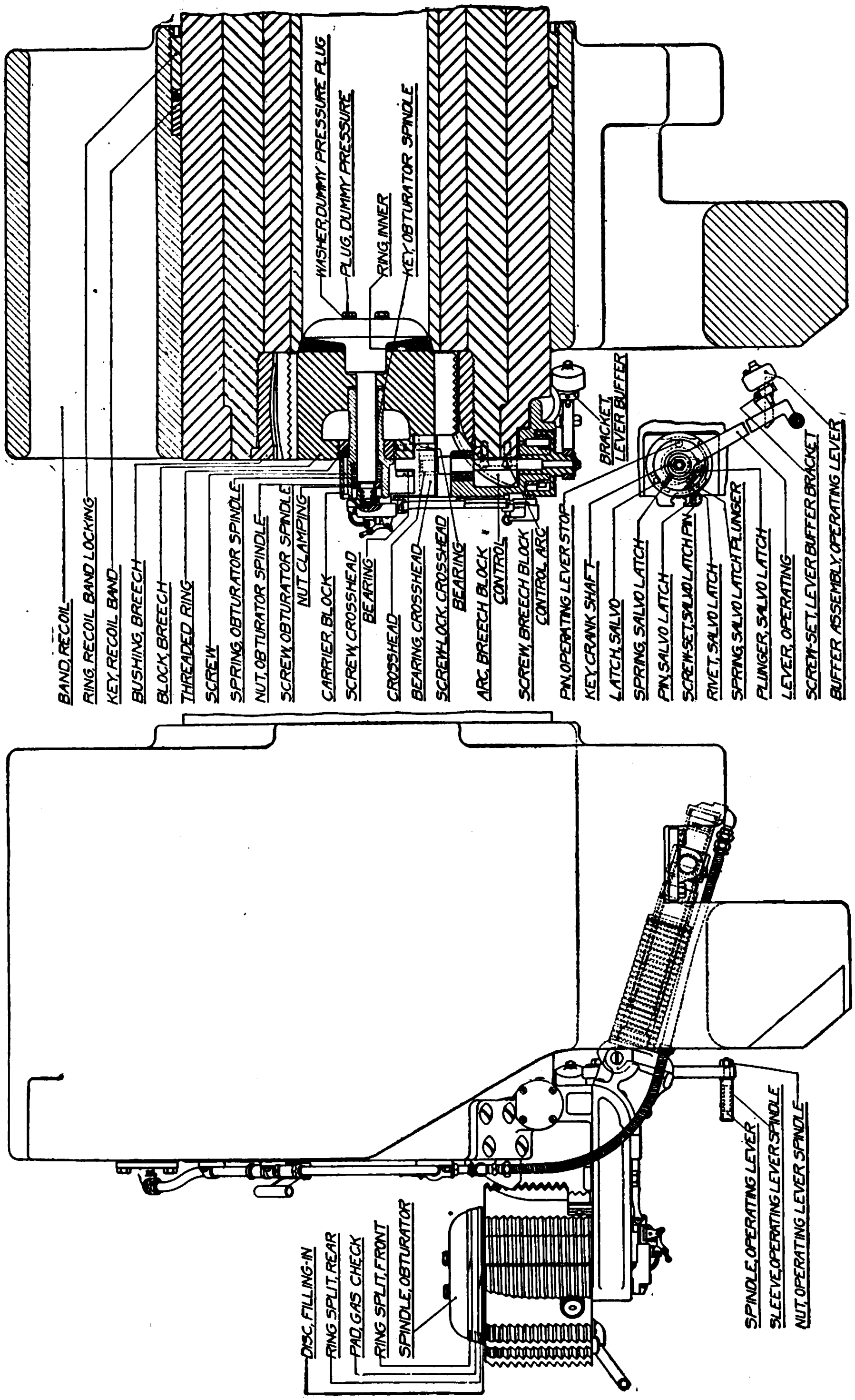



FIGURE 19.—14-inch breech mechanism Mk. II—right side (breech open) and vertical section.

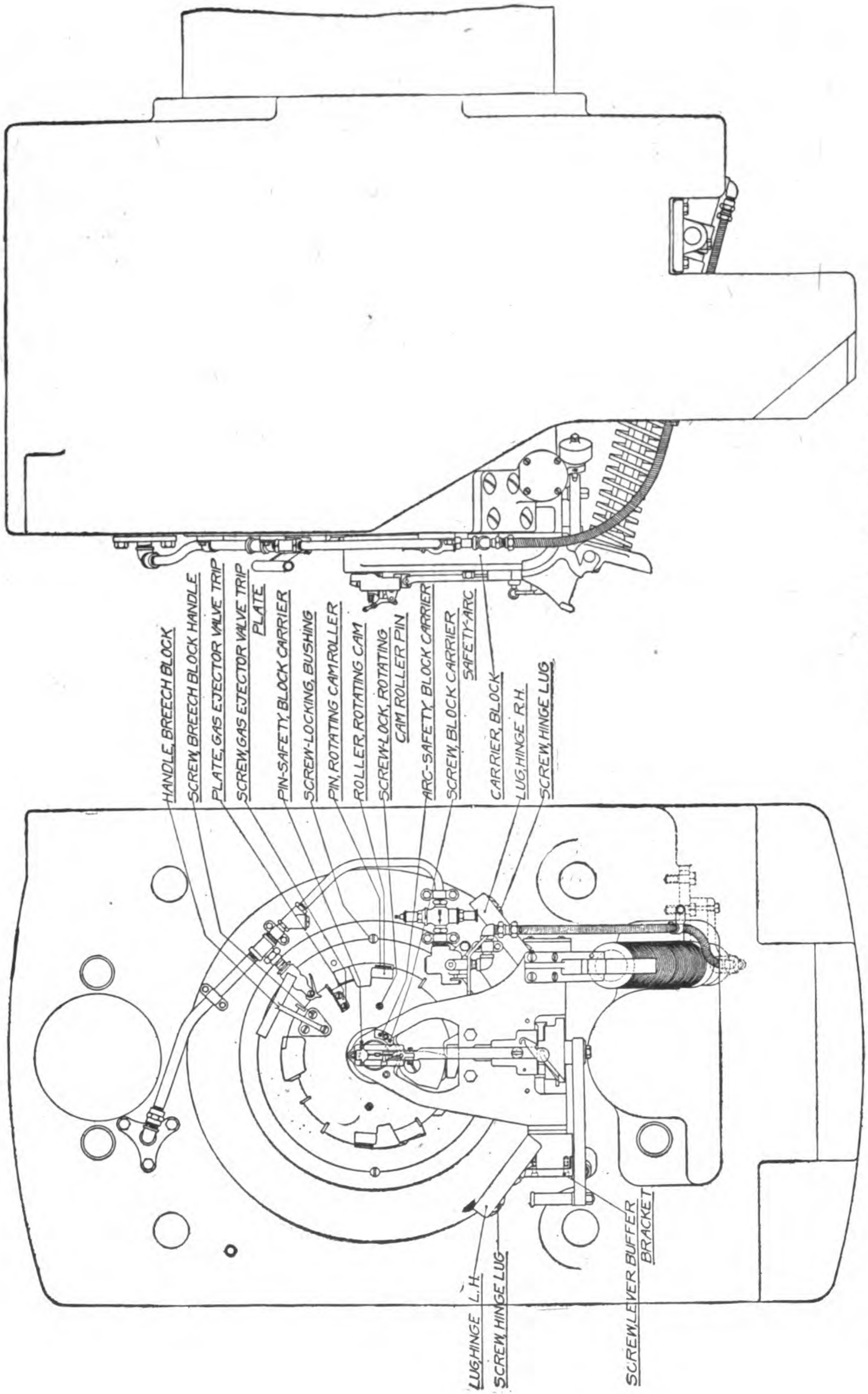



FIGURE 20.—14-inch breech mechanism Mk. II—end and right side.

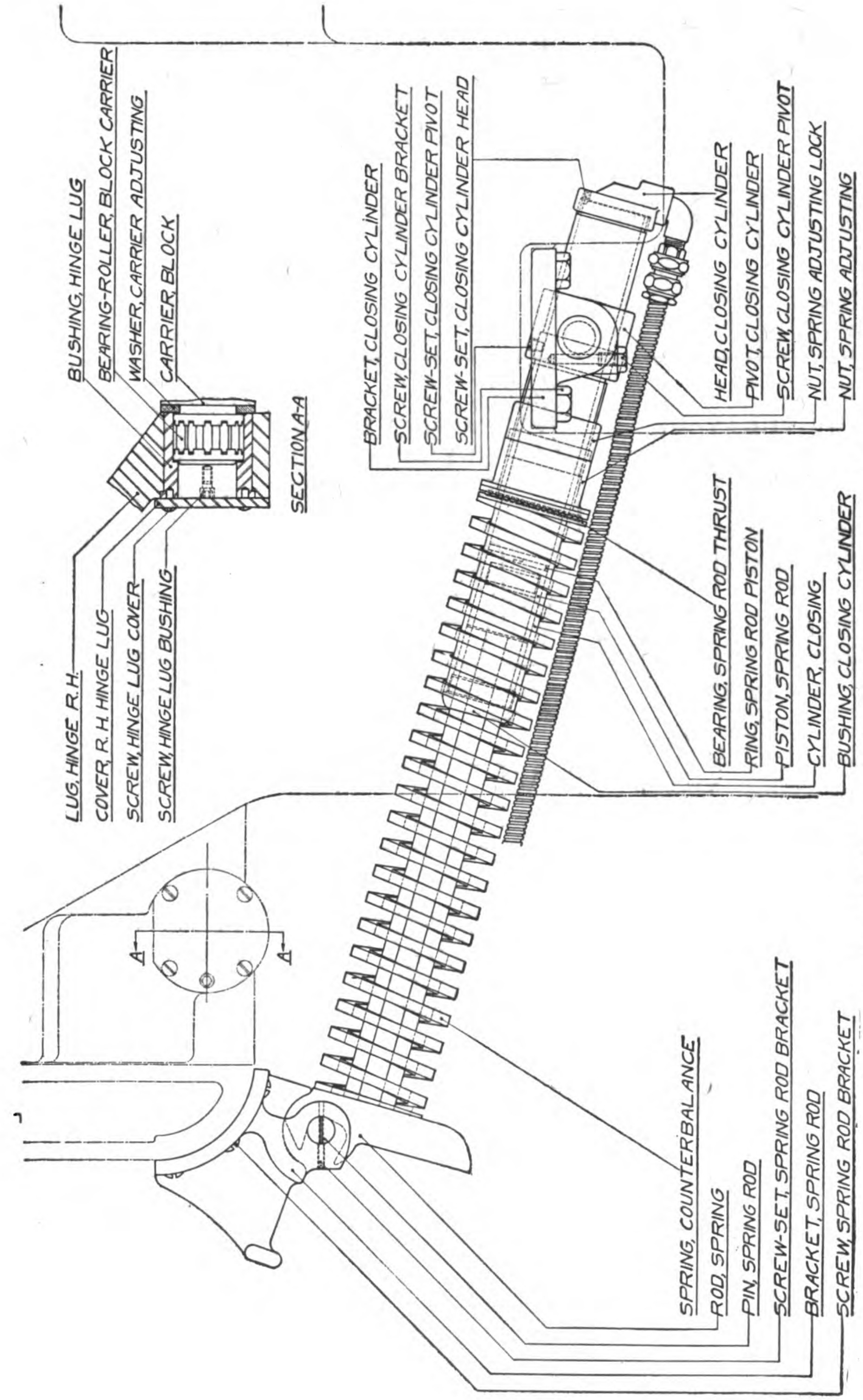



FIGURE 21.—Counterbalance assembly for 14-inch breech mechanism Mk. II.

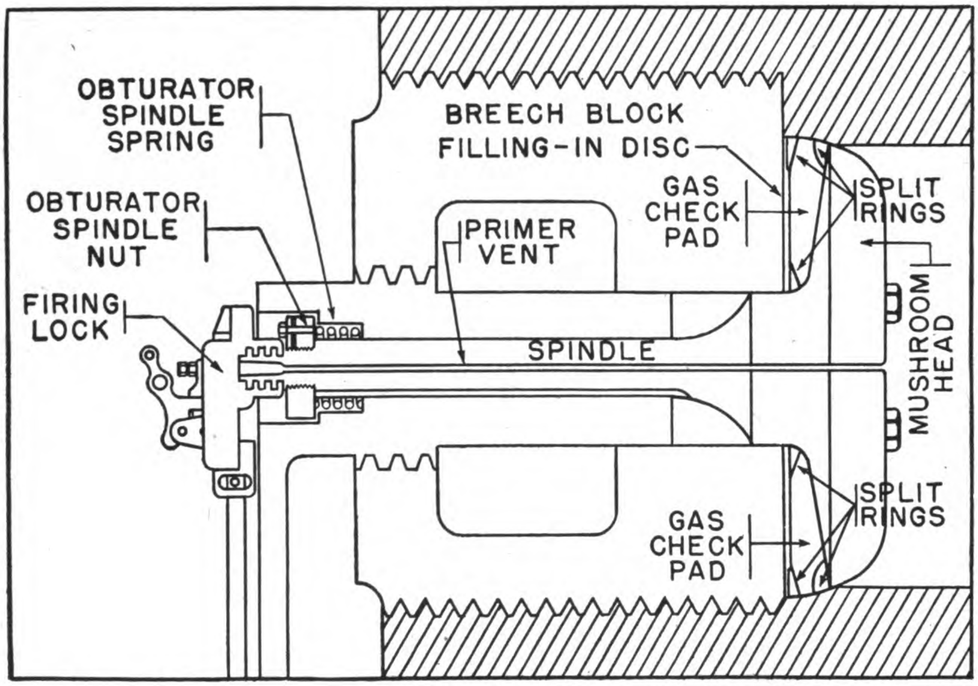



FIGURE 22.—Breechblock and obturating mechanism (schematic).

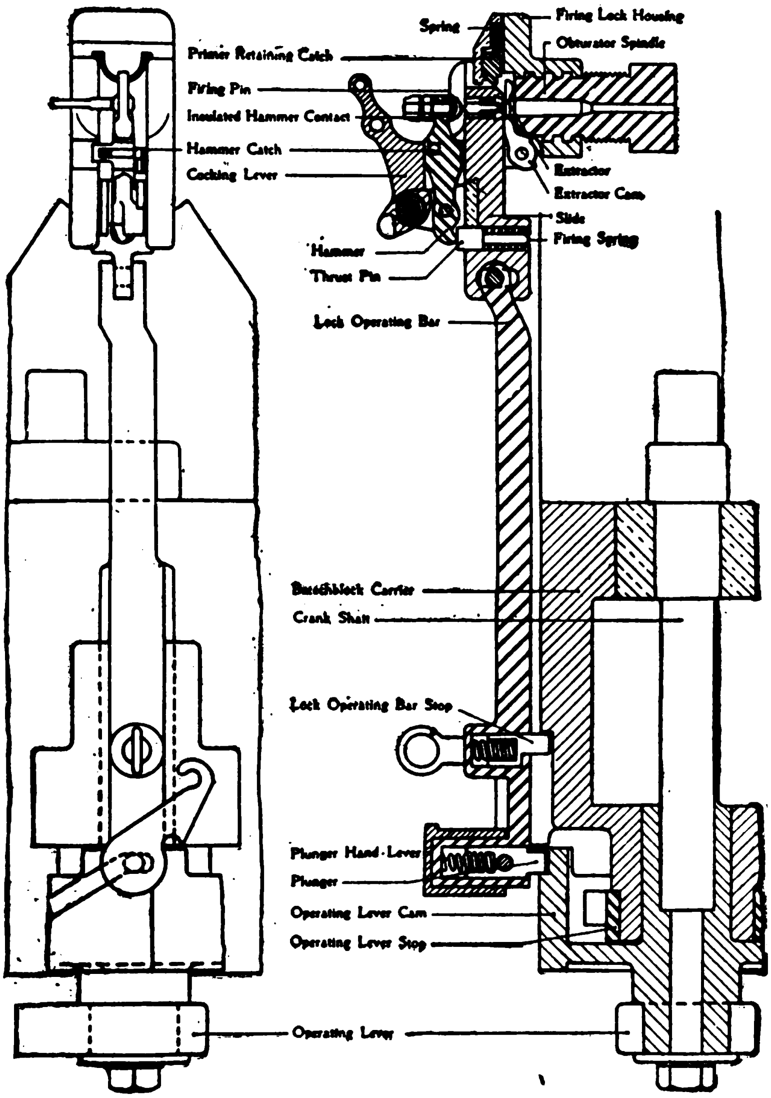



FIGURE 23.—Firing lock Mk. I and its operating mechanism.

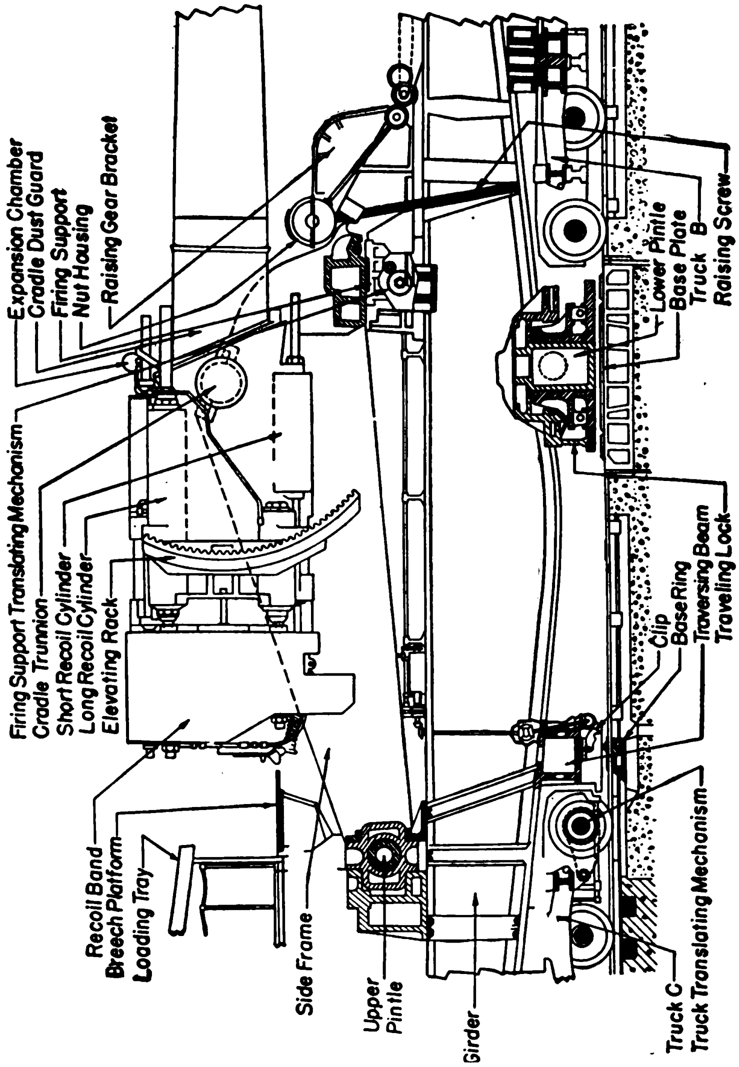



FIGURE 24.—Top carriage assembly of 14-inch railway gun.

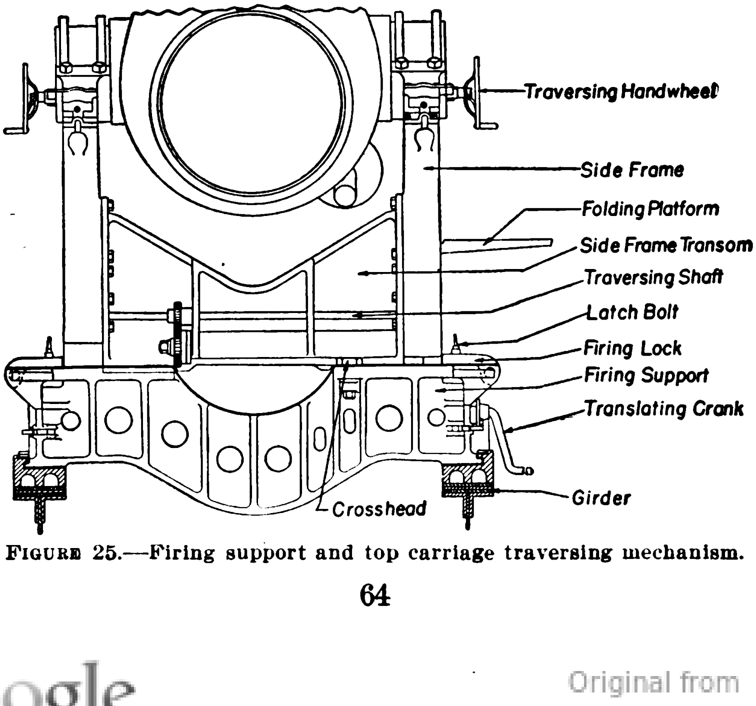



FIGURE 25.—Firing support and top carriage traversing mechanism.

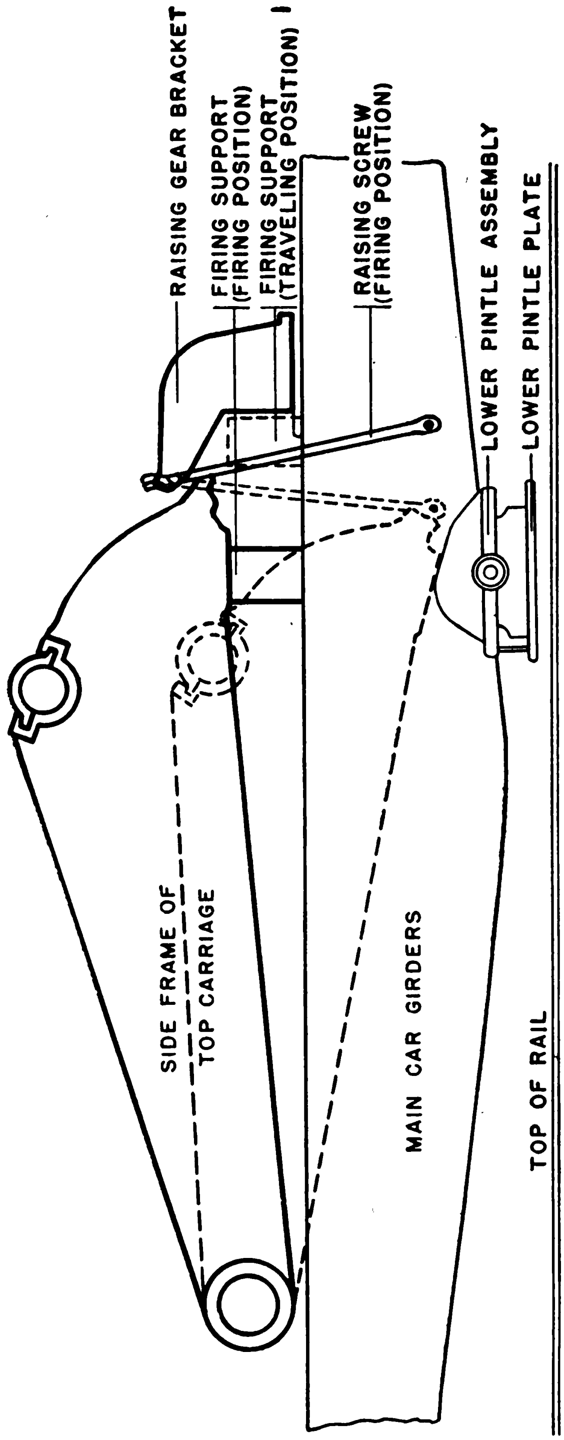



FIGURE 26.—Top carriage lifting mechanism for 14-inch railway gun.

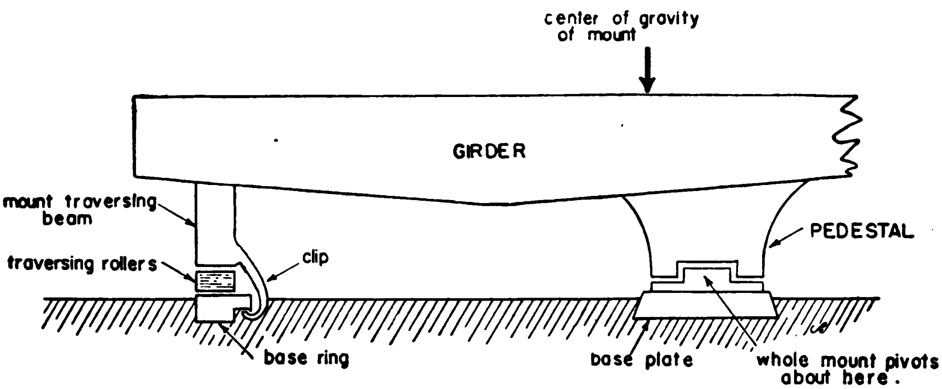



FIGURE 27.—Mount traversing mechanism for 14-inch railway gun.

NOTE.—The mount traversing mechanism can be used only in permanent emplacements.

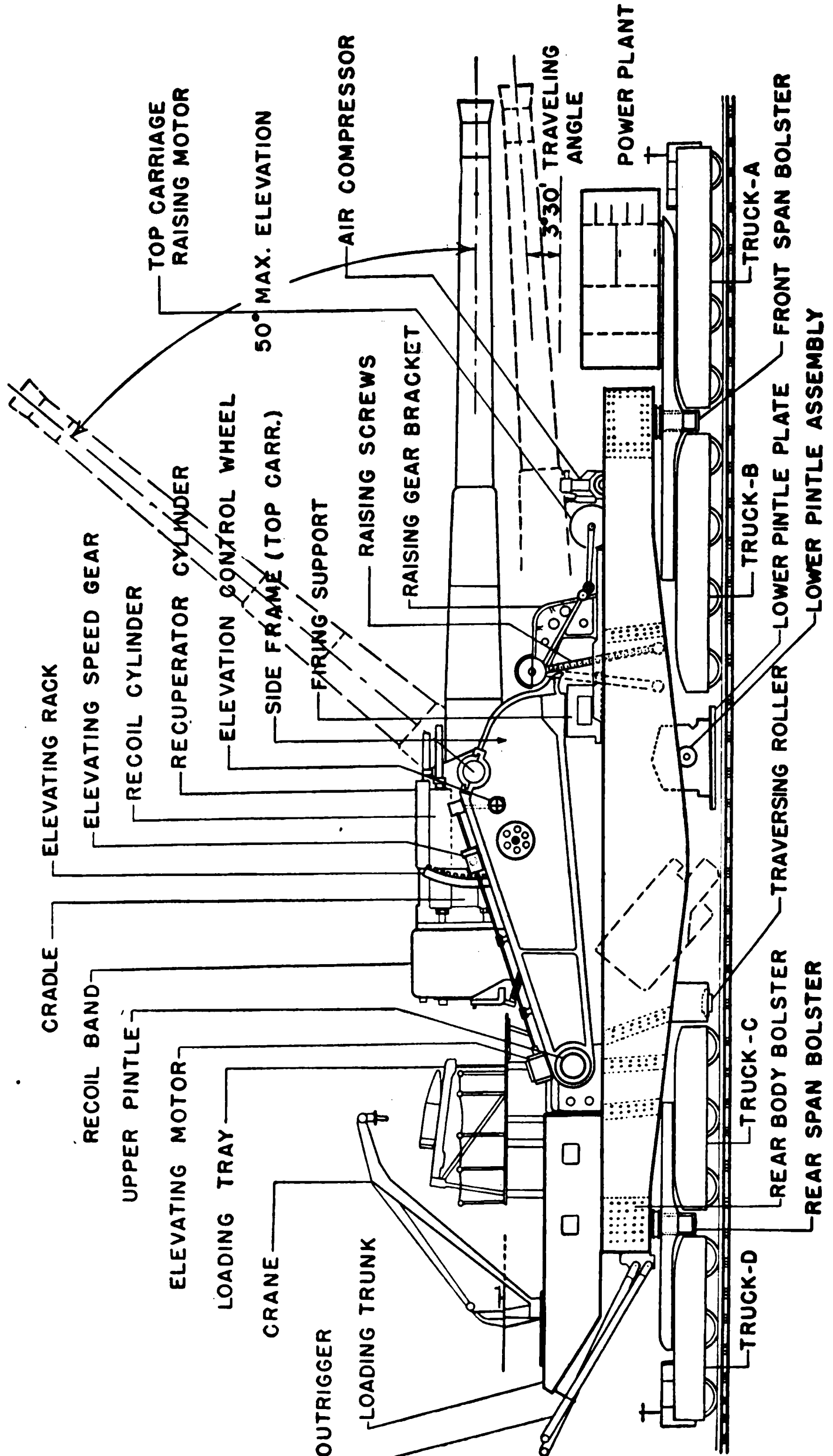



FIGURE 28.—14-inch gun M1920MII and railway mount M1920.

**17. 8-inch gun M1888 on railway mount M1918.**—*Q*. What type and model of gun is assigned to your battery? *A*. 8-inch gun M1888.

*Q*. On what type and model of mount is the gun mounted? *A*. Railway mount M1918.

*Q*. Point out or describe the location of each of the following parts and explain the purpose of each:

*Gun*

Tube.
Hoops.
Jacket.
Keys (or splines).
Grooves (rifling).
Lands (rifling).
Muzzle.
Breech.
Powder chamber.
Recoil band.
Recoil lug.
Trunnions.
Bore.

*Breech mechanism*

Breechblock.
Breech recess.
Breech ring.
Filling-in disk.
Gas check pad.
Obturator.
Obturator spindle.
Obturator spindle nut.
Rotating crank.
Rotating crank lock.
Slotted sector.
Threaded sector.
Split ring.
Translating crank.
Translating roller.
Translating stud.
Tray.
Tray back latch.
Tray guide rails.
Tray handle.
Tray latch.
Tray back latch handle.

*Firing mechanism*

Catch lever.
Contact clip.
Ejector.
Firing leaf.
Firing leaf pivot.
Hinge.
Hinged collar.
Housing.
Safety bar.
Safety lock.
Screw housing.
Slide.
Slide handle.
Spring pin.

*Bottom carriage*

Azimuth circle.
Base ring.
Conical rollers.
Lower roller path.
Grease cups.
Oil holes.
Pintle.
Racer clips.

*Top carriage*

Counterrecoil springs.
Elevating handwheel.
Elevating mechanism.
Elevating rack.
Loading platform.
Pistons.
Recoil cylinder.
Recoil cylinder filling plug.
Recuperator cylinders.
Traversing handwheel.
Traversing mechanism.
Trunnion bed.
Trunnion caps.

*Railway gun car*

Outriggers.
Outrigger footplates.
Outrigger adjusting screws.
Outrigger floats.
Outrigger turnbuckles.

*Jack mechanism*

Crank handle.
Crankshaft.
Jack screw.
Worm.
Worm wheel.

*Ground platform*

Fishplates.
H-beams.
H-beams lashings.
Jack beams.

*Ammunition car*

Chain blocks.
Powder racks.
Stanchions.
Shell racks.
Trolley beam.

*A*. (Practical demonstration.)

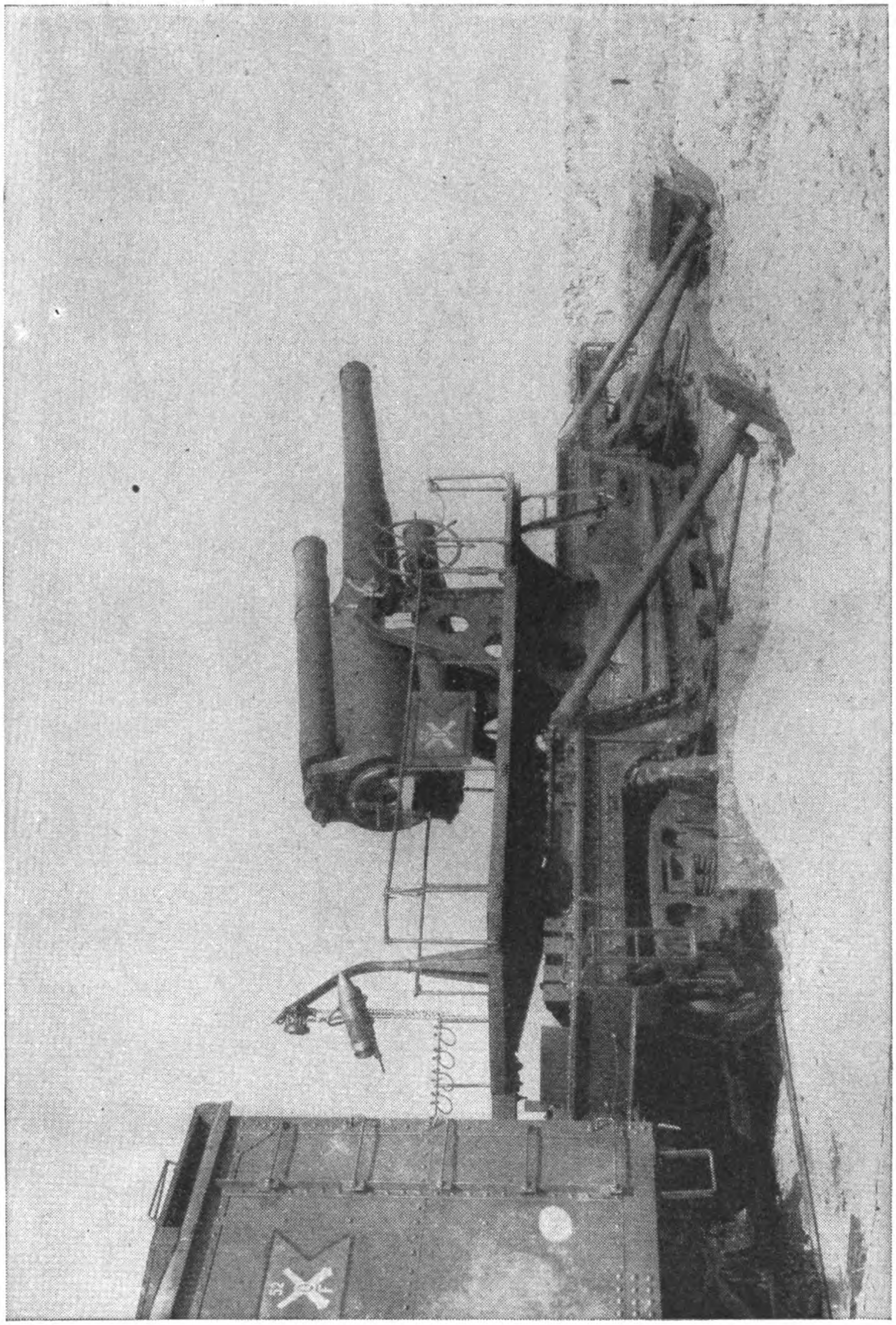


FIGURE 29.—8-inch gun on railway mount M1918 emplaced.

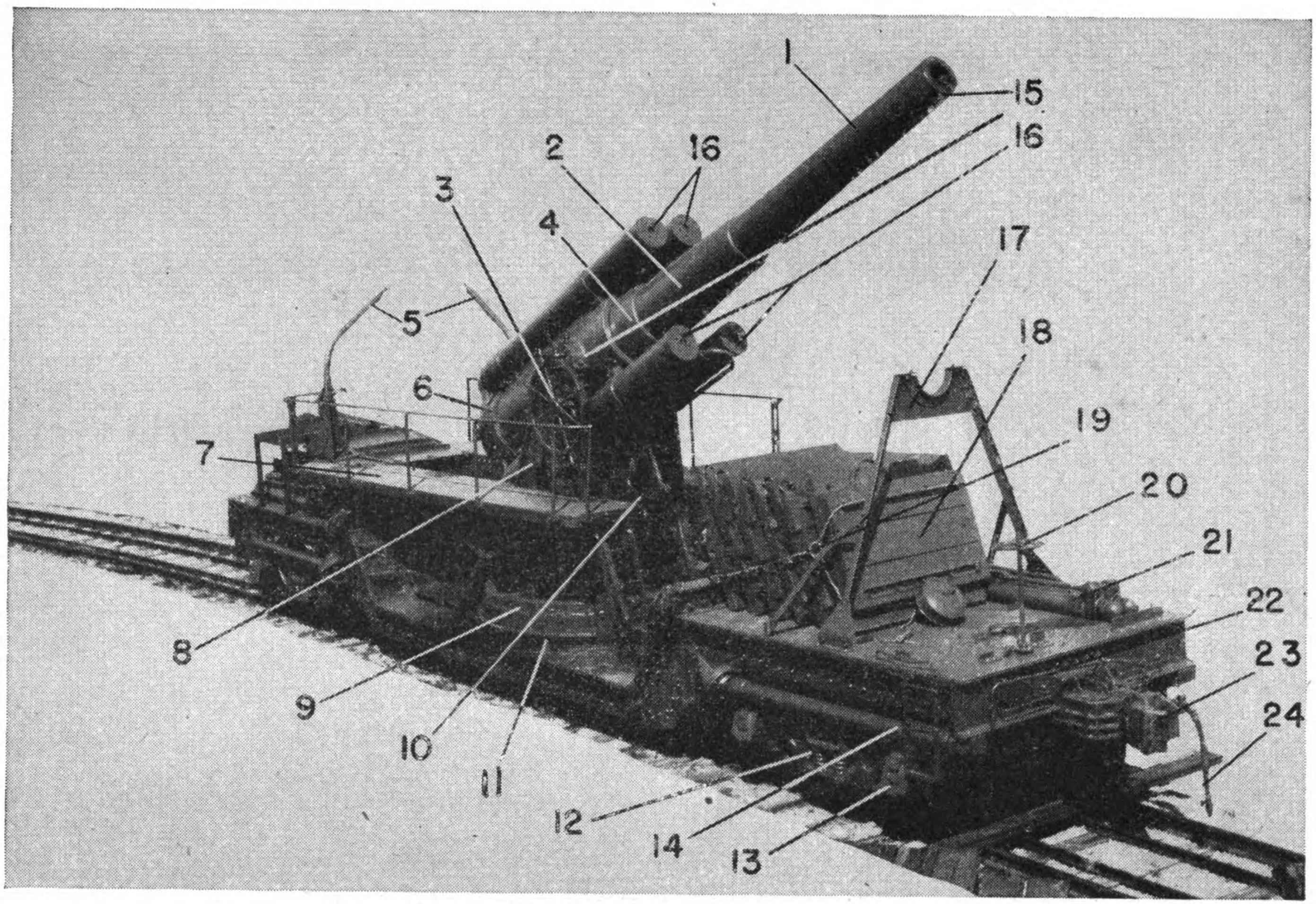



FIGURE 30.—8-inch gun on railway mount M1918 not emplaced.

1. C–row.
2. D–row.
3. Elevating handwheel.
4. A–row.
5. Crane masts.
6. Recoil band.
7. Loading platform.
8. Side frame.
9. Racer.
10. Elevating rack.
11. Base ring.
12. Four-wheel trucks.
13. Journal boxes.
14. End outrigger strut.
15. Chase.
16. Counterrecoil cylinders.
17. Traveling lock bracket.
18. Floats.
19. Float lashing.
20. Hand brake wheel.
21. Side outrigger struts.
22. Uncoupling lever.
23. MCB coupler.
24. Air hose.

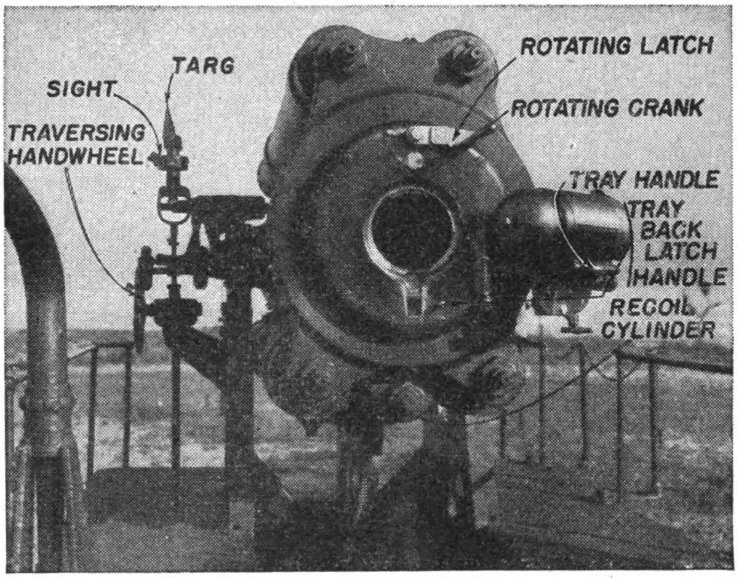
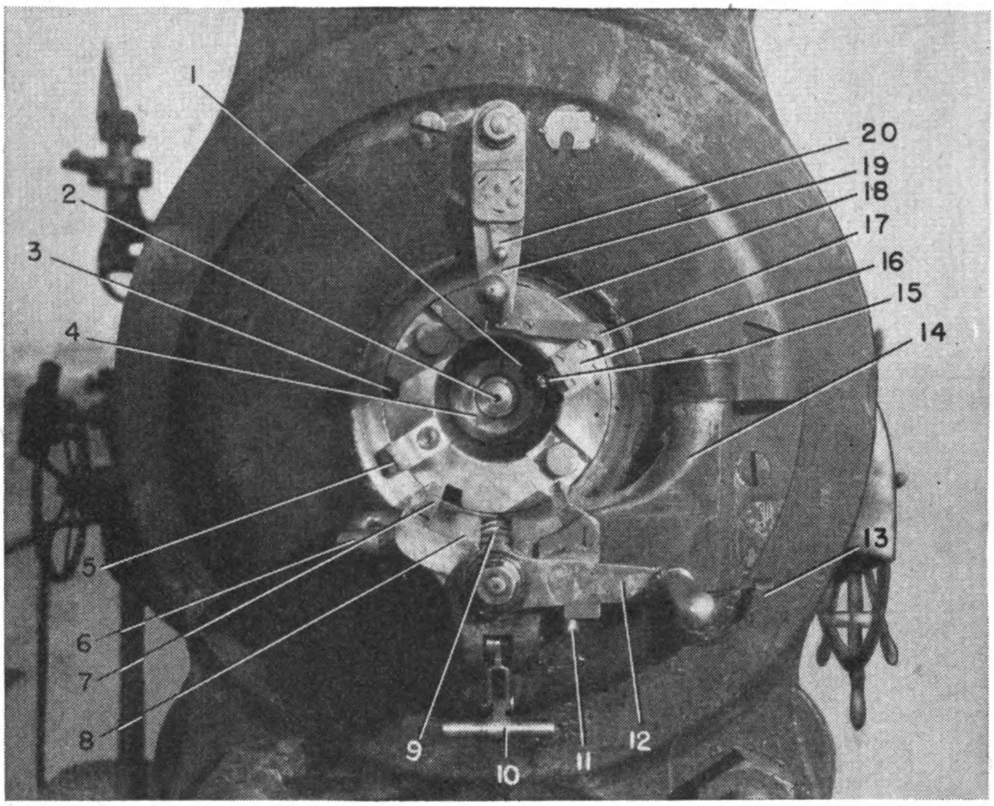
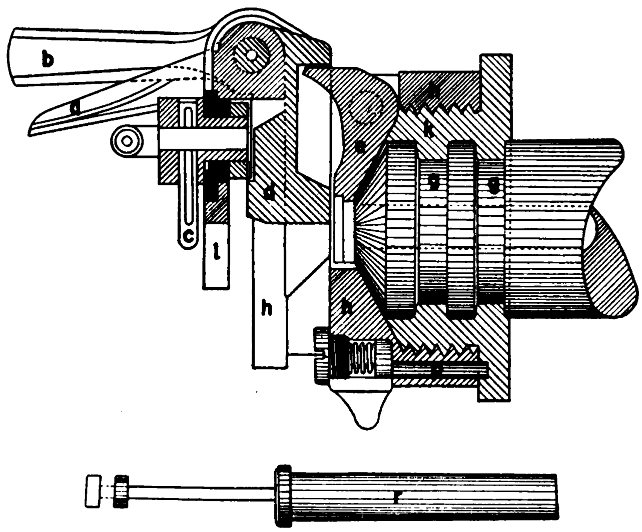



FIGURE 31.—Rear view of 8-inch gun M1888 breech open.




1. Obturator spindle lock nut.
2. Vent.
3. Guide groove.
4. Obturator spindle nut.
5. Translating stud.
6. Tray handle.
7. Guide rail.
8. Tray.
9. Translating roller.
10. Tray latch handle.
11. Securing latch handle.
12. Translating crank.
13. Tray (lock) securing latch.
14. Tray hinge.
15. Safety bar slide.
16. Safety bar slide housing.
17. Rider.
18. Groove for rider.
19. Rotating crank and handle.
20. Rotating crank catch (lock).

FIGURE 32.—8-inch railway gun M1888, breech closed.



a. Catch lever.
b. Slide handle.
c. Contact clip.
d. Slide.
e. Ejector.
g. Obturator spindle grooves.
h. Housing.
k. Hinged collar.
l. Firing leaf.
p. Spring pin.
r. Primer.

FIGURE 33.—Firing mechanism, seacoast M1903.

**18. 12-inch mortars M1890 and M1890MI on railway carriage M1918.**—*Q*. What type and model of mortar is assigned to your battery? *A*. 12-inch mortar, model ———.

*Q*. What kind and model of carriage? *A*. Railway carriage M1918.

*Q*. Point out or describe the location of the following parts of the top carriage and explain the purpose or function of each. (For the gun, breech mechanism, firing mechanism, bottom carriage, railway gun car, jack mechanism, ground platform, and ammunition car, see the appropriate items under the 8-inch railway gun, par. 17.) *A*.

| | |
|---|---|
| Air gage. | Reservoir. |
| Air valve. | Sleigh |
| Liquid gage. | Sleigh runner. |
| Liquid pump lever. | Front sleigh yoke. |
| Liquid valve. | Rear sleigh yoke. |
| Recuperator. | Washers, bronze and steel. |

*Q*. Name the principal parts of the breech mechanism. *A*. The breechblock, hinge pin, tray, tray latch, tray back latch, translating crank, translating roller, rotating crank, rotating crank catch.

*Q*. Name the principal parts of the firing mechanism. *A*. The hinged collar, housing slide, and firing leaf.

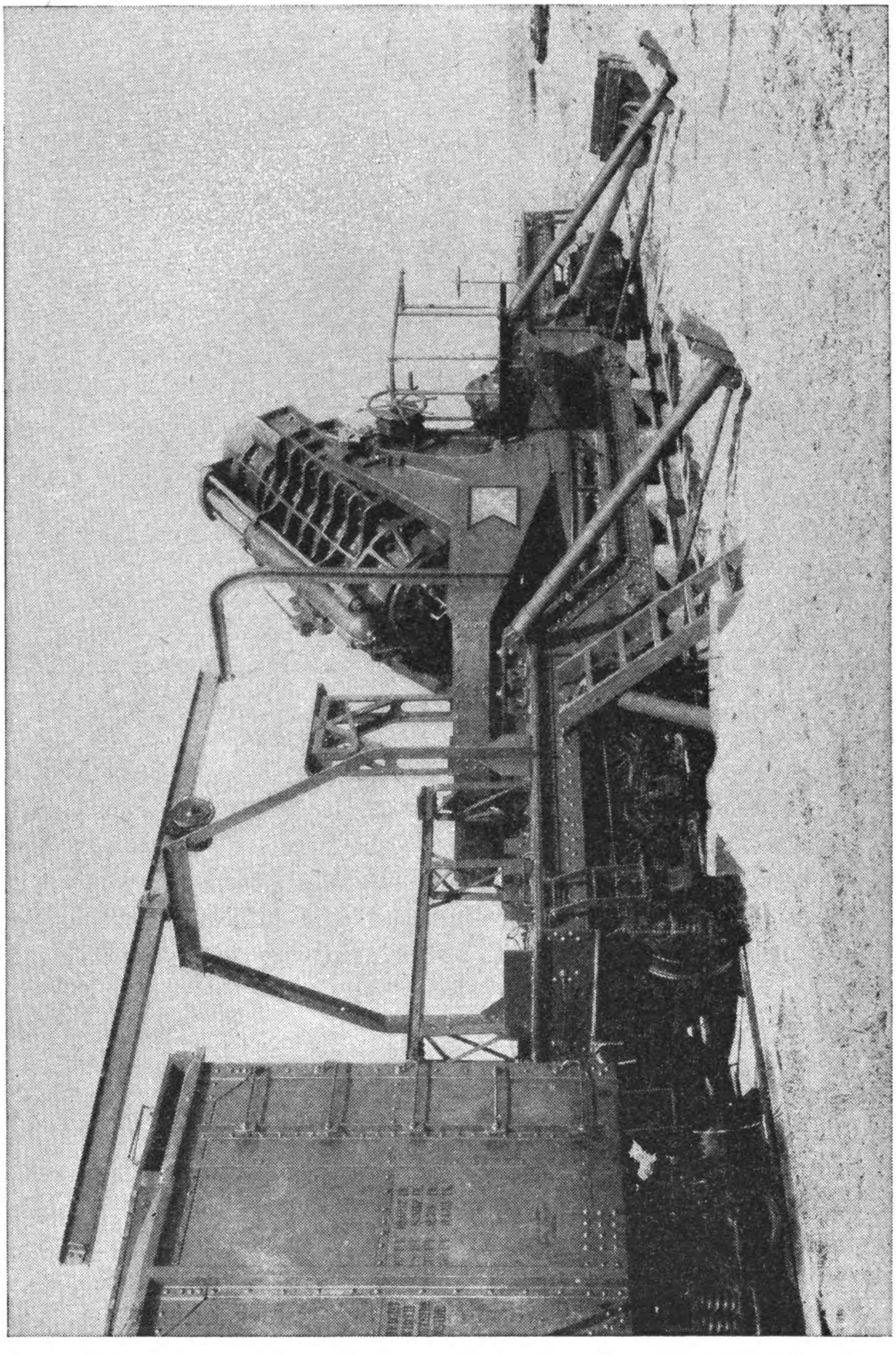


FIGURE 34.—12-inch mortar on railway mount M1918, emplaced.

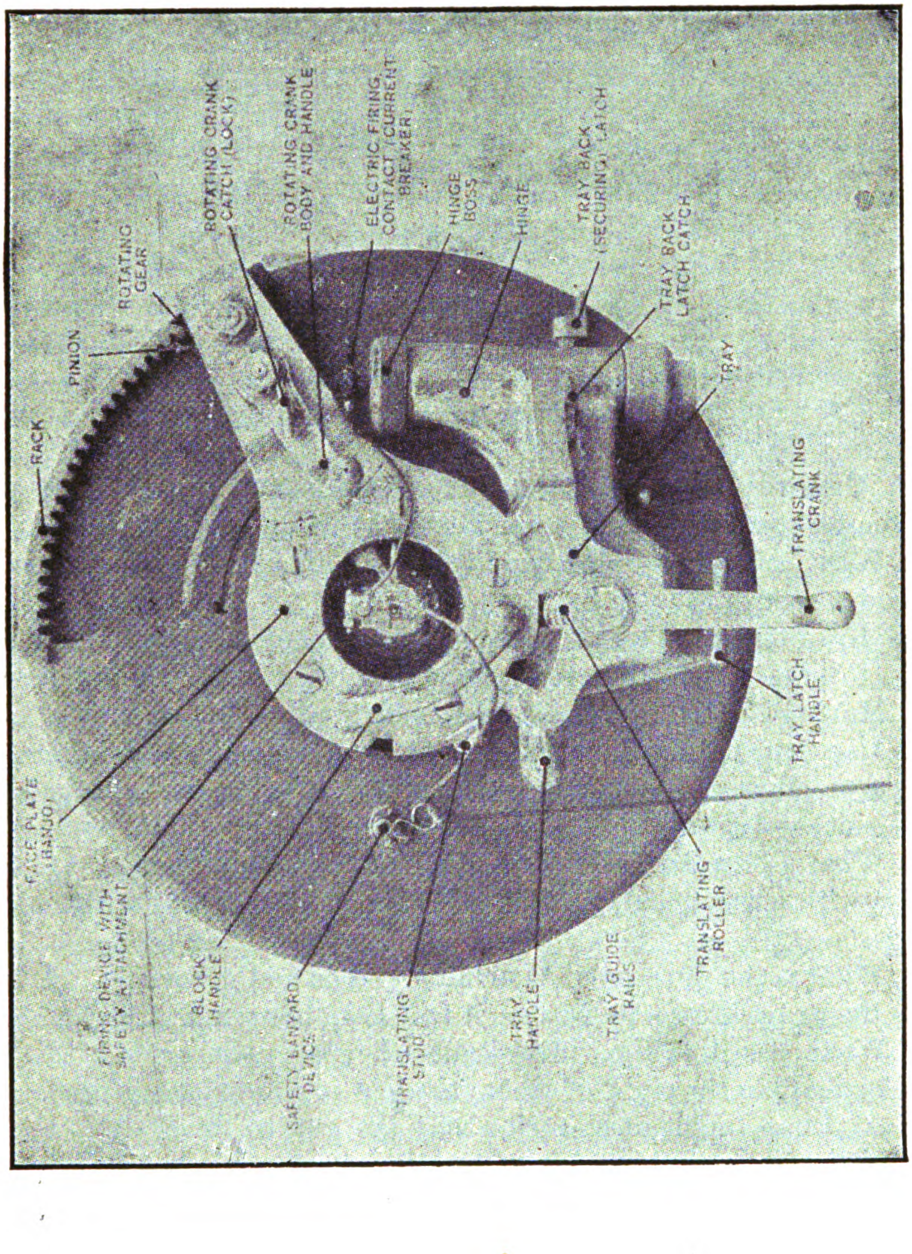



FIGURE 35.—Breech mechanism, 12-inch mortar M1890, showing firing mechanism.

## CHAPTER 4

# ACTION, CARE, AND MINOR ADJUSTMENT OF VARIOUS PARTS OF GUN AND CARRIAGE



## SECTION I

## 155-MM GUNS



**19. General characteristics.**—*Q*. What is meant by caliber? *A*. The diameter of the bore of a gun between the lands of the rifling.

*Q*. What is meant by "155-mm" when speaking of the 155-mm gun? *A*. The caliber of the gun is 155-mm.

*Q*. How long is the gun? *A*. About 37 calibers or about 19 feet.

*Q*. How much do the gun and mount weigh? *A*. About ——— tons.

*Q*. How much does the projectile weigh? *A*. 95 pounds.

*Q*. How much does the powder charge weigh? *A*. The normal charge weighs about 20 pounds; the supercharge (normal charge and increment) weighs about 25¼ pounds.

*Q*. What is the range of this gun? *A*. About 8½ miles (14,900 yards) with normal charge; about 10 miles (17,400 yards) with supercharge.

*Q*. What is the purpose of the rifling (lands and grooves)? *A*. To make the projectile rotate so that it will keep nose first in flight.

*Q*. What else does the rifling cause the projectile to do? *A*. To move or drift to the right of where the gun is pointed when fired.

*Q*. At what angles of elevation may the gun be fired? *A*. From 0° to 35° or from 0 mils to about 622 mils.

*Q*. What is the total traverse of the gun on the carriage? *A*. 60° or about 1,070 mils.

*Q*. What type of firing mechanism is used? *A*. The percussion type, which means that the primer is exploded by striking it with a firing pin.

*Q.* What type recoil system is used on this gun? *A.* Hydropneumatic, variable recoil.

*Q.* What is a variable recoil system as used on the 155-mm gun? *A.* A recoil system built purposely to allow longer recoil at low angles of elevation than at high angles. The length varies from about 6 feet at minimum elevation to about 3½ feet at maximum elevation. It is automatically controlled by the elevation of the gun.

**20. Action of gun and carriage.**—*Q.* How is the weight of the gun supported in the traveling position? *A.* The gun and cradle are trunnioned to the top carriage. The top carriage rests on a bearing surface on the rear part of the bottom carriage. The front of the bottom carriage bears a spring which is shackled to the gun axle. The gun axle runs through a channel in the front of the bottom carriage and is allowed to move up or down to take care of road shocks. The trails are pivoted to the bottom carriage and are supported at their rear ends by a spring attached to the limber axle. The recoil and recuperator piston rods are detached from the breech ring, and the gun is slid back along the trails to distribute some of the load to the limber axle.

*Q.* How is the weight of the gun supported in the firing position? *A.* The gun is in battery with piston rods attached to the breech ring. The rear ends of the trails are removed from the limber and are spread and lowered to the ground. The gun and carriage are raised from the gun axle spring until it can be unshackled from the gun axle. The carriage is then lowered until the top of the bottom carriage rests on the top of the axle. The axle pivot pin is inserted through the bottom carriage and the axle, pinning them together. This provides a rigid support for the weight of the gun and carriage directly on the axle.

*Q.* What is the purpose of the recoil mechanism? *A.* To take up the energy of recoil and stop the gun gradually as it comes back in recoil.

*Q.* How does the recoil mechanism work? *A.* The recoil mechanism consists of a piston rod and piston which slide over a control rod, all contained within a cylinder filled with oil. The piston has holes or ports in it that connect with narrow openings or grooves between the piston rod and the control rod. The piston rod is bolted to a lug on the breech ring. The cylinder and control rod are attached to the carriage. When the gun recoils the piston is pulled to the rear and the oil, in order to flow to the other side of the piston, has to pass through the ports in the piston and the grooves in the control rod and the space between the piston rod and the control rod. The resistance to the flow of oil gradually stops the gun.

*Q*. How is the length of recoil varied? *A*. The piston rods of the recoil and counterrecoil mechanism are connected to the lug of the breech ring of the gun. The recoil rod is hollow and houses the control rod, which does not recoil, being rotatively attached at its front end to the cylinder head. Ports are cut in the recoil piston leading from the rear of the piston into the interior which connect with grooves cut in the control rod. All space in the recoil cylinder not otherwise occupied is filled with oil, and the oil in rear of the recoil piston must, in recoil, pass through the ports and control rod grooves. These grooves are so arranged that rotation of the control rod varies the area of the orifices through which the oil must pass. The rotation of the control rod is accomplished by geared segments linked to the top carriage in such a manner that the position of the rod is automatically controlled by the elevation of the cradle. As the angle of elevation increases, the length of recoil is shortened.

*Q*. What is the purpose of the counterrecoil or recuperator mechanism? *A*. To return the gun to battery after recoil.

*Q*. How does the recuperator work? *A*. The recuperator mechanism consists of two cylinders, one containing a piston and piston rod and filled with oil, the other containing a mushroom valve and a floating piston and filled partly with oil and partly with compressed nitrogen. The floating piston separates the gas in the forward end from the oil in the rear end. As the gun recoils the recuperator piston moves to the rear and pushes oil into the second cylinder where it flows freely through the mushroom valve and pushes the floating piston forward further compressing the gas. When the gun stops recoiling the gas expands and pushes it back into battery.

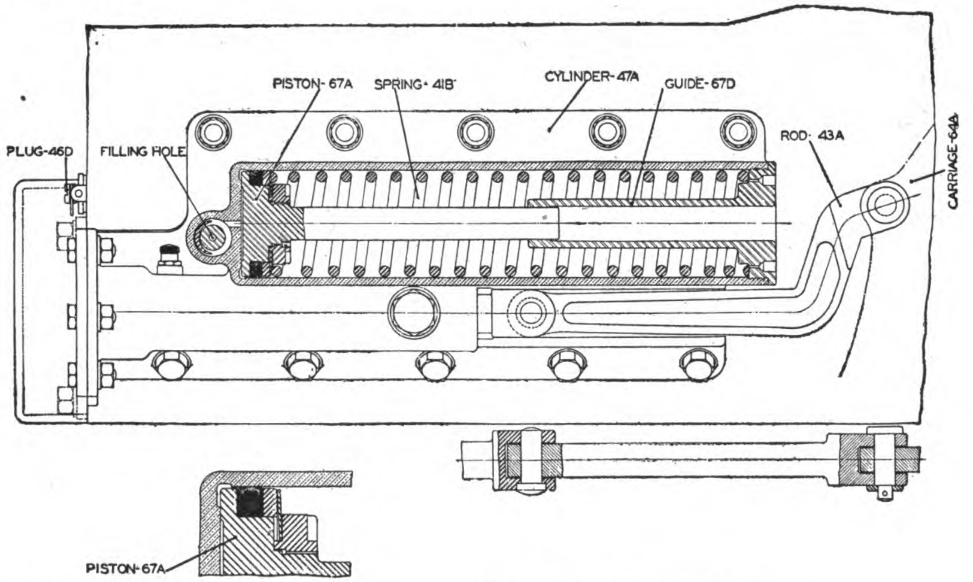
*Q*. What controls the counterrecoil of the gun? *A*. The oil flowing back through the mushroom valve has to pass through small openings that slow up the flow. Near the end of counterrecoil the counterrecoil buffer on the rear end of the control rod traps oil in the end of the recoil piston rod and gradually stops the gun.

*Q*. What is the purpose of the replenisher? *A*. The replenisher serves as an automatic filler for the recoil cylinder to insure that the recoil cylinder is full at all times. It also acts as a reservoir to permit the escape from the recoil cylinder of excess oil which is due to expansion on account of heat developed during firing or hot weather.

*Q*. Explain the operation of the replenisher. *A*. The replenisher consists of a cylinder which holds extra oil in front of a piston. The replenisher piston is kept pressed against the oil by a spring. If expansion of the oil in the recoil cylinder occurs due to heat, the excess oil in the recoil cylinder is forced into the replenisher cylinder forcing the replenisher piston back against its spring. If oil is needed in the recoil cylinder, the replenisher spring forces the piston against the oil in the replenisher cylinder. The oil is forced through the passage into the recoil cylinder to fill any void present in the cylinder.

*Q.* How does the firing mechanism operate? *A.* When the lanyard is pulled the percussion hammer strikes the firing pin which moves forward and strikes the percussion cap in the base of the primer, exploding the primer. The firing pin is then pushed back into the block by the firing pin spring.

*Q.* What safety precaution is prescribed for this type of firing mechanism? *A.* The firing mechanism block must not be inserted into the housing in the breechblock until the breech is fully closed and locked.




**64A.** Carriage, top.
**47A.** Cylinder, replenisher.
**67D.** Guide, replenisher piston.
—— Hole, recoil cylinder filling.
**67A.** Piston, replenisher.
**46D.** Plug, recoil cylinder drain.
**43A.** Rod, connecting.
**41B.** Spring, replenisher piston.

FIGURE 36.—Replenisher, assembled views.

*Q.* Explain the operation of the breech mechanism when the breech is opened. *A.* The breech is opened by pressing down on the operating lever handle and swinging the operating lever back and to the right around the hinge pin. This unscrews the breechblock and swings the block and carrier to the rear. The block is held open by

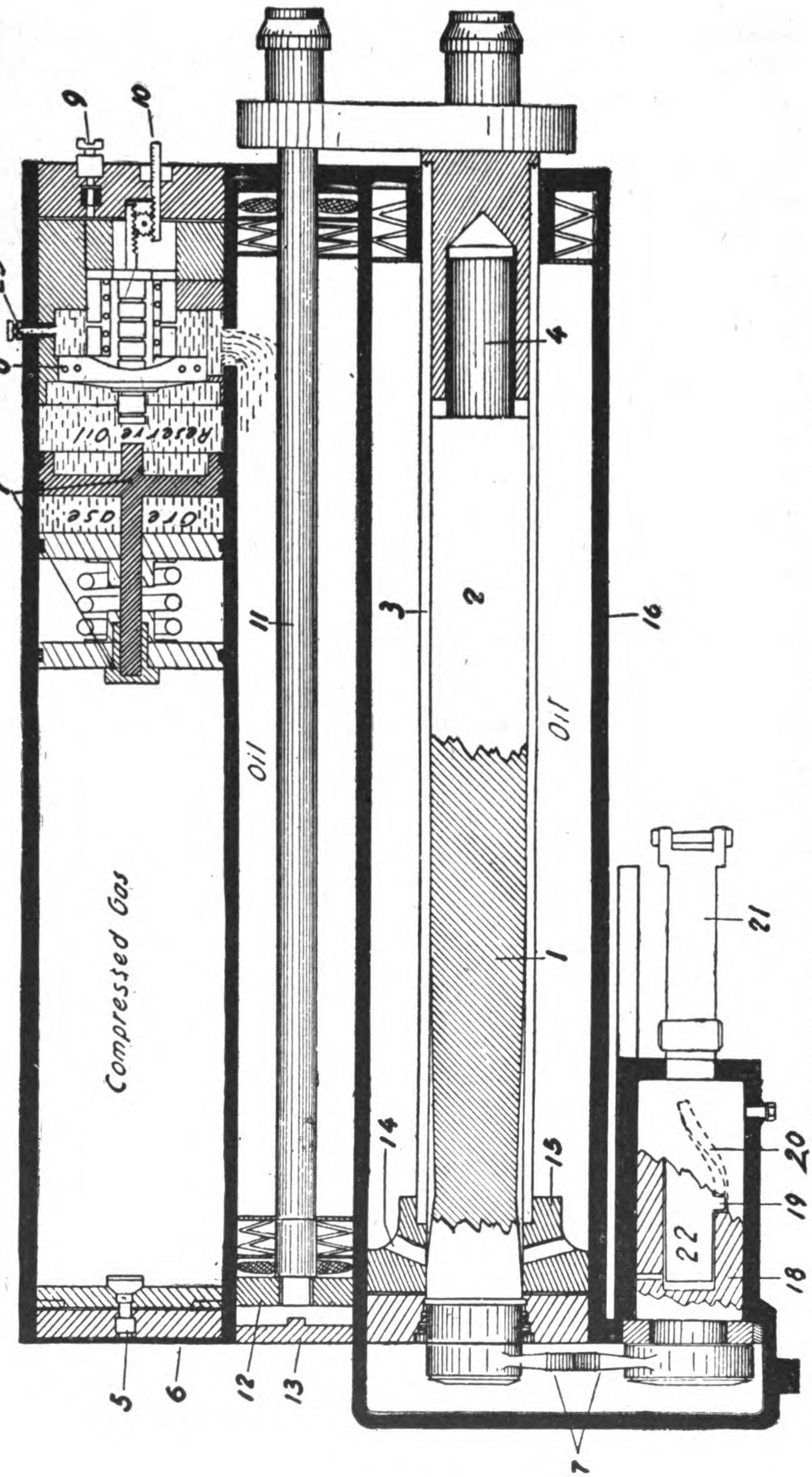



FIGURE 37.—Horizontal cross section of recoil and recuperator mechanism, 155-mm gun.

1. Control rod.
2. Control rod.
3. Hollow recoil rod.
4. Counterrecoil buffer.
5. Air valve.
6. Recuperator cylinder.
7. Floating piston assembly.
8. Regulator valve.
9. Filling and drain plug.
10. Oil index rod.
11. Counterrecoil rod.
12. Counterrecoil piston.
13. Counterrecoil cylinder.
14. Port in recoil piston.
15. Recoil piston.
16. Recoil cylinder.
17. Gear segments.
18. Sleeve.
19. Cam.
20. Cam groove.
21. Regulating arm.
22. Valve turning rod.
23. Recuperator filling plug.

the operating lever latch which is caught by the operating lever catch on the right side of the breech ring.

*Q.* Explain the operation of the breech mechanism when the breech is closed. *A.* When the breech is closed the threaded parts of the block mesh with the threaded parts of the breech ring on the gun. The block is prevented from turning by the operating lever which is held fast because the handle is caught by the block carrier lever catch on the left end of the carrier.

*Q.* Of what use is the counterbalance? *A.* It helps in opening and closing the breech.

*Q.* What is meant by obturation? *A.* Obturation is the prevention of escape to the rear of the gases that propel the projectile.

*Q.* What parts of the gun provide obturation? *A.* The breech-block and obturating mechanism.

*Q.* How do they work? *A.* The obturating mechanism consists of a "mushroom head" and spindle that extends back through the middle of the breechblock, a gas check pad, three metal split rings, and a filling-in disk. The gas check pad is held between the mushroom head and the filling-in disk which is next to the front face of the breech-block. Two of the split rings are carried around the outer edge of the pad and the other is around the inner edge next to the spindle. When the gun is fired the gases press back on the mushroom head which squeezes the gas check pad causing it to expand outward and inward. This forces the two outer rings up against the wall of the powder chamber and the inner ring against the spindle, thus preventing the escape to the rear of powder gases or lubrication of the gas check pad. After pressure falls the gas check pad contracts and relieves the pressure from the split rings so the breech may be opened.

**21. Care and minor adjustment of gun and carriage.**—*Q.* What general lubrication is necessary on the carriage? *A.* All machined surfaces must be kept free from rust and dirt, and covered with a light coat of lubricating oil, class A. Special attention must

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be given to trunnions, pintle surfaces, shaft bearings, piston rods and cylinders, sliding surfaces, axles, bearings, elevating mechanism, and traversing mechanism. Grease and oil cups should be kept filled and free from dirt or grit.

*Q.* What care should be taken of the breech mechanism? *A.* It should from time to time be dismantled, cleaned, and oiled with lubricating oil, class A. The breech should be kept closed when possible to keep dust and grit out of the mechanism. It should always be cleaned, oiled, and adjusted just before and just after firing. The vent should be cleaned after firing in the same way as the powder chamber and bore.

*Q.* How is the breechblock dismantled? *A.* Open the breech, unlock the firing mechanism housing from the obturator spindle by withdrawing the firing mechanism housing key and key spring. Unscrew the obturator spindle from the firing mechanism housing and remove those parts from the block. Split rings, gas check pad, and filling-in disk may then be removed.

*Q.* How is the breechlock assembled? *A.* Put the front split ring on the obturator spindle, followed by the gas check pad, rear split rings and filling-in disk. Put the firing mechanism housing in the block, insert the obturator spindle and screw it in, at the same time adjusting the split rings to their positions. Replace the firing mechanism housing key and key spring.

*Q.* What is used to lubricate the gas check pad? *A.* Graphite lubricating grease, medium, liberally applied, and carefully worked in with the fingers.

*Q.* What is used for sponging the powder chamber during firing? *A.* Sponging solution, prepared by thoroughly dissolving 1 pound of castile soap in 4 gallons of water. This is better than plain water because it lubricates the breech recess in addition to extinguishing burning residue. Water only may be used when the soap solution is not available.

*Q.* How should the powder chamber and bore be cleaned after firing? *A.* By sponging with hot water or a hot solution of cleaning compound (½ pound of sodium carbonate, or sal soda, dissolved in 1 gallon of boiling water). After cleaning, the bore should be allowed to drain. When drained and wiped thoroughly dry, apply lubricating oil, class A. Never try to use oil in place of hot water for cleaning. This procedure should be repeated every day for a period of from 1 to 2 weeks until "sweating" definitely ceases.

*Q.* What is used in the bore as a preservative during periods of inactivity? *A.* Rust-preventive compound.

*Q*. Can you tell how much oil is in the replenisher? *A*. Yes, by the position of the spindle on the replenisher piston.

*Q*. How do you check this? *A*. By inserting a gage into the rear end of the replinisher cylinder until it touches the spindle.

*Q*. What are the normal limits between which this gage should read? *A*. From 100 to 200 mm.

*Q*. What does a gage reading of 80 mm mean? *A*. That there is more oil in the cylinder than necessary.

*Q*. Is the gun ever fired with a millimeter reading less than 100? *A*. In an emergency when it is necessary to continue without an interruption, firing is permitted until the reading is down to 50 mm.

*Q*. How are the recoil cylinder and replenisher filled? *A*. Remove the plug from the drain hole in the front end of the recoil cylinder and insert the drain tube. Remove the plug from the filling hole on the side of the replenisher cylinder. Prime the pump until oil flows from the coupling at the end of the pipe, and screw the coupling into the filling hole. Pump in oil until it flows from the drain tube free from air bubbles. Unscrew the drain tube and pump in oil until the gage reading on the end of the spindle is 150 mm. Detach the pump and replace both plugs.

*Q*. How can you tell when the recuperator needs filling? *A*. By the position of the oil gage in the rear end of the recuperator cylinder. If it sticks out less than 5 mm the recuperator needs filling.

*Q*. How is the recuperator filled? *A*. Remove the recuperator filling and drain plug in the rear cylinder head, insert the drain valve release, drain completely, and remove the valve release. Prime the pump and connect it to the filling hole on the right side of the cradle. Give the pump exactly 100 full strokes. Detach the pump and replace both plugs.

*Q*. What kind of oil should be used in the recoil and recuperator cylinders? *A*. Heavy recoil oil.

*Q*. What type of oil is used in the oil cups? *A*. Lubricating oil, class A.

## Section II

## 14-INCH GUN M1920MII ON RAILWAY MOUNT M1920

**22. General characteristics.**—*Q*. What is meant by caliber? *A*. Caliber is the diameter of the bore of the gun measured between two opposite lands of the rifling.

*Q*. What is the caliber of the weapon manned by your battery? *A*. 14 inches.

*Q*. What is the length of the bore? *A*. The 14-inch railway gun M1920 is approximately 50 calibers (59 feet 6 inches) in length.

*Q*. How much do the gun and carriage weigh? *A*. 370 tons.

*Q*. What is the maximum range of the 14-inch railway gun? *A*. 38,800 to 48,200 yards or approximately 22 to 27 miles.

*Q*. What is the purpose of the rifling (lands and grooves)? *A*. To make the projectile rotate so that it will keep nose first in flight.

*Q*. What else does the rifling cause the projectile to do? *A*. To drift or move to the right.

*Q*. What is the total traverse of the piece on the carriage? *A*. 7°. (3½° on either side of the normal.)

*Q*. Can 360° traverse ever be obtained? *A*. Yes, if the mount is emplaced on a previously prepared permanent emplacement.

*Q*. At what angles of elevation may the piece be fired? *A*. From 0° to 50°. The elevating mechanism will depress the piece to −7° to facilitate loading.

**23. Action of gun and carriage.**—*Q*. What type of firing mechanism is employed with the 14-inch railway gun? *A*. The firing lock Mk. I.

*Q*. How is the firing lock attached to the breech mechanism? *A*. The assembled firing lock is attached to the rear end of the obturator spindle by pushing it over the end of the spindle and giving it one-fourth turn to the locked position. Annular grooves on the rear of the spindle and in the firing lock housing are divided longitudinally into two plain and two grooved sectors, which make possible this manner of assembly.

*Q*. Put on and take off the firing lock. *A*. (Practical demonstration.)

*Q*. Describe the operation of the firing mechanism. *A*.

(1) *Percussion firing*.—The hammer and the cocking lever are mounted on a bracket attached to the rear of the firing lock slide. The cocking lever is in rear of the hammer and is provided with a hole in the top for attaching the lanyard. A torsional spring around the axis of the cocking lever tends to drive the lever forward. The hammer has a spring catch fitted into its right side. When the cocking lever is drawn to the rear by means of the lanyard, a latch on the lever engages the catch on the hammer so that the hammer is also drawn to

the rear. The hammer is drawn back until the hammer catch slides off the latch on the lever and the hammer is released. Under the action of the firing spring, which bears against the lower end of the hammer through a thrust pin, the hammer is driven forward striking the firing pin which in turn fires the primer.

(2) *Electric firing.*—One side of the circuit is connected to a terminal at the top of the hammer. This terminal is attached to a contact piece insulated from the rest of the hammer which makes contact with the primer through the firing pin, which is itself insulated from its surrounding parts. The other side of the circuit is grounded to the gun. Application of the firing current causes ignition of the primer.

*Q.* What type of primer is used with the firing lock Mk. I? *A.* The combination percussion-electric primer Mk. XVMI.

*Q.* What is the extractor? *A.* The extractor is a device which extracts the fired primer from the obturator spindle. It is a forked-shaped piece, located in the firing lock housing, which straddles the head of the primer. The extractor is actuated by an extractor cam provided with a torsional spring.

*Q.* What is the firing lock slide? *A.* It is a slide which moves vertically in grooves in the sides of the firing lock housing. It contains the firing pin and operates the extractor cam. Its front face is a hardened plate which takes the thrust of the primer when the gun is fired. The slide also provides a safety feature since the slightest withdrawing of the slide from its closed position moves the firing pin out of its firing position and prevents firing either electrically or by percussion.

*Q.* Describe the operation of the firing lock slide. *A.* The lower end of the slide is connected to the lock operating bar. This bar moves vertically in a T-slot in the rear face of the breechblock carrier. A plunger at the bottom of the operating bar moves in a helical groove on a cam attached to the lower end of the crankshaft, just above the operating lever. When the breech is opened, the operating lever cam withdraws the operating bar by means of the operating bar plunger, causing the slide to be lowered and the primer ejected. When the breechblock is closed, the lock operating bar is automatically raised, which in turn raises the slide until the firing pin is opposite the primer and the lock is ready to fire. For safety reasons the primer is not inserted until the block is fully closed. When the block is closed the operating bar is pulled down by hand by means of the operating bar plunger hand lever, the primer inserted in the chamber of the spindle until it passes the primer retaining catch, and the operating bar again raised until the slide is in the firing position. In case of a misfire the lock can be reprimed in the same manner without opening the breech.

*Q*. What is meant by obturation? *A*. Obturation is the prevention of escape to the rear of the gases that propel the projectile.

*Q*. What parts of the gun provide obturation? *A*. The breechblock and obturating mechanism.

*Q*. How do they work? *A*. The obturating mechanism consists of a "mushroom head" on a spindle that extends back through the middle of the breechblock, a gas check pad, three metal split rings and a filling-in disk. The gas check pad is held between the mushroom head and the filling-in disk which is next to the front face of the breechblock. Two of the split rings are carried around the outer edge of the pad and the other is around the inner edge next to the spindle. When the gun is fired, the gases press back on the mushroom head, squeezing the gas check pad between the mushroom head and the filling-in disk. The pad expands outward and inward, pushing the two outer split rings up against the wall of the powder chamber and the inner ring against the spindle, preventing the escape of powder gases to the rear and the loss of the lubricating substance in the gas check pad. After the pressure goes down (when the projectile has left the gun) the gas check pad contracts and relieves the pressure on the split rings so the breech may be opened. (See fig. 22.)

*Q*. How is the breech mechanism operated? *A*. To open the mechanism, the operating lever is swung to the rear and right by hand as far as it will go. This rotates the crankshaft which by means of the cross head rotates and unlocks the block. The cam rollers and roller paths guide the block to the point of engagement with the control arc. The mechanism is then swung to the rear and downward by means of the breechblock handle attached to the rear face of the block. When open, the mechanism is supported by the counterbalance spring which also serves as a buffer. When the valve which admits compressed air to the closing cylinder is opened, the air pressure on the piston at the end of the spring rod closes the mechanism. The operating lever is locked in the closed position by the salvo latch, and is unlocked by the recoil of the gun or by releasing the salvo latch by hand. A gas ejector is also incorporated in this breech mechanism. The ejector valve is automatically opened by a trip plate when the block is rotated, allowing air to be blown through holes in the breech bushing and into the bore of the gun. The compressed air for closing the mechanism is taken from the gas ejector system. Before reaching the inlet valve, the air is passed through a reducing valve which maintains a constant pressure.

*Q.* What is the purpose of the recoil mechanism? *A.* To take up the energy of recoil and stop the gun gradually as it comes back in recoil.

*Q.* What is the purpose of the counterrecoil or recuperator mechanism? *A.* To return the gun to battery after recoil.

*Q.* Of what does the recoil mechanism consist? *A.* It consists of four cylinders, two short and two long. The cylinders are fastened to the cradle and are filled with a mixture of glycerin and water. Pistons connected by piston rods to the gun work in these cylinders.

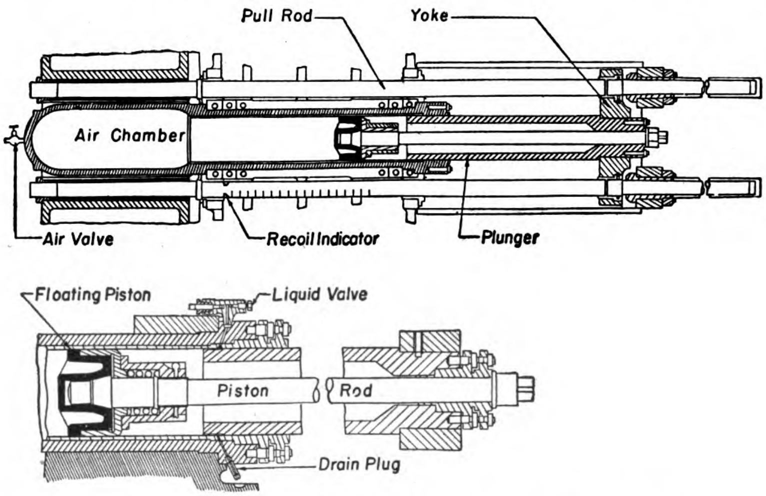



FIGURE 38.—Recuperator cylinder, 14-inch railway gun.

*Q.* How does the recoil mechanism work? *A.* When the gun recoils, the pistons in the recoil cylinders are pulled to the rear, compressing the recoil liquid and forcing it through restricted spaces to the other side of the pistons. The resistance to the passage of the liquid through the restricted spaces and the compression of the liquid set up forces which oppose the movement of the pistons and bring the gun to a smooth stop after 35 inches of recoil.

*Q.* Where is the expansion chamber located? *A.* It is on top of the front end of the cradle. It is the highest part of the recoil system at all elevations. It is connected by pipes to the forward end of each recoil cylinder.

*Q.* What is the purpose of the expansion chamber? *A.* To provide space for expansion of the recoil liquid when it gets hot.

*Q.* Of what does the recuperator mechanism consist? *A.* The system is hydropneumatic and consists of two cylinders, one below and one above the gun, each with a main piston, pull rods, and floating piston. Each cylinder is filled with compressed air and a liquid which are separated from each other by the floating piston.

*Q*. How does the recuperator work? *A*. The recoil of the gun, acting through the main piston, still further compresses the air in the cylinders. This in turn reacts to return the gun to the firing position when the recoil has been stopped.

*Q*. Why is an elevating brake necessary? *A*. The elevating gearing consists of spur gears and the unbalanced weight of the tipping parts would cause it to turn if it were not for this brake.

*Q*. Of what does it consist? *A*. It is on the right side of the frame and consists of a brake drum and a brake band, lined with commercial brake lining which engages the outer surface of the drum.

*Q*. How is the elevating brake used? *A*. It is always on unless released. It is released by raising a lever located above the drum. It must be released whenever the gun is elevated or depressed.

*Q*. How is the gun and top carriage changed from the firing to the traveling position? *A*. The front end of the top carriage is raised by means of a lifting mechanism until its weight is no longer supported by the firing support. The firing support is then run forward until it is clear of the front end of the top carriage. The front end of the top carriage is then lowered between the main car girders until its weight is resting on a transom extending across the car body at the lower end of the girders. When the top carriage is in this position, the mount has proper clearance for travel on all the principal railroads of the United States and for passing all main line cuts, bridges, and tunnels.

**24. Care and minor adjustment of gun and carriage.**—*Q*. How should the powder chamber and bore be cleaned after firing? *A*. By sponging with a solution of cleaning compound as soon as possible after any firing. The solution is made by dissolving ½ to 1 pound (depending on the strength desired) of soda ash in each gallon of boiling water. The bore is washed with this solution, using a bore sponge wrapped with burlap. The bore is then wiped thoroughly dry using the sponge wrapped with dry burlap. Then apply medium or heavy rust-preventive compound. This procedure should be repeated every day for 1 to 2 weeks until all "sweating" stops.

NOTE.—Never try to use oil in place of the cleaning solution when cleaning the bore and chamber.

*Q*. What care must be taken in cleaning the bore? *A*. Care must be taken to prevent the staves of the brushes and sponges from rubbing against the lower part of the bore as this may cause excessive wearing of the lands.

*Q*. What is used for sponging the powder chamber during firing? *A*. The powder chamber requires no sponging during firing. It is cleared of any burning or smoldering particles by compressed air which is automatically injected as the breechblock is opened. For safety the mushroom head must be wiped after each round is fired and the bore announced "clear" by the chief of breech before air is *manually* turned off.

*Q*. What care should be taken of the breech mechanism? *A*. From time to time it should be dismantled, cleaned, and oiled with lubricating oil, class A. The breech should be kept closed at all times when not required to be open to keep dust and grit out of the mechanism. It should always be cleaned, oiled, and adjusted just before and just after firing. The vent should be cleaned after firing in the same way as the powder chamber and bore.

*Q*. What is used to lubricate the gas check pad? *A*. Graphite lubricating grease, medium, liberally applied and thoroughly worked in with the fingers.

*Q*. How is the obturator adjusted for firing? *A*. With the breechblock open, tighten the clamping nut on the obturator spindle as tight as it can be screwed by one man with the wrench provided.

*Q*. What liquid is used in the recoil and recuperator cylinders? *A*. A solution of equal parts by volume of glycerin, grade A, USP, and pure water (such as filtered rain water or distilled water). To each 3 gallons of the mixture must be added 1 ounce of sodium hydroxide, CP ($NaOH$), sticks or pellets.

*Q*. How are the recoil cylinders drained? *A*. By means of drain plugs in their rear ends. The long cylinders also have a pipe plug at the front end which can be used to drain the bottom of the front part.

*Q*. How are the recoil cylinders filled? *A*. The gun should be set at zero elevation. The recoil cylinders are filled through a funnel which is attached to the expansion chamber. Close the drain plugs at the lower rear end of the cylinders. Open the filling plug or vent at the upper rear end of each cylinder to permit the escape of air. Pour in liquid until each cylinder is completely filled. Close each vent when the liquid starts flowing out of it.

*Q*. What provision is made for draining and refilling the recuperator cylinders? *A*. At the rear of each cylinder is an air valve, and on the top of the upper cylinder and the bottom of the lower cylinder there are liquid valves. The air chambers and liquid chambers are connected by tubing, and they are also connected to the air and liquid pressure gages. The liquid chambers are also connected to the liquid pump.

*Q*. Where is the liquid pump and how is it filled? *A*. The liquid pump is fastened to the same support as the pressure gages. It is filled by unscrewing a cap in the cover and drained by unscrewing a plug in the bottom. It has a relief valve designed to blow off at a pressure of 2,200 to 2,500 pounds per square inch to protect it from excessive back pressure. *This valve should not be tampered with.*

*Q.* Describe the process of filling the cylinders. *A.* Open the liquid valves and read the pressure on the liquid pressure gage. If the pressure is less than the normal indicated on the scale, pump more oil into the system by operating the lever of the liquid pump. When the gage indicates the proper pressure stop pumping and close the liquid valves.

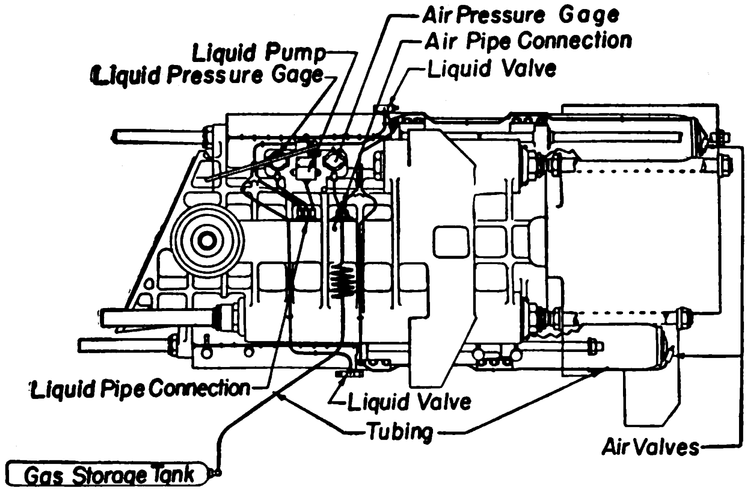



FIGURE 39.—Piping for filling recuperator cylinders, 14-inch railway gun.

*Q.* What provision is made for draining and refilling the air chamber? *A.* The air valve (see fig. 39) located at the rear end of each recuperator cylinder is fitted with two needle valves, one for emptying and one for filling. The filling valves are connected by tubing with the air pipe connection fastened to the cradle. This connection is connected by tubing to the air gage. The air pipe connection has an inlet with plug by which the coiled tubing from the compressed gas cylinder is attached.

*Q.* Describe the process of filling the air chamber. *A.* The filling valves are open and the gas pressure in each cylinder is read. If the pressure is below 1,980 pounds per square inch more gas is required. The filling valves are closed. The compressed gas cylinder is attached to the air pipe connection by means of coiled tubing. The filling valves are opened. The valve on the compressed gas cylinder is opened and the cylinders are charged until the air pressure gage indicates 1,980 pounds per square inch. The valve on the compressed gas cylinder is then closed, the filling valve on each air valve is closed, the coiled tube disconnected, and the plug in the air pipe connection screwed home.

*Q.* What general lubrication of the carriage is necessary? *A.* All machined surfaces must be kept free from dust and dirt, and covered with a light coat of lubricating oil, class A. Special attention must be given to trunnions, pintle surfaces, shaft bearings, piston rods, cylinders, sliding surfaces, axles, bearings, elevating mechanism, and traversing mechanism. Grease and oil cups should be kept free from dirt or grit.

*Q.* What type of oil is used in the oil cups? *A.* Lubricating oil, class A.

*Q.* If firing is not conducted, how often must the recoil and counterrecoil mechanisms be exercised? *A.* Every 6 months.

*Q.* How is this done? *A.*

(1) With the recuperator cylinders fully charged, the recoil cylinders filled, the gun well-lubricated in the cradle, and the cradle set at zero elevation, the maneuvering valve is closed.

(2) The gun is then set against the stops at maximum elevation, and the firing parts lock nut is unscrewed.

(3) The air filling valves on the recuperator cylinders are opened.

(4) The maneuvering valve is opened and the gas in the recuperators permitted to escape. The air pressure gage will indicate the existing pressures.

(5) If a maneuvering valve has not been installed the gas is released by means of the emptying needle valve in each air valve.

(6) When the air pressure has dropped sufficiently, the gun will slide back a short distance, being stopped by the building up of air pressure in the recuperators.

(7) The gun is brought to the full recoiled position by successive movements and the maneuvering valve is closed.

(8) The condition of all exposed parts is then noted.

(9) To return the gun to battery, fully charged compressed-gas cylinders are coupled to the maneuvering valve outlet or to the air pipe connection, and the recuperators are filled.

*Q.* When the mount is stored for an indefinite period what should be done to relieve the truck springs? *A.* The mount should be let down on the track emplacement I-beams to take the load off the springs.

## SECTION III

## 8-INCH GUN M1888 ON RAILWAY MOUNT M1918



**25. General characteristics.**—*Q*. What is meant by caliber? *A*. Caliber is the diameter of the bore of the gun measured between two opposite lands of the rifling.

*Q*. What is the caliber of the weapon manned by your battery? *A*. 8 inches.

*Q*. How long is the cannon? *A*. The 8-inch gun M1888 is 32 calibers or about 21 feet long.

*Q*. How much do the cannon and carriage weigh? *A*. The 8-inch gun M1888 on railway carriage M1918 weighs about 87 tons.

*Q*. What is the range of the gun? *A*. ——— yards (or approximately ——— miles).

*Q*. What is the purpose of the rifling (lands and grooves)? *A*. To make the projectile rotate so that it will keep nose first in flight.

*Q*. What else does the rifling cause the projectile to do? *A*. To move or drift to the right of where the gun is pointed when fired.

*Q*. At what angles of elevation may the piece be fired? *A*. From 0° to 42°.

*Q*. What is the total traverse of the piece on the carriage? *A*. 360°.

*Q*. What steepness of rifling is used? *A*. Variable, from 1 turn in 50 calibers to 1 turn in 25 calibers.

*Q*. How many recoil cylinders are used? *A*. One.

*Q*. How many recuperator cylinders are used? *A*. Four.

*Q*. What is the length of recoil? *A*. 48 inches.

*Q*. What type breech mechanism is used? *A*. Translating roller type, tray supported.

**26. Action of gun and carriage.**—*Q*. What is the purpose of the recoil mechanism? *A*. To take up the energy of recoil and stop the gun gradually as it comes back in recoil.

*Q*. Of what does the recoil mechanism consist? *A*. One recoil cylinder, with throttling grooves, piston, piston rod, which is fastened to the recoil lug at the breech of the gun, a piston rod buffer, and a bypass pipe for the recoil oil. The single recoil cylinder is attached to the bottom of the cradle in the center.

*Q*. How does the recoil mechanism work? *A*. When the gun recoils the piston is pulled to the rear and the oil, in order to flow to the other side of the piston, has to pass through the throttling grooves in the wall of the cylinder. This causes friction which absorbs the energy of recoil and gradually stops the gun.

*Q*. What is the purpose of the counterrecoil or recuperator mechanism? *A*. To return the gun to battery after recoil.

*Q*. Of what does the counterrecoil (recuperator) mechanism consist? *A*. Of four counterrecoil cylinders, two above and two below the gun, fastened to the cradle by forged steel bands. Each cylinder contains four sets of springs (each set consisting of three coil springs), a spring rod, and a spring rod piston, which is fastened to the recoil band.

*Q*. How does the counterrecoil mechanism work? *A*. When the gun recoils, the spring rods are withdrawn from their cylinders, and pull the spring rod pistons to the rear, thereby compressing the springs in each cylinder. When the force of recoil is spent, these compressed springs extend and carry the gun back into battery.

*Q*. What controls the counterrecoil of the gun? *A*. The counterrecoil buffer on the front of the recoil piston traps oil in the end of the recoil cylinder and gradually stops the gun.

*Q*. Name the principal parts of the breech mechanism. *A*. The breechblock, hinge pin, tray, tray latch, tray back latch, translating crank, translating roller, revolving crank, revolving crank catch, obturating mechanism, and firing mechanism.

*Q*. Explain the action of the breech mechanism when the breech is closed. *A*. When the breech is closed the threaded parts of the block mesh with the threaded parts of the breech ring on the gun. The tray is held against the face of the breech by the tray latch.

*Q*. Explain the action of the breech mechanism when the breech is opened. *A*. The breech is opened by moving the revolving crank catch handle to the right and turning the revolving crank. This unscrews the breechblock and brings the translating stud on the lower edge of the block into engagement with the translating roller. Operation of the translating crank now will withdraw the block from the breech recess onto the tray. The tray latch is tripped and the tray swung to the rear and right about the hinge pin, opening the breech. The tray is held in the open position by the tray back latch which must be tripped before the breech can be closed.

*Q*. Name the principal parts of the firing mechanism. *A*. The hinged collar, housing slide, and firing leaf.

*Q*. How does it work? *A*. The hinged collar fits over grooves in the rear end of the obturator spindle. It is prevented from opening by the housing into which it is screwed. The hinged collar and housing are prevented from turning on the spindle by the guide bar which projects from the right side of the housing into a groove in the breechblock. The slide is attached to the housing in a groove which allows vertical movement. With the slide raised a primer may be inserted into the primer seat in the end of the spindle. The slide is then lowered and holds the primer in place, allowing the button wire to extend to the rear. It is locked in this position by the slide catch. The firing leaf is pivoted to the slide at its upper end. It has a vertical slot cut in its lower edge through which the button wire extends when the slide is lowered. At the right-hand lower corner of the firing leaf is an eye into which the lanyard is hooked for firing by friction. When the leaf is pulled back it pulls the button wire back igniting the primer. A safety bar prevents accidental firing by lanyard before the breech is fully closed and locked. It engages the firing leaf and prevents it from moving to the rear, and is not withdrawn until the last movement of the breech is closing. It is actuated by the safety bar slide in the block.

*Q*. What safety precaution is prescribed for this type of firing mechanism? *A*. The primer must not be inserted in the primer seat until the breech is fully closed and locked.

*Q*. Put on and take off the firing mechanism. *A*. (Practical demonstration.)

*Q*. What is meant by obturation? *A*. Obturation is the prevention of escape to the rear of the gases that propel the projectile.

*Q*. What parts of the gun provide obturation? *A*. The breechblock and obturating mechanism.

*Q*. How do they work? *A*. The obturating mechanism consists of a "mushroom head" and spindle that extends back through the middle of the breechblock, a gas check pad, three metal split rings, and a filling-in disk. The gas check pad is held between the mushroom head and the filling-in disk which is next to the front face of the breechblock. Two of the split rings are carried around the outer edge of the pad and the other is around the inner edge next to the spindle. When the gun is fired the gases press back on the mushroom head which squeezes the gas check pad causing it to expand outward and inward. This forces the two outer rings up against the wall of the powder chamber and the inner ring against the spindle, thus preventing the escape of powder gases to the rear, and also preventing the loss of the lubricating substance in the gas check pad. After the pressure falls, the gas check pad contracts and relieves the pressure from the split rings so the breech may be opened.

*Q*. How is the weight of the cannon and carriage supported in the traveling position? *A*. By springs attached to railroad trucks.

*Q*. How is the weight of the cannon and carriage supported in the firing position? *A*. Through the car body sills to the ground platform placed under the center of the carriage.

**27. Care and minor adjustment of gun and carriage.**—*Q*. What is used for sponging the powder chamber during firing? *A*. Sponging solution, prepared by thoroughly dissolving 1 pound of castile soap in 4 gallons of water. This is better than plain water because it serves to lubricate the breech recess in addition to extinguishing burning residue. Water only may be used when the soap solution is not available.

*Q*. How should the powder chamber and bore be cleaned after firing? *A*. By sponging with hot water or a hot solution of cleaning compound (½ pound of sodium carbonate, or sal soda, dissolved in 1 gallon of boiling water). After cleaning, the bore should be allowed to drain. When drained and wiped thoroughly dry, apply lubricating oil, class A. Never try to use oil in place of hot water for cleaning. This procedure should be repeated every day for a period of from 1 to 2 weeks until sweating definitely ceases.

*Q*. What is used in the bore as a preservative during periods of inactivity? *A*. Rust-preventive compound.

*Q*. How is the oil drained from the recoil cylinder? *A*. Elevate the gun to about 10°, remove the vent plug and draw oil from the cylinder through the filling valve, collecting it in a 10-gallon can.

*Q*. What oil is used in the recoil cylinder? *A*. Light recoil oil.

*Q*. How is the recoil cylinder filled? *A*.

(1) Elevate the gun the maximum elevation, 42°, and remove vent plug.

(2) Assemble filling device and back off filling valve plug until oil can pass from filler to cylinder.

(3) Pour oil into cylinder until it reaches level of vent plug, which is near the front end of the cylinder. Insert vent plug and screw filling plug up tight.

(4) Drain surplus oil from filling device through petcock at lower end and collect it in an oil can.

(5) Disassemble filling device.

*Q*. What care should be taken of the breech mechanism? *A*. From time to time it should be dismantled, cleaned, and oiled with lubricating oil, class A. The breech should be kept closed when possible to keep dust and grit out of the mechanism. It should always be cleaned, oiled, and adjusted just before and just after firing. The vent should be cleaned after firing in the same way as the powder chamber and bore.

*Q*. How is the breechblock dismantled? *A*. Open the breech, remove the firing mechanism and the spindle nut and washers. Holding the filling-in disks, split rings, and pad against the obturator, remove these parts from the block. The filling-in disks, rings, and pad may then be removed from the obturator spindle.

*Q*. How is the obturator adjusted for firing? *A*. Assemble the breechblock with the spindle nut loose, but not enough to permit slipping of the gas check pad or split rings. Close the breech and rotate the block halfway closed, and screw up on the spindle nut as tight as it can be screwed by one man with the wrench provided. Tighten the clamping screw on the spindle nut and rotate the breechblock completely closed. The pad should now be in proper adjustment for firing. The adjustment may be checked by turning the obturator by hand. It should turn easily but without end play.

*Q*. What is used to lubricate the gas check pad? *A*. Graphite lubricating grease, medium, liberally applied, and thoroughly worked in with the fingers.

*Q*. What general lubrication is necessary on the carriage? *A*. All machined surfaces must be kept free from rust and dirt, and covered with a light coat of lubricating oil, class A. Special attention must be given to trunnions, pintle surfaces, shaft bearings, piston rods and cylinders, sliding surfaces, axles, bearings, elevating mechanism, and traversing mechanism. Grease and oil cups should be kept filled and free from dirt or grit.

*Q*. What type of oil is used in the oil cups? *A*. Lubricating oil, class A.

## Section IV

## 12–INCH MORTARS M1890 AND M1890MI ON RAILWAY CARRIAGE M1918



**28. General characteristics.**—*Q*. What is meant by caliber? *A*. Caliber is the diameter of the bore of the mortar measured between two opposite lands of the rifling.

*Q*. What is the caliber of the weapon manned by your battery? *A*. 12 inches.

*Q*. How long is the cannon? *A*. The 12-inch railway mortar M1890MI is 18 calibers or 18 feet long.

*Q*. How much do the cannon and carriage weigh? *A*. The 12-inch mortar M1890MI on railway carriage M1918 weighs about 88 tons.

*Q*. What is the maximum range of the gun? *A*. ——— yards (or approximately ——— miles).

*Q*. What is the purpose of the rifling (land and grooves)? *A*. To make the projectile rotate so that it will keep nose first in flight.

*Q*. What else does the rifling cause the projectile to do? *A*. To move or drift to the right of where the gun is pointed when fired.

*Q*. At what angles of elevation may the piece be fired? *A*. From 20° to 65°. However, only the elevations from 45° to 65° are employed since mortars are designed to furnish high angle fire.

*Q*. What is the total traverse of the piece on the carriage? *A*. 360°.

**29. Action of gun and carriage.**—*Q*. How does the firing mechanism work? *A*. The hinged collar fits over grooves in the rear end of the obturator spindle. It is prevented from opening by the housing into which it is screwed. The hinged collar and housing are prevented from turning on the spindle by the guide bar which projects from the right side of the housing into a groove in the breechblock. The slide is attached to the housing in a groove which allows vertical movement. With the slide raised a primer may be inserted into the primer seat in the end of the spindle. The slide is then lowered and holds the primer in place, allowing the button wire to extend to the rear. It is locked in this position by the slide catch. The firing leaf is pivoted to the slide at its upper end. It has a vertical slot cut in its lower edge through which the button wire extends when the slide is lowered. At the right-hand lower corner of the firing leaf is an eye into which the lanyard is hooked for firing by friction. When the leaf is pulled back it pulls the button wire back igniting the primer. A safety bar prevents accidental firing by lanyard before the breech is fully closed and locked. It engages the firing leaf and prevents it from moving to the rear and is not withdrawn until the last movement of the breech in closing. It is actuated by the safety bar slide in the block.

*Q*. What safety precaution is prescribed for this type of firing mechanism? *A*. The primer must not be inserted in the primer seat until the breech is fully closed and locked.

*Q*. Put on and take off the firing mechanism. *A*. (Practical demonstration.)

*Q*. What is meant by obturation? *A*. Obturation is the prevention of escape to the rear of the gases that propel the projectile.

*Q*. What parts of the gun provide obturation? *A*. The breechblock and obturating mechanism.

*Q*. How do they work? *A*. The obturating mechanism consists of a mushroom head on a spindle that extends back through the middle of the breechblock, a gas check pad, three metal split rings, and a filling-in disk. The gas check pad is held between the mushroom head and the filling-in disk which is next to the front face of the breechblock. Two of the split rings are carried around the outer edge of the pad and the other is around the inner edge next to the spindle. When the gun is fired the gases press back on the mushroom head, squeezing the gas check pad between the mushroom head and the filling-in disk. The pad expands outward and inward, pushing the two outer rings up against the wall of the powder chamber and the inner ring against the spindle, preventing the escape of powder gases to the rear and the loss of the lubricating substance in the gas check pad. After the pressure goes down the gas check pad contracts and relieves the pressure on the split rings so the breech may be opened.

*Q*. Explain the action of the breech mechanism. *A*. When the breech is closed the threaded parts of the block mesh with the threaded parts of the breech ring on the gun. The tray is held against the face of the breech by the tray latch. The breech is opened by moving the rotating crank catch handle to the right and turning the rotating crank. This unscrews the breechblock and brings the translating stud on the lower edge of the block into engagement with the translating roller. Operation of the translating crank now will withdraw the block from the breech recess onto the tray. The tray latch is tripped and the tray swung to the rear and right about the hinge pin opening the breech. The tray is held in the open position by the tray back latch which must be tripped before the breech can be closed.

*Q*. What is the purpose of the recoil mechanism? *A*. To take up the energy of recoil and stop the gun gradually as it comes back in recoil.

*Q*. What is the purpose of the counterrecoil or recuperator mechanism? *A*. To return the gun to battery after recoil.

*Q*. Of what does the recoil mechanism consist? *A*. The recoil mechanism consists of two identical units in the lower part of the cradle. Each unit consists of a cylinder fastened to the cradle and a piston and piston rod attached to lugs on the sleigh.

*Q*. How does the recoil mechanism work? *A*. When the mortar and sleigh recoil the piston is pulled to the rear and the oil, in order to flow to the other side of the piston, has to pass through the throttling grooves in the wall of the cylinder. This sets up resistance which absorbs the energy of recoil and gradually stops the gun.

*Q.* Of what does the recuperator mechanism consist? *A.* A cylinder, floating piston, main piston, pull rods, and bracket.

*Q.* How does the recuperator work? *A.* The cylinder is attached to the cradle, and the main piston is attached through the pull rods and bracket to the sleigh. Between the main piston, which is hollow, and the cylinder is a quantity of liquid and a quantity of compressed air, separated by the floating piston. As the mortar and sleigh move to the rear in recoil the main piston is pulled along with it. This pushes the liquid and the floating piston to the rear against the air, compressing it further. When the recoil stops, the air expands and moves the mortar and sleigh back into battery.

*Q.* How is the counterrecoil controlled? *A.* The counterrecoil buffers on the front of the recoil pistons trap oil in the ends of the recoil cylinders and gradually stop the mortar.

*Q.* How is the weight of the cannon and carriage supported in the traveling position? *A.* On springs attached to railroad trucks.

*Q.* How is the weight on the cannon and carriage supported in the firing position? *A.* Through the car body sills to the ground platform placed under the center of the carriage.

**30. Care and minor adjustment of gun and carriage.**—*Q.* How should the powder chamber and bore be cleaned after firing? *A.* By sponging with a solution of cleaning compound as soon as possible after any firing. The solution is made by dissolving ½ to 1 pound (depending on the strength desired) of soda ash in each gallon of boiling water. The bore is washed with this solution using a bore sponge wrapped with burlap. The bore is then wiped thoroughly dry using the sponge wrapped with dry burlap. Then apply medium or heavy rust-preventive compound. This procedure should be repeated every day for 1 to 2 weeks until all sweating stops.

NOTE.—Never try to use oil in place of the cleaning solution when cleaning the bore and chamber.

*Q.* What is used for sponging the powder chamber during firing? *A.* Sponging solution, prepared by thoroughly dissolving 1 pound of castile soap in 4 gallons of water. This is better than plain water because it serves to lubricate the breech recess in addition to extinguishing burning residue. Water only may be used when the soap solution is not available.

*Q.* What care should be taken of the breech mechanism? *A.* From time to time it should be dismantled, cleaned, and oiled with lubricating oil, class A. The breech should be kept closed when possible to keep dust and grit out of the mechanism. It should always be cleaned, oiled, and adjusted just before and just after firing. The vent should

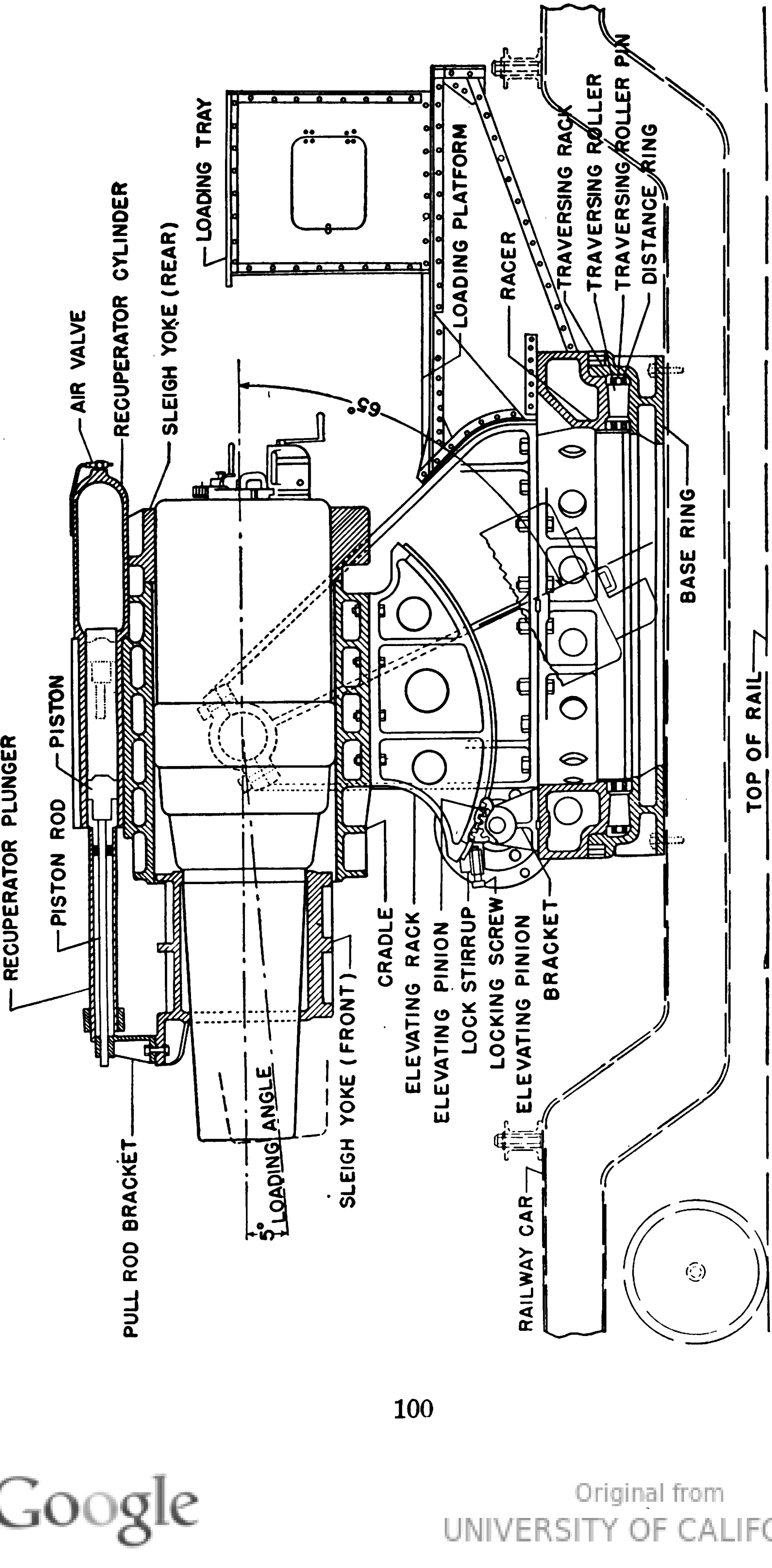



FIGURE 40.—12-inch railway mortar M1890MI on mortar carriage M1918 showing recuperator mechanism.

be cleaned after firing in the same way as the powder chamber and bore.

*Q*. How is the breechblock dismantled? *A*. Open the breech, remove the firing mechanism and the spindle nut and washers. Holding the filling-in disks, split rings, and pad against the obturator, remove these parts from the block. The filling-in disks, rings, and pad may then be removed from the obturator spindle.

*Q*. What is used to lubricate the gas check pad? *A*. Graphite lubricating grease, medium, liberally applied, and thoroughly worked in with the fingers.

*Q*. How is the obturator adjusted for firing? *A*. Assemble the breechblock with the spindle nut loose, but not enough to permit slipping of the gas check pad or split rings. Close the breech and rotate the block halfway closed, and screw up on the spindle nut as tight as it can be screwed by one man with the wrench provided. Tighten the clamping screw on the spindle nut and rotate the breechblock completely closed. The pad should now be in proper adjustment for firing. The adjustment may be checked by turning the obturator by hand. It should turn easily but without end play.

*Q*. What liquid is used in the recoil and recuperator cylinder? *A*. A solution of equal parts by volume of glycerin, grade A, USP, and pure water (such as filtered rain water or distilled water). To each 3 gallons of the mixture must be added 1 ounce of sodium hydroxide, CP ($NaOH$), sticks or pellets.

*Q*. How is the recoil cylinder filled? *A*. Set the mortar at 45° elevation with rear yoke against stops on the cradle and remove filling plugs at the top of the front end of the cylinders. Insert spout of filling funnel and fill to overflowing with the solution of glycerin and water. Depress to 0° and refill. Allow the air to escape through the filling holes, then refill, remove funnel, and screw the filling plugs in tight. To take care of slight losses through packing, a pump is provided.

*Q*. How is a recoil cylinder drained? *A*. Depress the mortar to 5°, remove the drain plug at the bottom of the front end of the cylinder, and drain the liquid off into buckets.

*Q*. How is the recuperator cylinder filled with air? *A*. Connect the air tank to the air tank connection by the copper tubing, open the valve on the tank, then open the valve on the air cylinder. When the pressure on the gage shows 1,370 pounds, close valves on air tank and recuperator and remove copper tubing and air tank. Two tanks are usually sufficient to run the air pressure from 0 pounds per square inch to 1,370 pounds per square inch.

*Q*. How is the liquid put in the recuperator? *A*. Pour the liquid, equal parts of glycerin and water, into the reservoir, until filled. Open the liquid valve. By means of a pump, force liquid into the cylinder until the gage shows a pressure of 1,500 pounds per square inch. Close the liquid valve. A check on this pressure is to see that the distance between the rear face of the washer on the front end of the piston rod and the front face of the stuffing box gland is approximately 3 inches. If this distance is more than 4 inches or less than 2 inches the proper relation between the liquid and air pressure does not exist. When the distance is approximately 5¾ inches, the piston is resting against the plunger, and serious damage will result if the mortar is fired. Unless only a small amount of liquid or air is to be put into the recuperator, both operations should be done at the same time in order to keep a balanced pressure in the cylinder.

*Q*. What general lubrication of the carriage is necessary? *A*. All machined surfaces must be kept free from rust and dirt, and covered with a light coat of lubricating oil, class A. Special attention must be given to trunnions, pintle surfaces, shaft bearings, piston rods and cylinders, sliding surfaces, axles, bearings, elevating mechanism, and traversing mechanism. Grease and oil cups should be kept free from dirt or grit.

*Q*. What type of oil is used in the oil cups? *A*. Lubricating oil, class A.

*Q*. When firing is not conducted, how often must the recoil and counterrecoil mechanisms be exercised? *A*. Every 6 months.

*Q*. How is this done? *A*. With the recuperator fully charged, recoil cylinders filled, mortar well-lubricated in the cradle, set the mortar at maximum elevation (against the stops). Open the air valve on the recuperator cylinder. When the air pressure has dropped sufficiently, the mortar will slide back a short distance, being stopped by the building up of air pressure in the recuperator. By successive movements the mortar comes to the full recoil position, when the air valve should be closed. Condition of the rods and under side of the mortar can then be ascertained. To return the mortar to battery, fully charged air cylinders should be used and the recuperator charged in the usual way. When the cradle has been returned to zero elevation, the air pressure should be reduced to service pressure.

## Chapter 5

# DUTIES OF RANGE SECTION



**31. Determination of firing data.**—*Q*. What are the three main steps in determining firing data for moving targets? *A*.

(1) Tracking the target.

(2) Location of the set-forward point.

(3) Calculation of firing data.

*Q*. Of what does each step consist? *A*.

(1) Tracking consists of locating the target with respect to the observation stations and guns.

(2) Location of the set-forward point consists of predicting where the target will be when the projectile strikes.

(3) Calculation of firing data consists of correcting the range and azimuth (or deflection) of the set-forward point for all known non-standard conditions (that is all conditions that would cause the projectile to strike at a different point from that given by the firing tables) and if necessary changing the range into an elevation for use in pointing the guns.

*Q*. What are the three standard methods of tracking the target? *A*.

(1) Horizontal base system.

(2) Vertical base system.

(3) Self-contained base system.

*Q*. How is a target tracked by horizontal base? *A*. Two observation stations are selected and the azimuth and distance from one to the other are determined by survey. The line connecting the two stations is called the base line. The direction and distance of the directing point of the battery from one or both of the base-line stations are also determined. These three points are then located to a small scale on a plotting board in the same relative positions as on the ground. An observer with an azimuth instrument is located in each observation station. When the time interval signal sounds, each observer determines the azimuth to the target from his station and telephones it to the plotting room. Arms on the plotting board, which are pivoted at each of the positions representing the base-line stations, are set to the azimuths received from the observers, and the intersection of the arms represents the observed position of the target, which is marked on the board. It is called a plotted point. Several plotted points define the track or path of the target and show the speed at which it is moving.

*Q*. How is the target tracked by vertical base? *A*. Only one observation station is used. It is equipped with a depression position finder with which the observer can determine the azimuth and range to the target. He telephones these data to the plotting room where the station arm is set in azimuth. The plotted point is then located at the proper range by means of a range scale on the edge of the arm.

*Q*. How is the target tracked by self-contained base? *A*. There is only one observation station, as in the vertical base system, but two observers are ordinarily used. One has an azimuth instrument and reads the azimuth to the target; the other operates a self-contained range finder and determines the range to the target at the same time that the azimuth is read. The plotted points are marked on the board in the same way as for vertical base.

*Q*. What three things must be known before the set-forward point can be located? *A*.

(1) The probable path of the target.

(2) The length of time from the instant the target was at the last plotted point used in determining the firing data for a particular shot to the instant of impact of that shot.

(3) The rate of travel of the target.

*Q*. How is this information obtained? *A*.

(1) The probable path of the target is obtained by extending the plotted path.

(2) The elapsed time consists of the dead time plus the time of flight. The dead time is selected before tracking commences and is usually the same as the observing interval. It is the time from the instant of observation to the instant of firing. The time of flight is obtained by estimating the range with the help of the range to the last set-forward point.

(3) The rate of travel is obtained by measuring the distance between the last two or three plotted points and dividing by the difference between the times of observation of the first and last points considered.

*Q*. How is this information used to establish the set-forward point? *A*. The elapsed time is multiplied by the rate of travel, which gives the distance ahead of the last plotted point that the

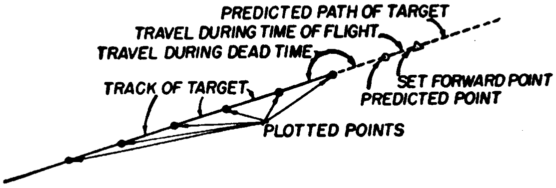



FIGURE 41.—Diagram of various positions of target.

target will be when the projectile strikes. This distance is laid off along the probable path of the target and the set-forward point marked on the plotting board.

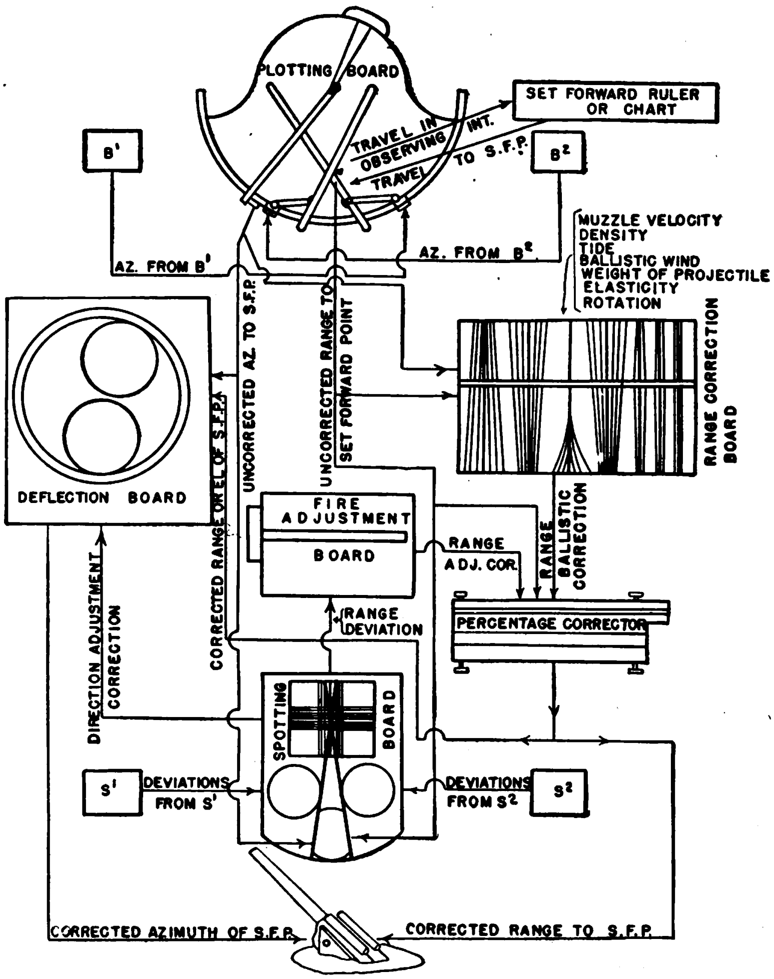



FIGURE 42.—Schematic diagram of routing of position-finding data and firing data.

*Q*. What are the firing data? *A*. The corrected range (or elevation) and the corrected azimuth (or deflection).

*Q.* How is the corrected range (or elevation) calculated? *A.* The range to the set-forward point is read from the plotting board to the operators of the range correction board and the percentage corrector. The operator of the range correction board makes the range corrections according to the data given him by the range officer and calls off the correction to the percentage corrector operator. The percentage corrector operator applies it to the uncorrected range and telephones the corrected range, or the corresponding elevation, to the guns.

*Q.* How is the corrected azimuth (or deflection) calculated? *A.* The azimuth to the set-forward point is read from the plotting board to the deflection board operator who makes the lateral corrections according to data given him by the range officer, applies the corrections to the uncorrected azimuth, and telephones the corrected azimuth to the guns. If deflections are being used, the travel of the target is read to the deflection board operator who computes the corrected deflection and telephones it to the guns.

*Q.* When is corrected azimuth sent to the guns? *A.* When case III pointing is employed.

*Q.* When is corrected deflection sent to the guns? *A.* When case II pointing is employed.

*Q.* On what does the accuracy of the firing data depend? *A.* On the accuracy and skill of each individual operator in adjusting and operating his board and transmitting the data. One inaccurate operation or one mistake in transmission of data by any member of the team may mean the difference between a hit and a miss.

*Q.* What are reference numbers? *A.* Arbitrary numbers used to represent actual values of units of measure used in seacoast artillery firing.

*Q.* Why are reference numbers used? *A.* To avoid the use of "plus," "minus," "up," "down," "right," and "left."

*Q.* What is the reference number that represents "zero" in any system called? *A.* The normal.

*Q.* Is there more than one system of reference numbers? *A.* Yes, there are several systems.

*Q.* Where are reference numbers used? *A.* On nearly every fire-control instrument of a battery.

*Q.* What do these numbers indicate? *A.* The settings determined on one instrument which are applied to the scales of other instruments marked with the same numbers.

*Q.* What is the system of position finding ordinarily used in your battery? *A.* ———.

*Q.* Is there an auxiliary or emergency postion-finding system in your battery? If so, describe it. *A.* ———.

*Q.* Trace the range and direction data from the plotting board to the gun, stating the operation performed at each step. *A.* (Description of method in use in your battery.)

**32. Plotting boards.**—*Q.* What data are obtained from the plotting board? *A.* Uncorrected range and direction from the guns to the target.

*Q.* What care should be taken of the board? *A.* Keep the board covered when not in use. Wipe off dust frequently. Keep all parts clean. Do not handle scale arms roughly; to do so may bend them or mar the graduated edges.

*Q.* What is meant by a right-handed base line? A left-handed base line? *A.* See figure 43.

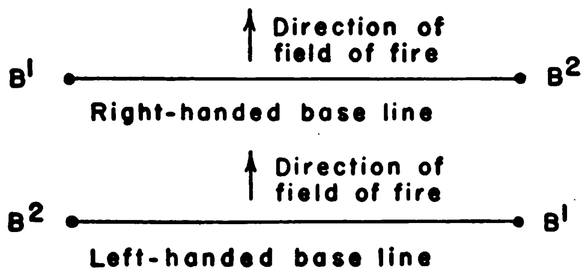



FIGURE 43.—Differentiation between right-handed and left-handed base lines.

*Q.* Given several points on the plot of a course shown on the plotting board, indicate a plotted point, a predicted point, and a set-forward point. *A.* (Practical demonstration.)

*Q.* Which point is used in determining the range and direction to the target. *A.* The set-forward point.

*Q.* Read the range and azimuth to the set-forward point. *A.* ———.

*Q.* What is the scale of this plotting board? *A.* ——— yards to the inch.

*Q.* Lay off on the board a distance of ——— yards. *A.* (Practical demonstration.)

*Q.* Find the distance between two given points. *A.* (Practical demonstration.)

*Q.* Point out the following parts:

| | |
|---|---|
| Azimuth circle. | Primary station. |
| Base line. | Secondary arm. |
| Directing point. | Secondary station. |
| Gun (mortar) arm. | Targ. |
| Primary arm. | |

*A*. (Demonstration.) For practical instruction the duties of each member of the range section should be performed. (See descriptions of devices which follow.)

*a. Plotting and relocating board M1923* (*Cloke*).—*Q*. Point out and state purpose of each of the following parts of the plotting and relocating board M1923:

Arm handles.
Arm clamps.
Azimuth circle.
Azimuth strip stop.
Base-line stop.
Base-line stop slide.
Bracket.
Gun plate.
Gun slide.
Master key.
Platen.
Platen clamping lever.
Platen slide.
Platen index.
Plotting arm.
Push button (gun).
Push button (master key).
Push button (platen).
Relocating arm.
Plotting arm center and relocating arm center.
Range scales.
Rider.
Slide.
Stop clamping lever.
Verniers (degree and mils).
Vernier covers.

*A*. (Practical demonstration.)

*Q*. How many sets of graduations are there on the azimuth circle? *A*. Four sets, two inside the groove and two outside.

*Q*. Describe the arrangement of the sets. *A*. The sets are in pairs, the inner pair for use with the plotting arm, and the outer pair for use with the relocating arm. In each pair the inner set is graduated every whole degree and the outer set every 10 mils.

*Q*. How do you determine which set to use in setting azimuths? *A*. The arm being used determines the pair, and the readings received from the observation station determine the set (degrees or mils).

*Q*. Where are the scales for hundredths of degrees and for single mils located? *A*. On the ends of the arms.

*Q*. What are they called? *A*. Vernier scales.

*Q*. How many vernier scales are there on each arm? *A*. Four.

*Q*. Describe the arrangement of the vernier scales. *A*. The scales are arranged in pairs, each pair for use with the particular edge of the arm that passes through the center of the azimuth circle. In each pair the inner scale is graduated every 0.05 degree and the outer scale every mil. Covers are provided so that all the scales except the one in use may be concealed.

*Q.* Why is this arrangement necessary? *A.* Because each arm may be adjusted so that either edge passes through the center of the azimuth circle.

*Q.* Name two methods of plotting on the Cloke type plotting board. *A.* The direct method and the offset method.

*Q.* Explain the direct method of plotting when a horizontal base is being used. *A.*

(1) Set the plotting and relocating arms at their respective azimuths (sent from the observation stations) and clamp.

(2) The platen slide being against its stop, and the platen being against the base-line stop, clamp the platen to the platen slide by means of the clamping lever.

(3) Slide the platen and the platen slide along the plotting arm until the master key touches the relocating arm.

(4) Push the gun push button, thus plotting a point which represents the directing point.

(5) Clear the platen from above the plotted point and unclamp the platen from the platen slide.

(6) Place a targ on the mark made by the push button and bring up the relocating arm so that it touches the targ.

(7) Read the range and azimuth of the plotted point using the relocating arm.

Set-forward points are located in the usual way, and the range and azimuth read as in (7) above.

*Q.* Explain the offset method of plotting when a horizontal base is being used. *A.* This method is used when there are several gun positions, and different ranges and azimuths must be sent to each gun. The gun plate with the various gun positions located on it is used instead of the gun slide. The rider is also used on the gun arm.

(1) Set the plotting and relocating arms at their respective azimuths (sent from the observation stations) and clamp.

(2) The platen slide being against its stop, and the platen being against the base-line stop, clamp the platen to the platen slide by means of the clamping lever.

(3) Slide the platen and platen slide along the plotting arm until the master key touches the relocating arm.

(4) Push the platen pivot push button, thus plotting a point which represents the position of the platen pivot.

(5) Locate a set-forward point from points plotted as above in the usual way.

It is now necessary to obtain a setting of the oriented platen such that the set-forward points of the different guns can be located, and the ranges and azimuths of these points obtained. To do this—

(6) Place a targ at the plotted set-forward point.

(7) The platen being unclamped from the platen slide, bring the plotting arm against the targ and clamp the arm.

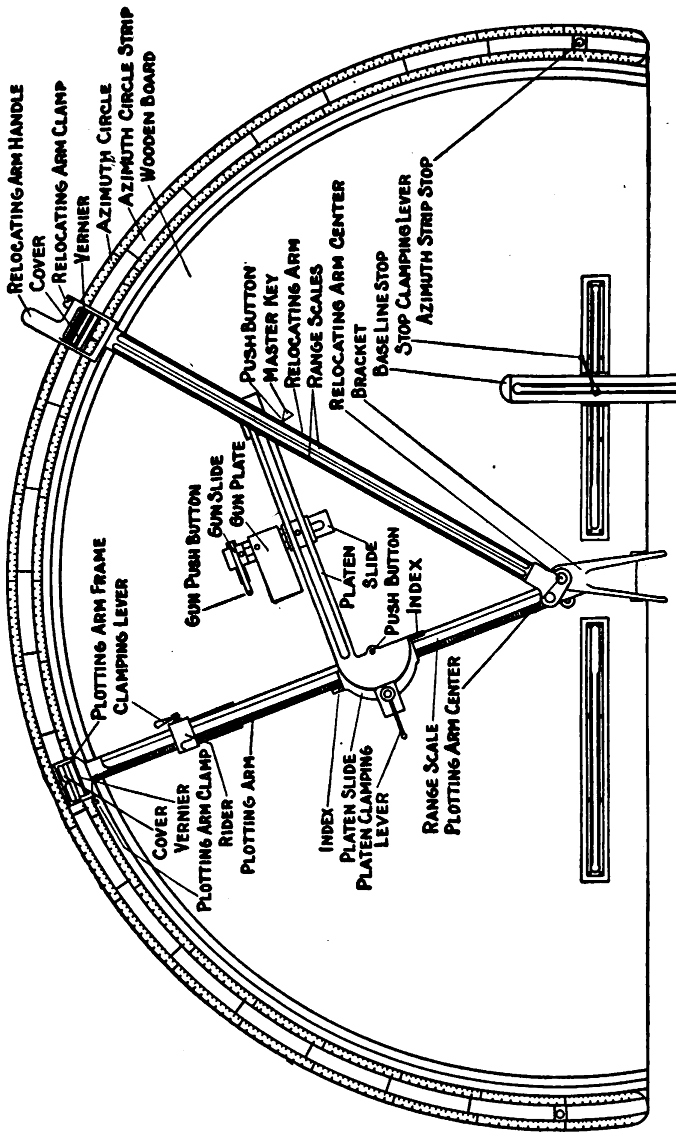



Figure 44.—Plotting and relocating board M1923 (Cloke).

(8) Slide the rider along the plotting arm until the end of the rider strip touches the targ, and clamp the rider to the plotting arm.

(9) Bring the platen and platen slide back against their stops and clamp them together by means of the clamping lever.

(10) Slide the platen slide, with platen clamped to it, along the plotting arm until it is brought up lightly but firmly against the rider.

(11) Place targ in turn on each gun position on the gun plate, bring the relocating arm against each position of the targ, and read the range and azimuth of each gun position in turn.

*Q.* Can this board be used with the vertical base system? *A.* Yes. The observation station is represented by the platen pivot. The plotting arm setter sets the plotting arm at the azimuth received from the reader of the depression position finder and repeats the range sent him by the same reader. The platen operator moves the platen slide, oriented and clamped, along the plotting arm until the platen slide index is opposite the range corresponding to that received from the depression position finder, and the plotted point is marked by pressing the gun push button. From here on the operation is identical with the operation using the horizontal base system, and it can be used for the direct or offset method of plotting.

*Q.* Can this board be used with the self-contained base system? *A.* Yes. The procedure is the same as for the vertical base, and it can be used for either the direct or offset method of plotting. When the range finder is located at the directing point the method of plotting is simplified. The relocating arm setter sets his arm at the azimuth of the target while the plotter sets the targ along the relocating arm at the observed range and pushes the targ button, plotting the position of the target. Predictions based on successive positions of the target are made in the usual manner. The relocating arm is then used to determine the range and azimuth to the set-forward point. The platen, master key, gun slide, and gun plate are not used in this simplified method. In this method the offset method of plotting cannot be used.

*b. Plotting and relocating board M1.*—*Q.* How does the plotting and relocating board M1 differ from the plotting and relocating board M1923 (Cloke)? *A.* The boards are similar in construction and operation, practically the only difference being in the size, plotting and relocating arm scales, the graduated azimuth circle, and the baseline stop. The M1 board is considerably larger and more sturdily built. There are four sets of scales for use with the plotting and relocating arms, namely 200, 400, 800, and 1,000 yards to the inch, giving maximum ranges of 12,800, 25,600, 51,200, and 64,000 yards, respectively. The graduated azimuth circle numbers are engraved on an endless chain actuated by a handwheel and run from 0° to 360°. The baseline stop is an adjustable slide which moves in an arc and can be clamped in any position. Some of the names of parts differ slightly from those of the M1923 board, as can be seen from the figures showing the two boards.

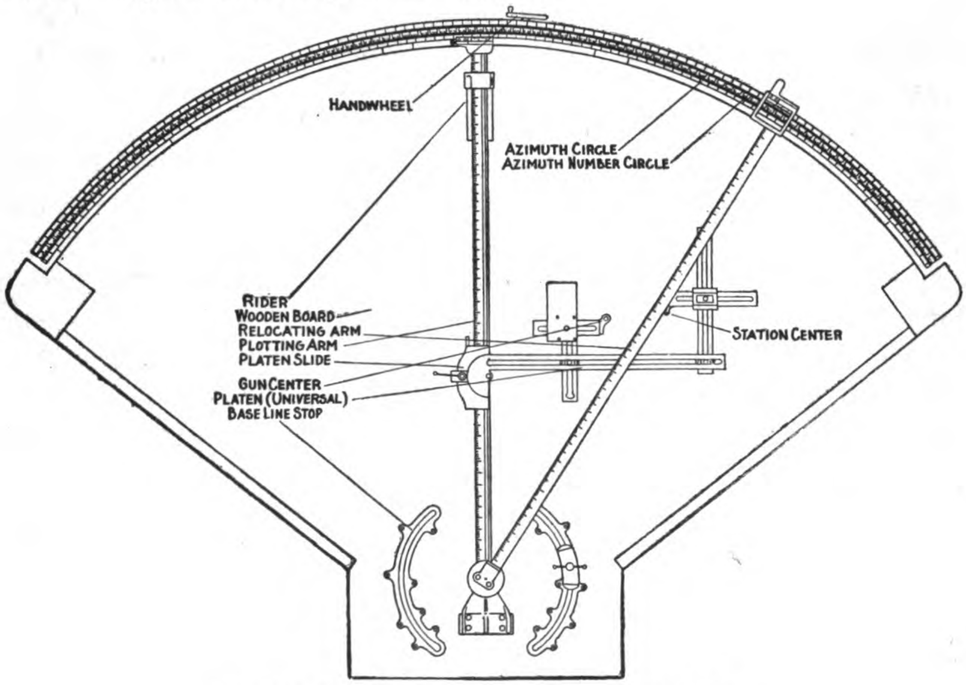



FIGURE 45.—Plotting and relocating board M1.

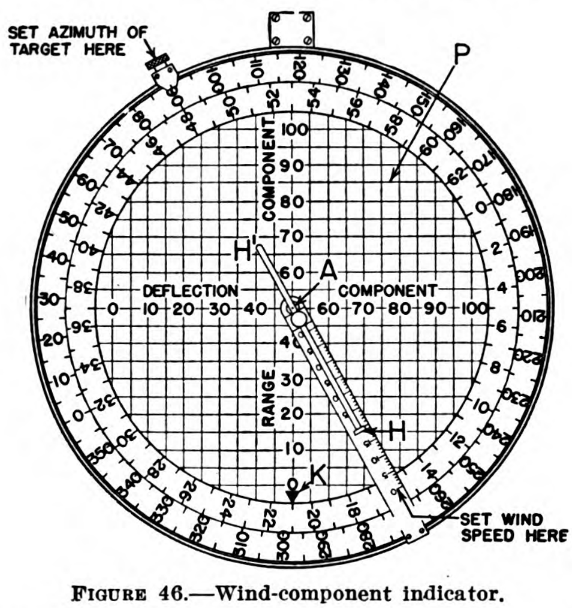



FIGURE 46.—Wind-component indicator.

**33. Wind-component indicator.**—*Q*. What is the purpose of the wind-component indicator? *A*. To determine the range and deflection components of the ballistic wind for use in making wind corrections.

*Q*. What data are needed to operate the instrument? *A*. The azimuth and speed of the ballistic wind and the azimuth of the set-forward point.

*Q*. Where are they obtained? *A*. The wind azimuth and speed are obtained from the meteorological message. The azimuth of the set-forward point is obtained from the plotting board.

*Q*. Explain the normal operation of the wind-component indicator. *A*. Set the pointer (H) on the target arm to the wind speed; turn the azimuth circle until the wind azimuth on the inner azimuth scale is opposite the pointer (K) at the lower end of the deflection component normal line; keep the target arm set to the approximate azimuth of the set-forward point by setting the index on the end of the target arm opposite the azimuth of the set-forward point on the outer scale, changing the setting whenever the azimuth of the set-forward point differs by as much as 2½°. Read the range component reference number on the vertical scale on the grid (P) where the horizontal line that runs under the pointer (H′) hits the scale, and read the deflection component reference number on the horizontal scale where the vertical line that runs under the pointer hits that scale.

*Q*. If there are no lines exactly under the pointer what do you do? *A*. Take imaginary lines and estimate the nearest unit between the readings on the scales.

*Q*. What is the normal of the wind component reference numbers? *A*. 50.

*Q*. In what units and from what azimuth reference line should the target azimuth be measured? *A*. In degrees from zero south.

*Q*. If the target azimuth is measured from zero north how is the instrument used? *A*. The only change in operation is to set the wind azimuth opposite the upper end of the deflection component normal line instead of the lower end.

*Q*. Where is the range component reference number used? *A*. On the range correction board.

*Q*. Where is the deflection component reference number used? *A*. In the operation of the deflection board.

*Q*. Is the wind-component indicator used when the deflection board M1 is used? *A*. No. A wind-component indicator is built into the deflection board M1.

**34. Range correction boards.**—*Q*. What is a range correction board? *A*. A device for computing corrections for nonstandard ballistic conditions and adding them together algebraically for use in making a correction to the range to the set-forward point.

*Q*. What other information may be obtained from the charts on the board? *A.* Usually time of flight, probable error, and angle of fall for each range.

*Q.* How is the accuracy of the range correction board tested? *A.* Test points are marked on the correction curves of the charts and the correction is shown on the margin of each chart. These are used to check the mechanical accuracy of the board and the accuracy of the operator.

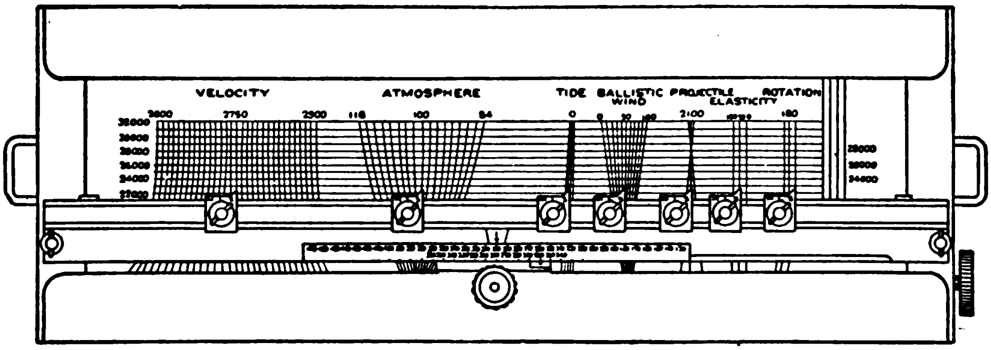


FIGURE 47.—Range correction board M1.

*Q.* Are corrected ranges obtained from the range correction board? *A.* No. A correction only is obtained. This is applied to the percentage corrector.

*Q.* Explain the operation of the range correction board M1. *A.* The operation of the board is continuous during firing, though performed periodically. The initial ballistic correction is determined under the direct supervision of the range officer in the following manner:

(1) The range correction board operator turns the roller handle until the proper chart appears on the face of the board.

(2) The ruler is adjusted readily to bring it parallel to the range lines of any chart, simply by loosening the clamp screws and swinging one end of the ruler the necessary amount and then tightening the clamp screws.

(3) The operator turns the wing nut clamps of all movable pointers until these are at "M" on each pointer, then brings each pointer individually to the normal of its respective set of curves by means of the knob at the bottom of the correction ruler and turns the wing nut clamp of each pointer to the position "S" on the pointer. After all pointers have been set properly, he brings the index of the correction scale to the normal (300) of that scale by turning the knob at the bottom of the ruler.

(4) He records with chalk, in a convenient place in the space provided at the top of the board, the necessary data to indicate the curves to be used, these data being secured from the following sources:

(*a*) The velocity curve to be used is obtained from the range officer.

(*b*) The atmosphere curve to be used is obtained from the meterological message.

(*c*) The height of site is obtained from the range officer and for fixed batteries the tide is received from the tide station. In fixed batteries, charts are constructed for a definite height of site, that is, for the height of the battery above mean low tide.

(*d*) The wind reference number is obtained from the operator of the wind-component indicator or the deflection board M1. This is based upon the range component of the ballistic wind for the proper maximum ordinate.

(*e*) The proper curve for the variations in the weights of projectiles is obtained from the range officer who uses for this purpose a table of weights prepared by the battery executive.

(*f*) The curve of temperature (elasticity) to be chosen is that indicated by the temperature in the meteorological message, or as taken from a thermometer at the battery.

(*g*) The curve of rotation to be used is that indicated by the azimuth of the trial shot point (or of the set-forward point) as called by the relocating arm setter.

(5) The wing nut clamp of the velocity movable pointer is brought to "M," and by turning the knob on the correction ruler the pointer is moved to the proper velocity curve and the wing nut clamp turned back then to the position "S." Carry out the same process with each movable pointer, setting each pointer before proceeding to the next.

(6) The operator calls the range correction in terms of reference numbers as indicated by the index on the correction scale to the operator of the range percentage corrector where it is set on the ballistic correction scale.

As the firing continues, the operator keeps the range to the set-forward point under the pointers, and shifts the pointers laterally by turning them successively to "M" and turning the operating knob whenever they deviate from the proper curve, transmitting the new ballistic correction whenever it changes by one unit of reference number. As the range component of the ballistic wind changes with the azimuth of fire, the data at the top of the board will be changed to indicate the new wind curve to be used. Likewise the data indicating the rotation curve to be used are changed when necessary.

*Q*. In mortar or howitzer fire how is the board operated in changing zones? *A*. The operator must anticipate the changes in zones, setting up the board for the new zone in time to have the new

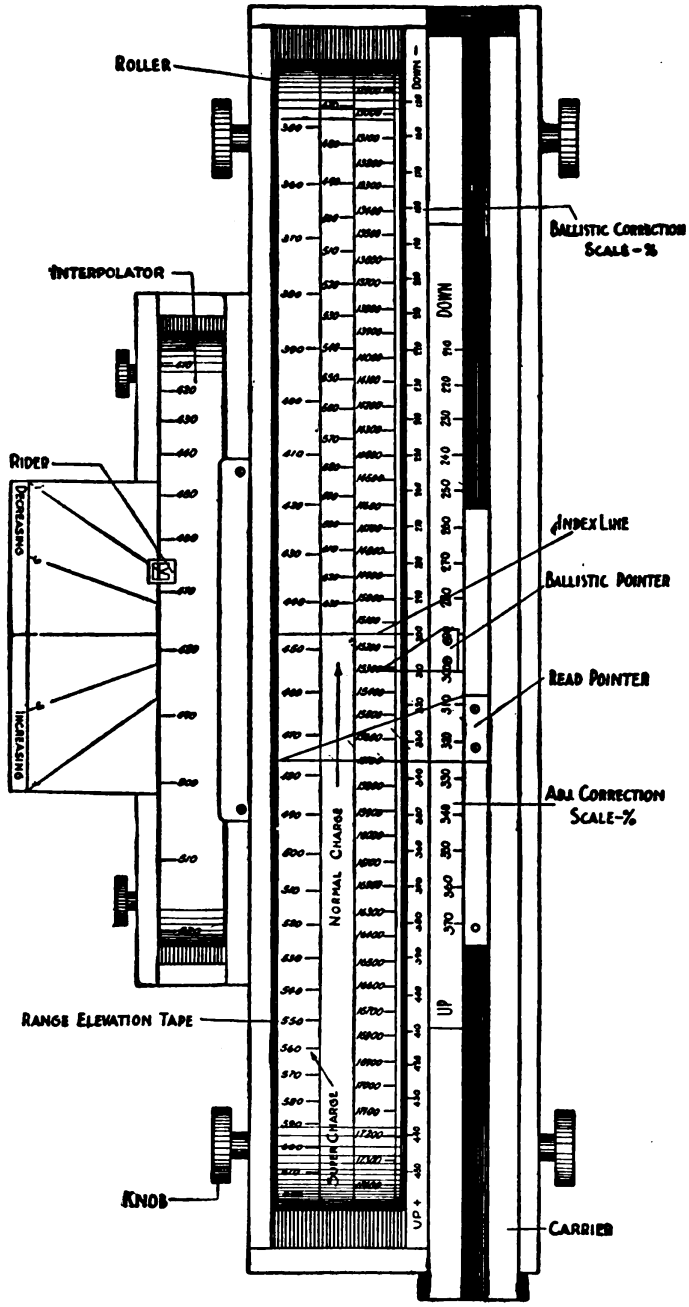



FIGURE 48.—Percentage corrector M1.

ballistic correction ready when the zone is changed. The muzzle velocity to be used for the new zone will be furnished by the range officer from previous determination. Other curves will be the same as for the previous zone.

*Q*. How do the Pratt range correction board M1905 (modified) and the range correction board M1923 compare with the range correction board M1? *A*. These boards differ in construction from the range correction board M1, but their operation is similar.

**35. Percentage corrector.**—*Q*. What is the percentage corrector? *A*. A device to apply corrections to the actual range to determine a corrected range or elevation.

*Q*. What is the standard percentage corrector called? *A*. Percentage corrector M1.

*Q*. Name the principal parts of the percentage corrector M1. *A*.

Ballistic correction scale.
Adjustment correction scale.
Read pointer.
Index line.
Ballistic pointer.
Rollers.
Range tape.

*Q*. Describe the different types of range charts used on the percentage corrector. *A*.

(1) For gun batteries the guns of which have range drums graduated for a particular projectile and powder charge, a single range scale is provided.

(2) For gun batteries using one weight of projectile and powder charge, when the range drums are graduated in ranges for a projectile of another weight, a range-time relation scale is furnished. The uncorrected range is set at the reading on the scale of ranges for the projectile being used. The corrected range is read from the scale corresponding to the graduations on the range drum. It is a range such that the gun will be given the proper elevation for the actual corrected range.

(3) For guns which are laid by quadrant, the chart contains a range scale, drawn parallel to which are scales of elevations for different powder charges. The uncorrected range is set on the range scale and the elevation is read from the proper elevation scale depending on whether reduced, normal, or supercharge is being fired.

(4) For mortar batteries the charts have elevation scales drawn opposite the range scale on the chart. The elevation scales for two adjacent zones overlap at the points on the range scale where the zone overlaps occur, permitting a rapid change from zone to zone without shifting the chart.

*Q*. How are the ballistic correction and adjustment correction scales graduated? *A*.

(1) On the older types of boards the normal is marked zero, and the scales are graduated in percent "up" and "down" from the center.

(2) On the newer boards, and when the range correction board scale is in reference numbers, the correction scales are graduated in terms of reference numbers, the ballistic correction scale reading the same as the correction scale on the range correction board.

*Q*. Explain the operation of the percentage corrector. *A*. By turning the rollers, set on the index line the uncorrected range which is the range called out by the plotter. Move the ballistic pointer until its reading edge indicates on the ballistic correction scale the ballistic correction called out by the operator of the range correction board. If there is no adjustment correction, set the "read" pointer at the normal of the adjustment correction scale; if there is an adjustment correction, move the "read" pointer until its reading edge indicates on the adjustment correction scale the adjustment correction. Read the corrected range (or elevation) opposite the reading edge of the "read" pointer on the range (elevation) scale for the proper charge and projectile and transmit the data to the guns.

*Q*. Explain the operation when the interpolator is used. *A*. The duties of the percentage corrector operator consist simply in setting the uncorrected ranges and the ballistic and read pointers. An additional operator operates the interpolator, wears the telephone headset, and transmits the corrected ranges or elevations to the guns.

*Q*. Describe the interpolator. *A*. The interpolator consists of a tape mounted on two rollers, below the tape being a piece of xylonite on which straight lines are drawn. The center line is at right angles to the tape. The other lines fan out from the center line. The reading lines on each side of the interpolator are numbered 1 and 3 and the side of the interpolator for use in determining proper interpolated range is indicated by the notation "range decreasing" and "range increasing." A rider is also attached to the tape.

*Q*. Describe the operation of the interpolator. *A*. On the first bell at which a corrected set-forward range is determined, the interpolator operator reads into his telephone the data indicated by the "read" pointer of the percentage corrector. He moves the interpolator tape so the data indicated by the "read" pointer of the percentage corrector are indicated on the interpolator by the central line (1) and places the rider on the tape at this point. Suppose the reading is 9,600. On the next bell on which data are sent from the plotting board, the interpolator operator reads into the telephone the new reading of the "read" pointer of the percentage corrector and moves the interpolator tape to indicate the new data under central line (1). Suppose the reading is 9,200. The rider will be moved to the right. The xylonite sheet is now moved in or out until the diagonal line (1) intersects the rider on the tape, and the rider is then moved back to the central line (1). The diagonal line for in-

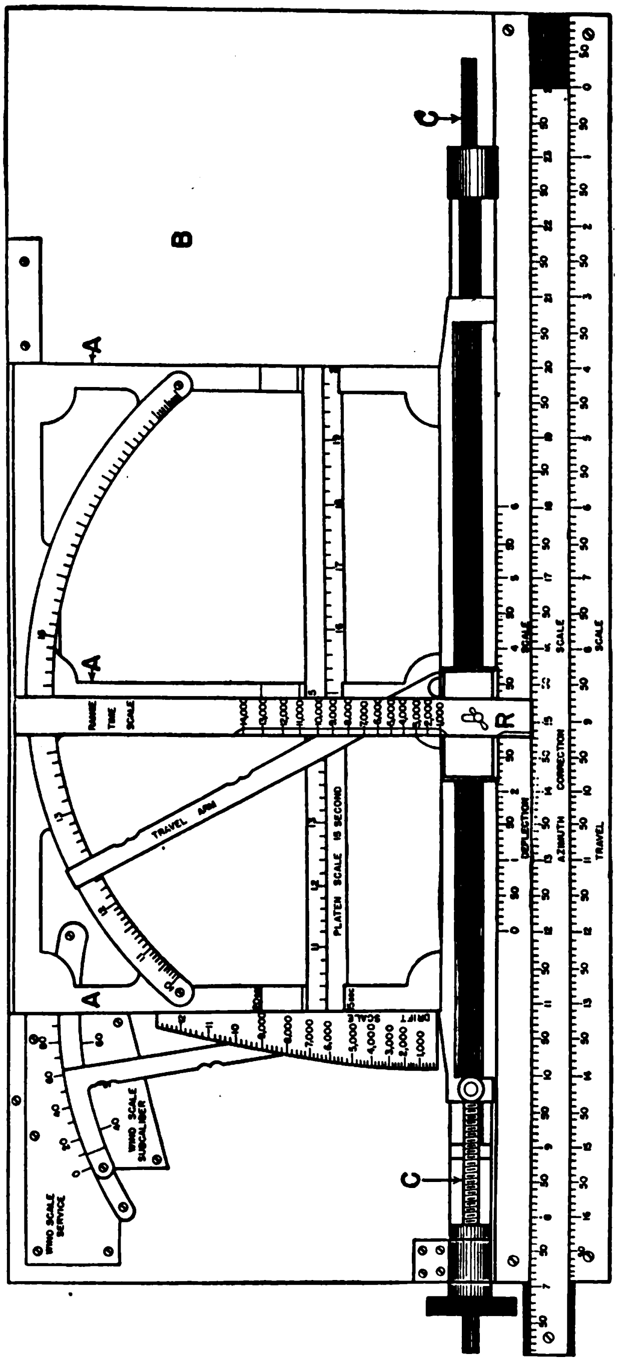



FIGURE 49.—Deflection board M1905 (for guns).

creasing range (3) indicates the proper data to be sent to the guns for the intermediate bell (the one between the bells upon which predictions and set-forward points are determined).

**36. Deflection boards.**—*Q.* What is the purpose of the deflection board? *A.* To compute the corrected deflection in case II firing and the corrected azimuth in case III firing.

*Q.* What is meant by deflection? *A.* The setting on the deflection scale of a sight such that, when the line of sight is on the aiming point, the piece is pointed in direction. In case of a telescopic sight, the aiming point is the target.

*Q.* In case II firing what goes to make up the deflection obtained from the deflection board? *A.* Angular travel of the target, corrections for wind and drift, and in some cases correction for rotation of the earth.

*Q.* In case III firing, what corrections are applied to the uncorrected azimuth to obtain the corrected azimuth? *A.* Corrections for wind and drift, adjustment corrections, and in some cases correction for rotation of the earth and for azimuth difference.

*a. Gun deflection board M1905.*—*Q.* Point out and state the purpose of each of the following parts of the gun deflection board M1905:

| | | |
|---|---|---|
| Drift scale. | Platen scale. | Travel arm. |
| Platen. | Range-time scale. | Wind scale. |

*A.* See figure 49.

*Q.* Which edge of the wind arm or of the travel arm is read in setting off the readings? *A.* The one which would pass through the center of the pivot of the arm if prolonged.

*Q.* How is the board adjusted for operation? *A.*

(1) Select and put in place the proper drift scale and range-time scale for the gun and ammunition being used.

(2) Select the proper side of the platen scale and put it in its proper place on the platen, according to the length of the observing interval being used.

*Q.* What are the rules for adjusting the platen scale for a 20-, 30-, and 40-second observing interval? *A.*

(1) For a 20-second interval, the scale should be in the slot marked "20 sec" with the side marked "15 second" exposed.

(2) For a 50-second interval, the scale should be in the slot marked "15 sec" with the side marked "30 second" exposed.

(3) For a 40-second interval, the scale should be in the slot marked "20 sec" with the side marked "30 second" exposed.

*Q.* When may the curved platen scale be used? *A.* Only when the observing interval is 30 seconds.

*Q.* What information is necessary for the operation of this deflection board? *A.* The wind reference number, obtained from the wind-component indicator; the corrected range to the set-forward point, obtained from the range percentage corrector; and the angular travel of the target, obtained from the angular-travel computer or from the plotting board.

*Q*. Explain the operation of the board to obtain the deflection for the sight. *A*.

(1) Set the wind arm to the proper reference number on the wind scale.

(2) Set the platen so that the point of the drift scale corresponding to the corrected range will be accurately over the right-hand edge of the wind arm.

(3) Set the travel arm (right edge) to the travel reference number on the platen scale.

(4) Set the range-time scale so that the point of the scale corresponding to the corrected range will be accurately over the reading edge of the travel arm.

(5) Set the lateral adjustment correction (obtained from the range officer) on the azimuth correction scale at the normal of the deflection scale.

(6) The beveled edge of the range-time scale then indicates on the azimuth correction scale the deflection to be used on the sight for case I or case II pointing.

*Q*. How is the deflection board used in case III? *A*. The set-forward point having been located on the plotting board, its azimuth must be corrected for wind and drift before being sent to the guns. Different methods are used at different batteries. One method of using the deflection board in case III is as follows:

(1) Set the wind arm at normal of wind scale.

(2) Set zero range on drift scale.

(3) Set T-square at normal of deflection scale and clamp to platen.

(4) Set the last three figures of set-forward point azimuth on azimuth correction scale opposite the normal of the deflection scale.

(5) Set the wind arm to the wind deflection reference number and move the platen by means of the handwheel until the leaf intersects the wind arm at the corrected range to the set-forward point.

(6) Read the last three figures of corrected azimuth of the set-forward point on the azimuth correction scale under the bevel edge of the T-square.

(7) Set the azimuth of the new set-forward point on the azimuth correction scale opposite the normal of the deflection scale.

(8) Move the platen by means of the handwheel until the range scale on the leaf intersects the wind arm at the corrected range of the new set-forward point, and read the last three figures of the

corrected azimuth of the set-forward point under the bevel edge of the T-square.

(9) Repeat (6), (7), and (8) for each set-forward point.

*Q*. How is this board adapted for subcaliber firing? *A*. The range-time scale and the drift scale are removed and replaced by the corresponding subcaliber scales. The subcaliber wind scale is used instead of the service wind scale. The operation of the board is then the same as for service firing.

*b. Mortar deflection board M1906.*—*Q*. Point out and state the purpose of each of the parts shown in figure 50. *A*. See figure 50.

*Q*. What corrections does this board apply? *A*. It applies corrections to the uncorrected azimuth for wind, drift, and adjustment. It does not apply corrections for rotation of the earth.

*Q*. How is the deflection chart oriented on the mortar deflection board? *A*.

(1) Bring the "read" and "set" pointers of the board to the same azimuth reading.

(2) Bring adjusting and lateral wind-correction scales to normal of 3.00.

(3) Fasten the deflection chart to rollers so that the zero deflection line falls immediately beneath the normal of the adjusting scale.

*Q*. Explain the operation of the board. *A*.

(1) Unless otherwise ordered, set the lower index of the adjusting scale to the normal of the lateral wind-correction scale. Turn the handle and ratchet ring until the proper degree on the cylinder is brought into view, and set the uncorrected azimuth pointer marked "set" to the uncorrected azimuth of the set-forward point as called out by the plotter. Turn the rear rod knob until the horizontal line representing the corrected elevation, obtained from the percentage corrector, coincides with the fiducial edge of the adjusting scale. Turn the slide knob until the arrow of the adjusting scale points to the proper curve representing the cross-wind component reference number, as obtained from the wind-component indicator. Read the corrected azimuth of the set-forward point under the "read" pointer. As changes occur, move the chart to the new corrected elevation and the arrow to the new cross-wind reference number.

(2) If the wind measurements are not available, the pointer (normal) of the adjusting scale may be set on the wind curve representing a deflection wind reference number of 50 (normal, or zero, wind correction) thus correcting for drift alone.

(3) Corrections resulting from observation of fire are applied on the lateral wind correction scale. Move the adjusting scale right

or left until the lower arrow of the scale coincides with the proper graduation on the lateral wind correction scale, as indicated by the correction ordered. This correction is in reference numbers with normal of 3.00.

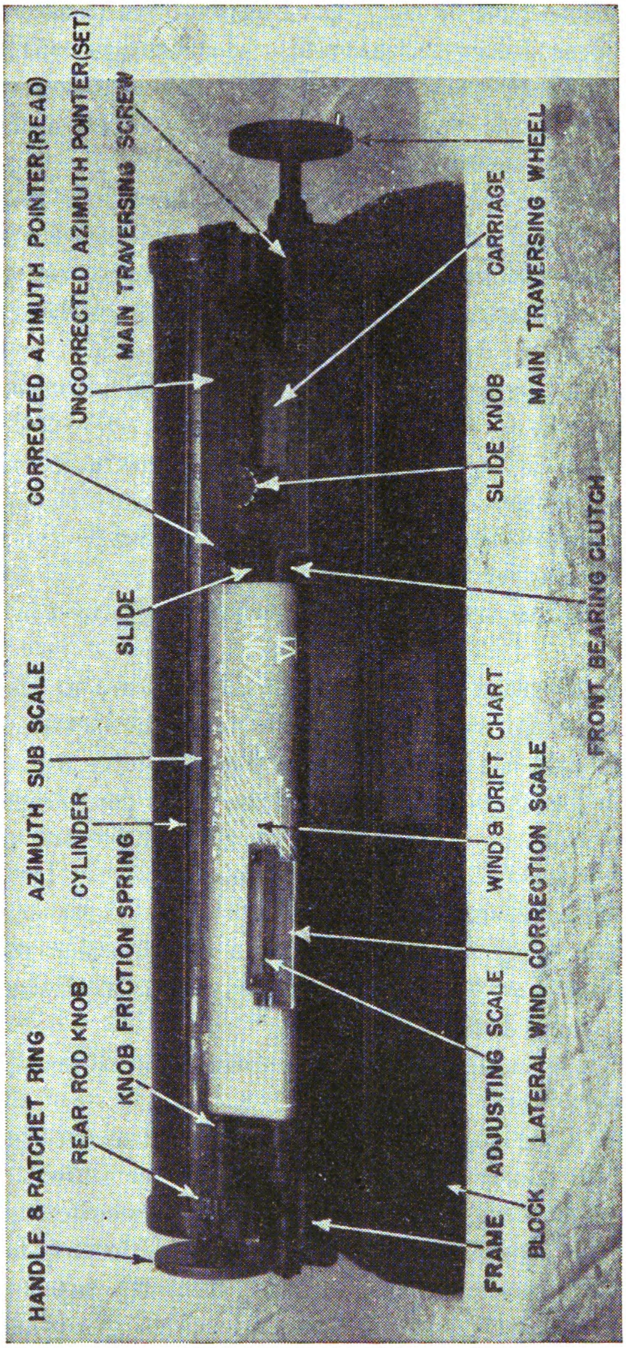



FIGURE 50.—Mortar deflection board M1906.

(4) On this deflection board adjustment corrections are applied as flat angular corrections, which is satisfactory for low-angle fire.

When used for mortars the azimuth adjustment slide rule should be used also to give the appropriate correction for changes in elevation.

*Q*. How is the board adjusted for subcaliber firing? *A*. By substituting the proper wind and drift chart.

*c. Universal deflection board.*—*Q*. Point out and state the purpose of each of the parts shown in figure 51. *A*. See figure 51.

*Q*. What corrections are applied on the universal deflection board? *A*. Corrections for drift, wind, rotation of the earth, and adjustment resulting from observation of fire.

*Q*. What data are necessary to the operation of the board for case III firing? *A*. Uncorrected azimuth of the set-forward point, deflection wind-component reference number, corrected range or elevation, and the adjustment correction to be applied as a result of observation of fire.

*Q*. Explain the operation of the universal deflection board in case III firing. *A*.

(1) The plotter having announced the approximate range to the target and whether moving from right to left or left to right, wind as much of the azimuth tape as possible on the roller on the side toward which the target is moving.

(2) Set the pointer arm at the corrected range to the set-forward point.

(3) Set the rider (for the rotational correction) at the curve corresponding to the approximate azimuth of the set-forward point.

(4) The wind-and-drift curve to be used is determined by the deflection wind component obtained from the wind-component indicator. With the adjustment correction scale at zero, move the carrier, with arm, until the wind-and-drift correction pointer is brought to the proper wind-and-drift curve.

(5) Thereafter keep the pointer arm set at the proper elevation, the rider on the proper rotational curve, and the pointer on the proper wind-and-drift curve.

(6) Set the slide to indicate the hundreds of degrees azimuth of the set-forward point.

(7) Move the tape so that the azimuth of the set-forward point called out by the plotter is set opposite the set index.

(8) Read the corrected azimuth on the tape opposite the read index.

*Q*. Explain the operation of the universal deflection board in case II firing. *A*. For use in case II firing, azimuth tapes for the universal deflection board carry at one end scales graduated to correspond to the graduations of the deflection scales of telescopic sights, except that the azimuth tape scale is numbered from left to right.

(1) See that the adjustment correction slide is set at normal or at the adjustment correction ordered.

(2) Move the tape by rolling it up on the left roller until the scale with the same normal as that of the sight being used comes into position for use on the board.

(3) Move the azimuth tape until the angular travel reference number as received from the operator of the angular travel computer is under the set index.

(4) Move the pointer arm until its index is set at the corrected range to the set-forward point.

(5) Move the rotation correction rider until it coincides with the proper curve corresponding to the azimuth of the set-forward point.

(6) Move the wind-and-drift correction pointer by moving the carrier to the right or left until the index of the pointer is over the proper wind-and-drift curve.

(7) The corrected deflection is read on the tape under the read index.

*Q*. How are adjustment corrections applied to the universal deflection board? *A*. Through the adjustment correction slide, which is graduated in 0.05° spaces to right and left of normal (zero correction). The direction in which the slide is to be moved to make the correction is indicated by an arrow on the slide.

(1) Set the movable slide coincident with the fixed index of the adjustment correction slide and opposite its normal (zero correction).

(2) Move the adjustment correction slide in the proper direction until the amount of the correction is read opposite the fixed index and the marker.

(3) The set index has been displaced by the amount of the correction and readings made on the azimuth tape opposite the read index will give corrected azimuth which includes the adjustment correction.

(4) Move the reference pointer so that it will again be opposite the normal of the adjustment correction slide.

(5) Apply additional adjustment corrections with reference to the index of the marker, and after the corrections have been accomplished always move the marker until it is again opposite the normal of the adjustment correction slide.

*d. Angular travel computer.*—*Q*. What is the purpose of the angular travel computer? *A*. To determine the deflection due to angular travel (called the "angular travel reference number") for case II pointing.

*Q*. Point out and state the purpose of each of the following parts of the computer: azimuth scale; median line; deflection scale; travel arm. *A*. See figure 52.

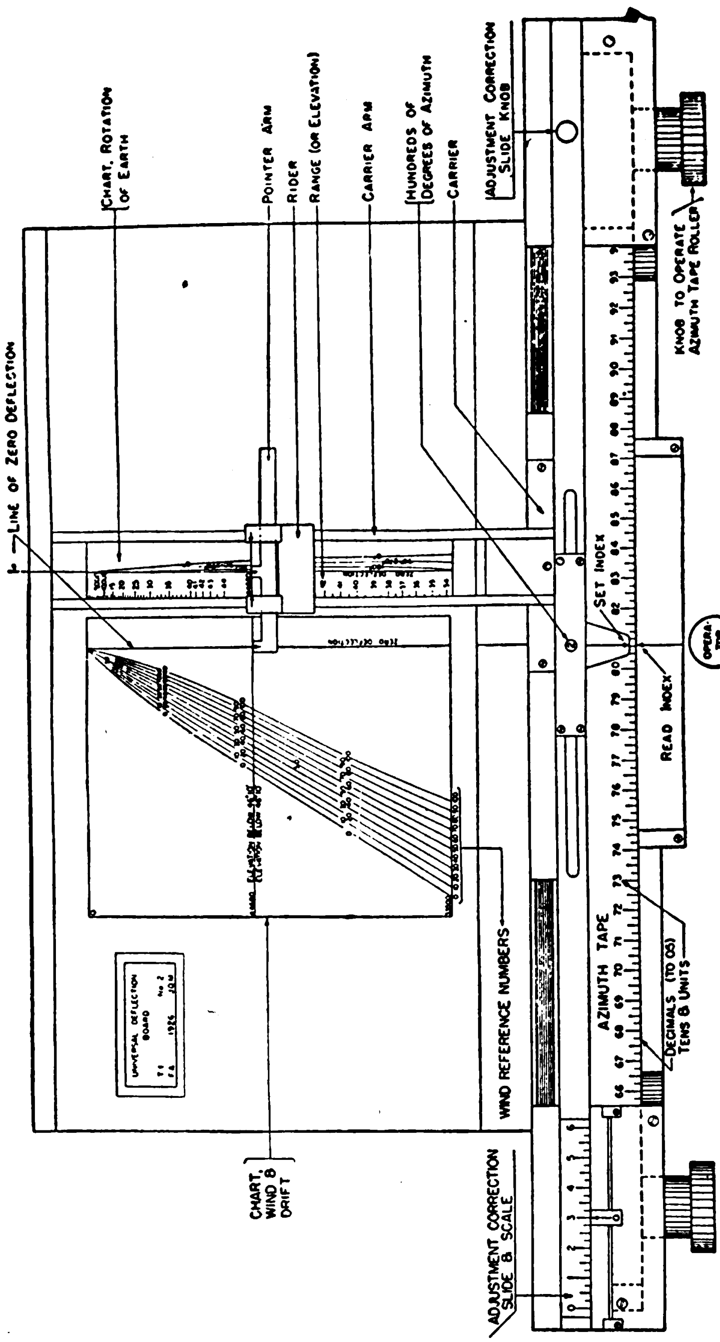



FIGURE 51.—Universal deflection board.

*Q.* How is the board adjusted for operation? *A.* By mounting the proper range-time scale, according to the gun and ammunition being used, and the proper deflection scale, according to the deflection graduations in the telescopic sight.

*Q.* What data are necessary for the operation of the board? *A.* The corrected range of the current set-forward point and the uncorrected azimuths to the current set-forward point and the next preceding one.

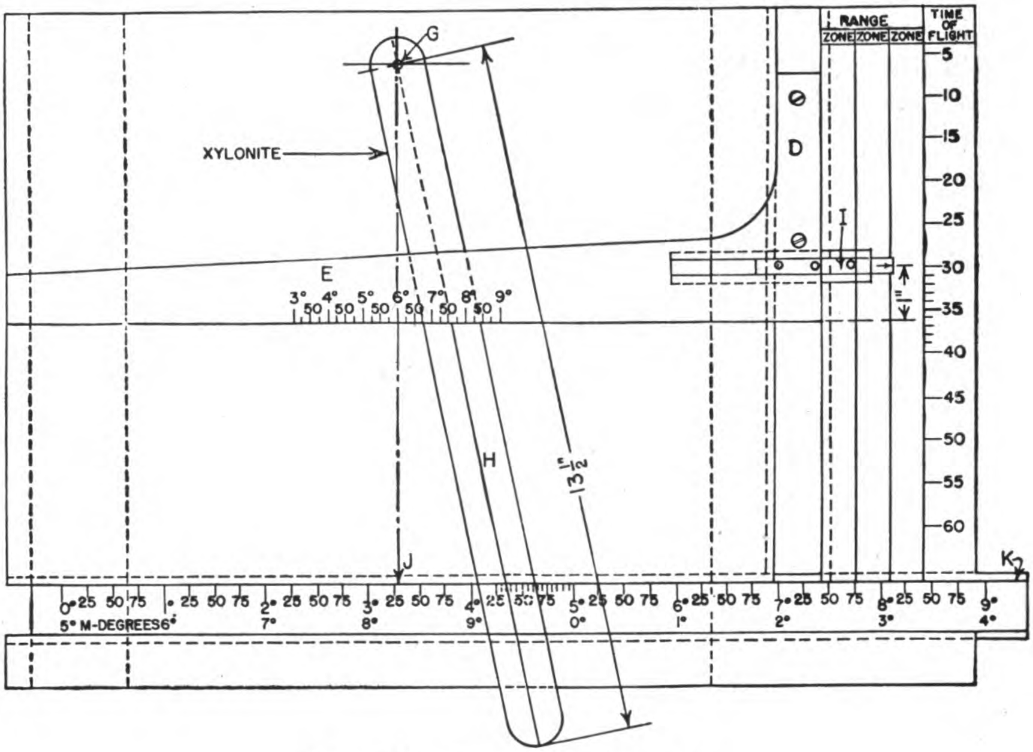



FIGURE 52.—Angular travel computer.

*Q.* Explain the operation of the angular travel computer. *A.*

(1) Set the azimuth scale so that the uncorrected azimuth (last three numbers) of the next preceding set-forward point is opposite the median line of the board.

(2) Set the pointer on the T-square opposite the range to the current set-forward point.

(3) Set the travel arm to the uncorrected azimuth of the current set-forward point.

(4) Read the angular travel reference number indicated by the travel arm on the deflection scale.

*Q.* How is the board adjusted for subcaliber firing when the same time interval is to be used? *A.* By substituting the proper range-time scale.

*Q.* Can the same deflection scale be used if the observing interval is changed? *A.* No, because it is constructed for a particular observing interval.

*e. Deflection board M1.*—*Q.* What is the present standard instrument for determining the corrected azimuth or the corrected deflection for seacoast artillery firing? *A.* The deflection board M1.

*Q.* What corrections are applied on this instrument? *A.* Corrections due to wind, drift, rotation of the earth, travel of the target, and adjustment corrections.

*Q.* Can it be used for both case II and case III firing? *A.* Yes.

*Q.* Can it be used for both mobile and fixed seacoast artillery? *A.* Yes. It can be adjusted to operate in either degrees and hundredths, or in mils, by a replacement of gearing and a change of scales and correction curves.

*Q.* What is the purpose of the wind resolving mechanism? *A.* It is for the purpose of splitting the ballistic wind up into its range and deflection components. It takes the place of the wind component indicator.

*Q.* Is it necessary to reset the wind resolving mechanism as the azimuth of the target changes? *A.* No. Once the wind speed and direction are set, the wind arm rotates with the main azimuth plate and scale as the target moves in azimuth. The wind reference numbers,

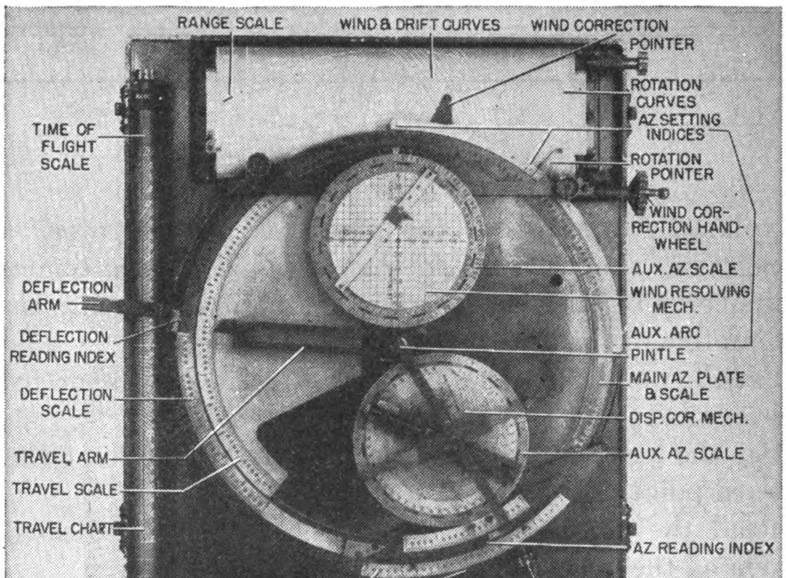



FIGURE 53.—Deflection board M1.

representing the range and deflection components, are read from the face of the top plate of the wind resolving mechanism.

*Q.* Explain how to set and read the wind resolving mechanism. *A.*

(1) Set the "read" pointer to the speed of the ballistic wind on the wind arm.

(2) Set the wind azimuth pointer to the azimuth (from zero north) of the ballistic wind using the index "N" on the same end of the wind arm as the wind speed scale if target azimuths are measured from north; if target azimuths are measured from south, use index "S" on the opposite end of the wind arm from the wind speed scale to set wind azimuth.

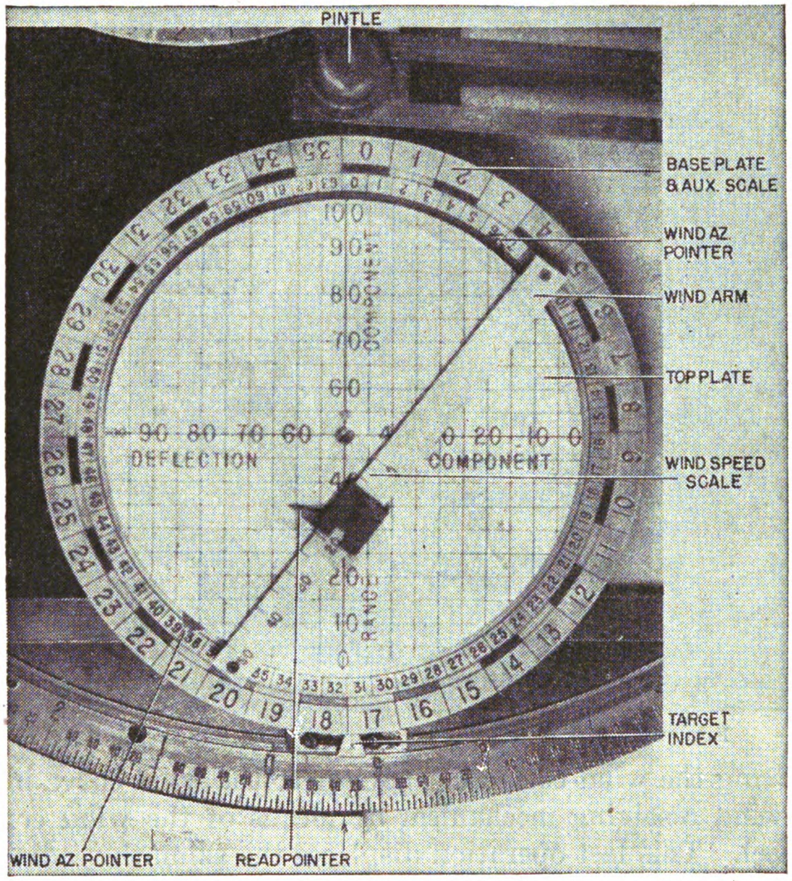



FIGURE 54.—Wind resolving mechanism on deflection board M1.

(3) Under the "read" pointer on the top plate, read the range and deflection components of the ballistic wind.

*Q.* Explain how to set uncorrected azimuth on the instrument. *A.* Rotate the main azimuth plate and scale until the proper number of hundreds and tens of the azimuth to be set are opposite the target index (on the wind resolving mechanism); set the units and hundredths of the azimuth on the main azimuth scale opposite the azimuth setting index (above the wind and drift curves).

*Q.* How do you set in a correction for wind and drift? *A.* Corrections for wind and drift are combined into one set of curves on the ballistic correction chart.

(1) Set the chart at the corrected range to the set-forward point.

(2) Release the adjustment lock knob and wind lock knob and bring the wind correction pointer to the normal curve (50) by means of the wind correction handwheel.

(3) Clamp both the adjustment lock knob and the wind lock knob.

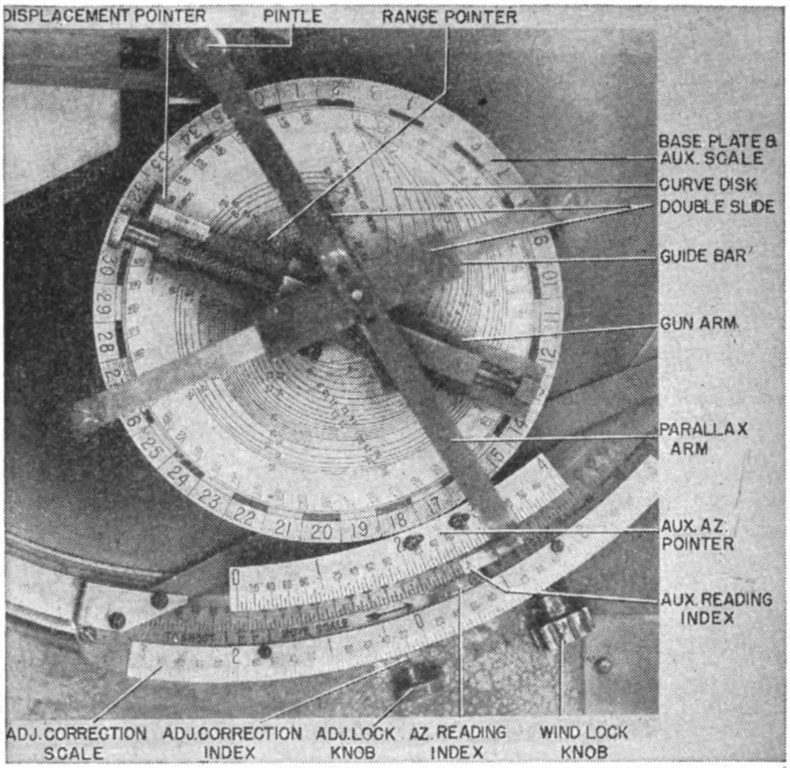



FIGURE 55.—Displacement corrector on deflection board M1.

(4) Bring the wind correction pointer to the wind curve indicated on the wind resolving mechanism by means of the wind correction handwheel. This last operation displaces the azimuth reading index by the amount of the correction.

*Q.* How is a correction for rotation of the earth set into the instrument? *A.*

(1) Set the ballistic correction chart at the corrected range to the set-forward point.

(2) Bring the rotation pointer to the proper azimuth curve on the chart. This pointer is fastened to the auxiliary arc bearing the setting index so that in setting a rotation correction the setting index is displaced by the amount of correction and the main azimuth plate must be reset to the proper azimuth.

*Q.* Explain how to set in a lateral adjustment correction. *A.*

(1) Loosen the adjustment lock knob.

(2) Shift the reading index and the adjustment scale so that the desired correction is indicated opposite the adjustment correction index and tighten the lock knob. The adjustment correction index remains locked to the wind correction pointer.

*Q.* Explain the purpose of the displacement corrector. *A.* The displacement corrector is for the purpose of correcting the firing data for parallax due to displacement; that is, if the guns are at a distance from the directing point sufficient to require the data, as computed for the directing point, to be corrected for use on the guns, the displacement corrector applies the necessary lateral correction. Also, if the two guns of a battery are separated sufficiently to require different firing data, and one gun is designated the directing gun, the displacement corrector will apply a lateral correction to the firing azimuth for the other gun.

*Q.* Explain how to set in a correction for displacement. *A.*

(1) Set the gun arm to the azimuth of the displaced gun from the directing point.

(2) Revolve the curve disk until the distance to the displaced gun, in yards, is set under the displacement pointer.

(3) Set the range pointer over the proper range curve on the curve disk.

(4) Read the corrected azimuth opposite the index on the parallax arm.

*Q.* What is the purpose of the angular travel computing mechanism? *A.* The angular travel computing mechanism is used in case II pointing for the purpose of correcting the deflection for the angular travel of the target during the time of flight.

*Q.* Explain its operation. *A.* After the main azimuth plate is set to the uncorrected azimuth to the set-forward point, set the travel arm to the normal (6.00) of the travel scale. When the next uncorrected azimuth is set, the travel arm, which is attached to the main azimuth plate by a slip friction device, will move with the main azimuth plate and indicate, on the travel scale, the angular travel of the target during the observing interval. The travel chart is rotated until the time of flight corresponding to the corrected range to the set-forward point is indicated opposite its index, and the deflection arm is set over the proper travel curve. The deflection is then read opposite the deflection reading index.

*Q.* How are ballistic and adjustment corrections applied for case II pointing? *A.* In the same manner as for case III pointing. The deflection scale is attached to the arm carrying the azimuth reading index so that when that index is displaced, either by the wind correction pointer or for the purpose of adding an adjustment correction, the deflection scale is displaced by the same amount.

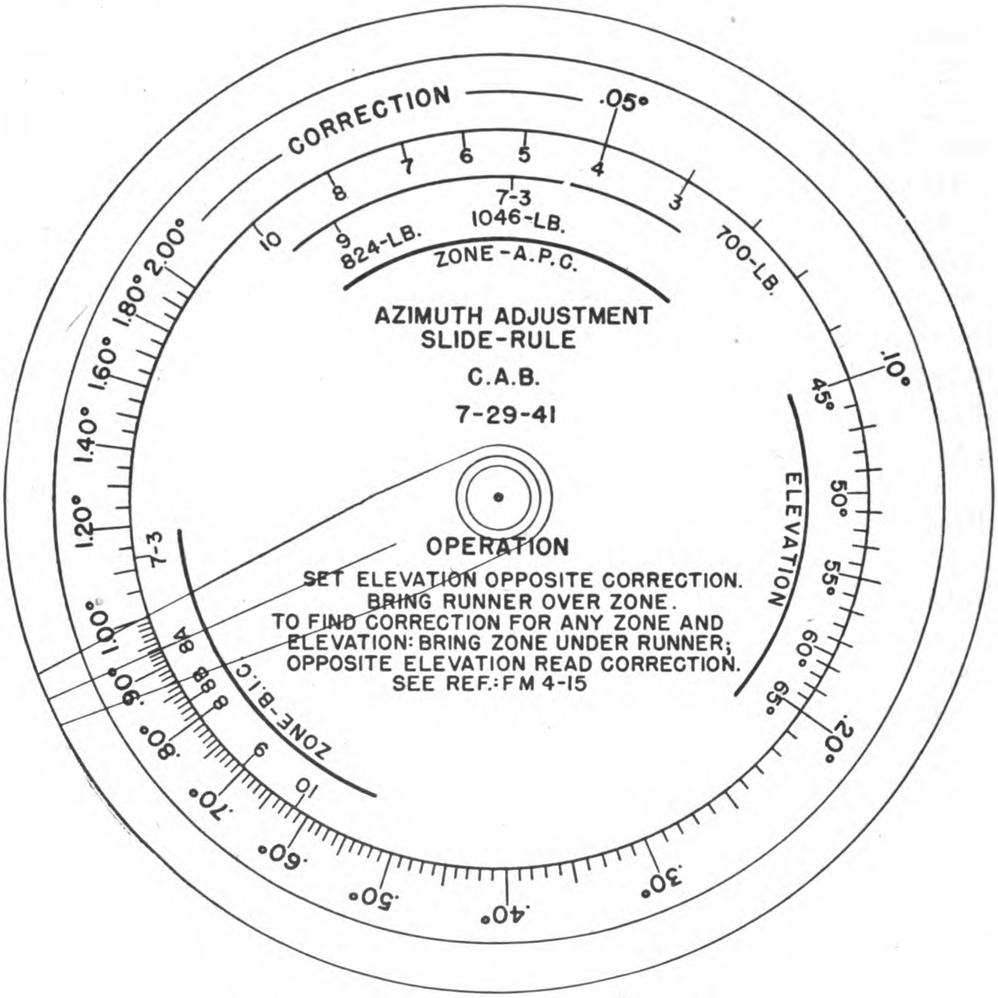



FIGURE 56.—Azimuth adjustment slide rule.

*Q.* How many men are required to operate this board? *A.* Two men are required for both case II and case III pointing. Operator A operates the wind resolving mechanism and the ballistic correction chart and pointers and sets the uncorrected azimuths. Operator B wears a telephone headset connecting him with the azimuth setters or gun pointers at the guns. He operates the lateral adjustment correction mechanism and angular travel device and transmits the corrected azimuths or deflections to the guns. He operates the displacement corrector when that mechanism is used.

**37. Azimuth adjustment slide rule.**—*Q*. What is the purpose of the azimuth adjustment slide rule? *A*. To vary an angular adjustment correction according to the elevation in high-angle fire.

*Q*. Who operates the azimuth adjustment slide rule? *A*. The deflection board operator.

*Q*. How is the azimuth adjustment slide rule operated? *A*. Assume that a mortar battery is firing in zone 8-A using base increment charges. The operator hears a correction ordered of "left 0.15°" when firing at 55° elevation. He sets the 55° elevation mark opposite the 0.15° correction mark as shown in figure 56 and sets the runner over the mark representing zone 8-A, on the B. I. C. scale. He then applies the 0.15° correction on his deflection board. (When using this instrument, the adjustment scale on the deflection board should be marked in absolute values instead of reference numbers.) He observes the change in the correction as the elevation changes and keeps the correction set to the nearest 0.05°. Thus when the elevation increases to 60° the operator should change the correction on the deflection board to 0.20°. When the zone changes, the upper disk is moved to bring the new zone marking under the runner. He then reads the new correction opposite the appropriate elevation on the elevation scale and applies it on the deflection board.

**38. Spotting board M2.**—*Q*. What is the purpose of the M2 spotting board? *A*. The M2 spotting board is the standard instrument for determining range and lateral deviations of shots from the target when bilateral terrestrial observation is available.

*Q*. How is the M2 spotting board oriented? *A*.

(1) See that the proper scales are inserted in the range scale (*C*) and the spotting platen (*J*), and that the proper sides of the deviation grid (*B*) and deviation disks (*L*) are up, depending on whether spotting is to be in percent of the range or in yards.

(2) Convert the distances from the directing point of the battery to each spotting station into inches at the scale of the board.

NOTE.—The graduations of the station arms are in inches.

(3) Loosen the clamp screws holding the station arms (*G*) in position and set each station to its proper distance in inches from the directing point.

(4) Turn each station arm until its index reads (on the inner azimuth circle of the orienting disk (*D*) ) the azimuth from the directing point to that spotting station.

(5) Tighten the clamp screws.

(6) By turning the range and azimuth handwheels (*E*) and (*F*), the indexes of the orienting disk are made to read the range and

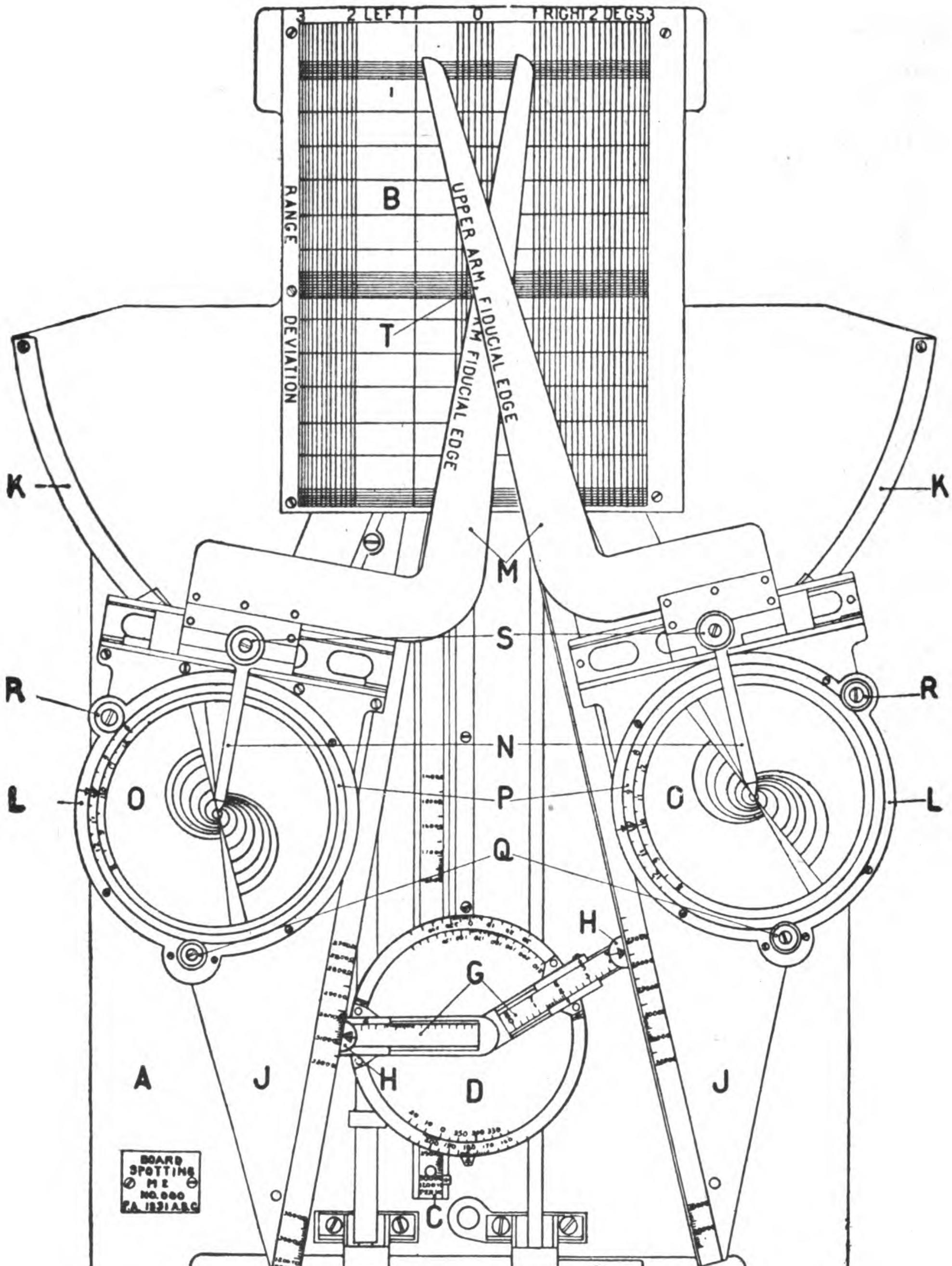



FIGURE 57.—Spotting board M2.

azimuth of any target in the field of fire. The board then represents to scale in their proper relative positions, the target, the directing point, and each spotting station.

*Q.* How is the spotting board M2 operated? *A.*

(1) See that the deviation grid (*B*) and deviation disks (*L*) are set so that each has its proper face up.

(2) Keep the orienting disk (*D*) set to the uncorrected range and azimuth to the set-forward point as determined on the plotting board.

(3) Set the range ring (*P*) on each deviation disk (*L*) to read the range from the directing point to the target.

(4) Set the range scale on the inner plate (*O*) of each deviation disk (*L*) to the range from that station to the target as shown by the reading of each station targ (*H*) on the spotting platen range scales.

(5) Set each deviation pointer (*N*) to the curve corresponding to the splash reading reported by the spotting observer at that station.

(6) On the deviation grid (*B*) read the range and lateral deviation indicated by the intersection of the deviation arms (*M*).

(7) Two operators are required, each connected by telephone to a spotting observer. One sets the uncorrected range to the set-forward point and operates the left-hand deviation disk. The other sets the uncorrected azimuth to the set-forward point, operates the right-hand deviation disk, and reads from the deviation grid the range and lateral deviations indicated by the intersection of the deviation arms (*M*).

**39. Organization and duties of range section.**—*a. General.*—*Q.* What is the range section? *A.* A group of battery personnel charged with the duty of range finding. It is under the command of the range officer and includes—

(1) The observing details.

(2) The spotting details.

(3) The plotting room detail.

Q. How are the details of the section organized and assigned? *A.*

(1) Each observing detail consists of an observer and a reader, and is assigned to a particular observation station ($B^1$, $B^2$, etc.).

(2) Each spotting detail consists of an observer and a reader. The reader may be omitted where the observer can read deviations on an internal scale. The detail is assigned to a particular spotting station ($S^1$, $S^2$, etc.).

(3) The plotting room detail varies according to the instruments in use. Its duty is to operate the apparatus in the plotting room.

*b. Observing detail.*—*Q.* What are the duties of the observer, observing detail? *A.* He is responsible for the care, adjustment, and functioning of his instrument, the functioning of his detail, and the police of his station. On arrival at his station he inspects his instrument and reports its condition, as previously explained. When the target has been indicated and identified he reports "B[1] (B[2], etc.) on target," and when the battery commander commands TRACK, he alines his instrument with the target, and keeps the cross wires accurately on the observing point of the target. When the third bell of the time-interval signal strikes, he stops following the target long enough to allow his reader to read the data and transmit it to the plotting room.

*Q.* What are the duties of the reader and recorder? *A.* He functions under the direction of the observer and assists him in his general duties. On arrival at his station he tests the communications with the plotting room. When tracking starts he reads the azimuth, or azimuth and range, at each time-interval, transmits the data to the proper arm setter in the plotting room, and records it.

*c. Spotting detail.*—*Q.* What are the duties of the spotting observer? *A.* He is responsible for his instrument, his detail, and the police of his station. He identifies the target and reports to the battery commander "S[1] (S[2], etc.) on target." Thereafter he keeps the target alined with his instrument so that the vertical cross wire is accurately upon it. When a splash occurs he adjusts his instrument thereon and transmits the deviation to the plotting room, or halts his instrument long enough for his reader to read and transmit the data. If he is reporting deviations from the target and has no reader, he records his own data. In order that he may identify the splashes, he should be informed from the battery of the instant of firing and the time of flight of the projectile.

*Q.* What are the duties of the spotting reader and recorder? *A.* They are similar to those of the recorder at an observation station.

*d. Plotting room detail.*—*Q.* Who is in charge of the plotting room detail? *A.* The range officer.

*Q.* What are the duties of the plotter? *A.* He is chief of the plotting room detail, and responsible to the range officer for the equipment and personnel, and the police of the plotting room. He receives the reports from the observing and spotting details and from the various members of the plotting room detail, and reports to the range officer, "Sir, range section in order," or any defects that cannot be remedied without delay. He is responsible for the orientation, adjustment, and functioning of the plotting board. During drill, practice, or action, he plots on the board the observed positions of the targets and determines the set-forward points.

*Q.* What are the duties of the platen operator? *A.* He is required only when the plotting and relocating board is used. He assists in orienting the board and during plotting operates the platen.

*Q.* What personnel are included in the plotting room detail when the Whistler-Hearn or 110° plotting board is used? *A.*

Plotter.
No. 1, angular travel device operator (case II) or gun arm azimuth reader (case III).
No. 2, primary arm setter.
No. 3, secondary arm setter.
No. 4, range correction board operator.
No. 5, set-forward device operator.
No. 6, percentage corrector operator.
No. 7, deflection board operator.
No. 8, assistant deflection board operator (note 1).
No. 9, fire adjustment board operator (an officer, if available).
No. 10, spotting board operator (note 2).
Nos. 11 and 12, assistant spotting board operators (note 2).
No. 13, data transmission device operator (note 3).
Nos. 14 and 15, recorders (note 4).

NOTES.—1. No. 8 is used only with the deflection board M1.

2. Where airplane observation of the fall of shots is provided, the use of the spotting board may become unnecessary. In such cases Nos. 10, 11, and 12 become unnecessary and may be eliminated. With some spotting boards only one assistant is necessary.

3. If the battery is not equipped with a data transmission device, No. 13 will be eliminated. Where the data transmission system M5 is used, four operators are required.

4. Recorders in such numbers as are necessary to insure complete and accurate records for the purpose of drill and target practice analyses must be provided. Nos. 14 and 15 are provided as regularly assigned members of the plotting room detail. When they are not required for recording purposes they may be given other duties. Operators of instruments will record their own data when practicable.

*Q.* What personnel are included in the plotting room detail when the plotting and relocating board M1 or M1925 (Cloke) is used? *A.*

Plotter.
Platen operator.
No. 1, angular travel device operator (case II only). (Not needed when deflection board M1 is used.)
No. 2, plotting arm setter.
No. 3, relocating arm setter.

Nos. 4 to 15, inclusive (same as plotting room detail for Whistler-Hearn and 110° plotting board).

*Q*. What, in general, are the duties of all members of the range detail? *A*. After the details are posted each member examines, adjusts, and tests the particular apparatus which he operates, and reports to his chief of detail, "Sir, ——— in order," or any defects which cannot be corrected without delay. He is responsible for the proper functioning of the apparatus assigned to him. At the close of drill or action the battery commander commands: BATTERY DISMISSED. The range officer commands: CLOSE STATIONS. Chiefs of detail supervise the replacement and securing of equipment and police of the stations.

*Q*. What are the duties of No. 1 (angular travel device or gun arm azimuth reader)? *A*.

(1) When the Whistler-Hearn board is used for case II pointing he operates the tally dial and subdial, keeping them properly set, and calling out the angular travel at the proper times.

(2) For case III pointing he reads from the gun (or mortar) arm azimuth circle the uncorrected azimuth of the set-forward and predicted points.

(3) When the plotting and relocating board or the 110° board is used he operates the angular travel computer. Using data from the plotting board he determines from the angular travel computer the angular travel reference number for use on the deflection board.

(4) When deflection board M1 is used, and for case III pointing with the plotting and relocating board or the 110° board, No. 1 is eliminated.

*Q*. What are the duties of No. 2 (primary arm setter)? *A*. He wears a telephone headset on the line from the $B^1$ station and sets the $B^1$ arm at the azimuth received from the $B^1$ reader. If, when the vertical or self-contained base is used, the $B^1$ station is used to locate the target, he also repeats the range received from the $B^1$ reader to the plotter; if the $B^1$ station is not used he has no duties. When the plotting and relocating board is used, he is the plotting arm setter, in which case he sets the plotting arm to the azimuth received from either the $B^1$ or the $B^2$ reader, depending on the set-up of the board.

*Q*. What are the duties of No. 3 (secondary arm setter)? *A*. He wears a telephone headset on the line from the $B^2$ station. His duties are in general similar to those of No. 2. When the plotting and relocating board is used he is the relocating arm setter. Except when using the Whistler-Hearn board he has the additional duties of operating the gun arm (or relocating arm), as directed by the plotter, in determining the range to the set-forward point, and of calling off the set-forward azimuth, when used.

*Q*. What are the duties of No. 4 (range correction board operator)? *A*. He operates the range correction board and transmits the ballistic range corrections to No. 6. Except when deflection board M1 is used he operates the wind-component indicator.

*Q*. What are the duties of No. 5 (set-forward device operator)? *A*. He operates the set-forward ruler (or chart) and calls out the travel to the set-forward point to the plotter. When the predictor M1 is used No. 5 is eliminated. His duties are the same for all systems of position finding.

*Q*. What are the duties of No. 6 (percentage corrector operator)? *A*. He operates the percentage corrector. He is equipped with a telephone headset on the line to the guns.

*Q*. What are the duties of Nos. 7 and 8 (deflection board operator and assistant)? *A*. No. 7, assisted by No. 8 when necessary, operates the deflection board and transmits deflections to the guns for case II pointing and azimuths for case III pointing.

*Q*. What are the duties of No. 9 (fire adjustment board operator)? *A*. He conducts the adjustment for range by use of the fire adjustment board or the over-short adjustment chart. This operator should be an officer, or an enlisted man familiar with the mechanics of fire adjustment.

*Q*. What are the duties of Nos. 10, 11, and 12 (spotting board operator and assistants)? *A*. They determine the range and lateral deviations.

*Q*. What are the duties of No. 13 (data transmission device operator)? *A*. When data transmission services are used he receives the corrected range or elevation and the deflection or corrected azimuth and sets them on his instrument. For zone fire he indicates the proper zone.

*Q*. What are the duties of Nos. 14 and 15 (recorders)? *A*. They keep the records necessary for analysis of drill and practice.

**40. Battery commander's detail.**—*Q*. What is the battery commander's detail. *A*. A group of personnel who assist the battery commander in the conduct of fire. The size of the detail depends upon the matériel in use. The detail is a part of the headquarters section.

*Q*. What personnel is included in the detail? *A*.

(1) Battery commander's observer.

(2) Operator of the intelligence telephone.

(3) Operator of telephone to group command post.

(4) Operator of telephone to the guns.

*Q.* What in general is the nature of the duties of the battery commander's detail? *A.* They make such observations as may be directed by the battery commander for the purpose of enabling him to keep a check on the accuracy of the work of the range section and to conduct fire efficiently.

CHAPTER 6

# USE, ORIENTATION, AND ADJUSTMENT OF OBSERVATION INSTRUMENTS



**41. Azimuth instruments.**—*Q.* What is an azimuth instrument used for? *A.*

(1) To measure the azimuth (direction) to any point such as a target; and

(2) To measure the angular deviation of a splash from the target.

*Q.* Name the three main parts of an azimuth instrument and state their uses. *A.*

(1) The telescope which contains the lenses that enable the observer to see distant objects.

(2) The base which supports the telescope and provides gears for traversing and scales for reading the azimuths.

(3) The tripod which supports the base.

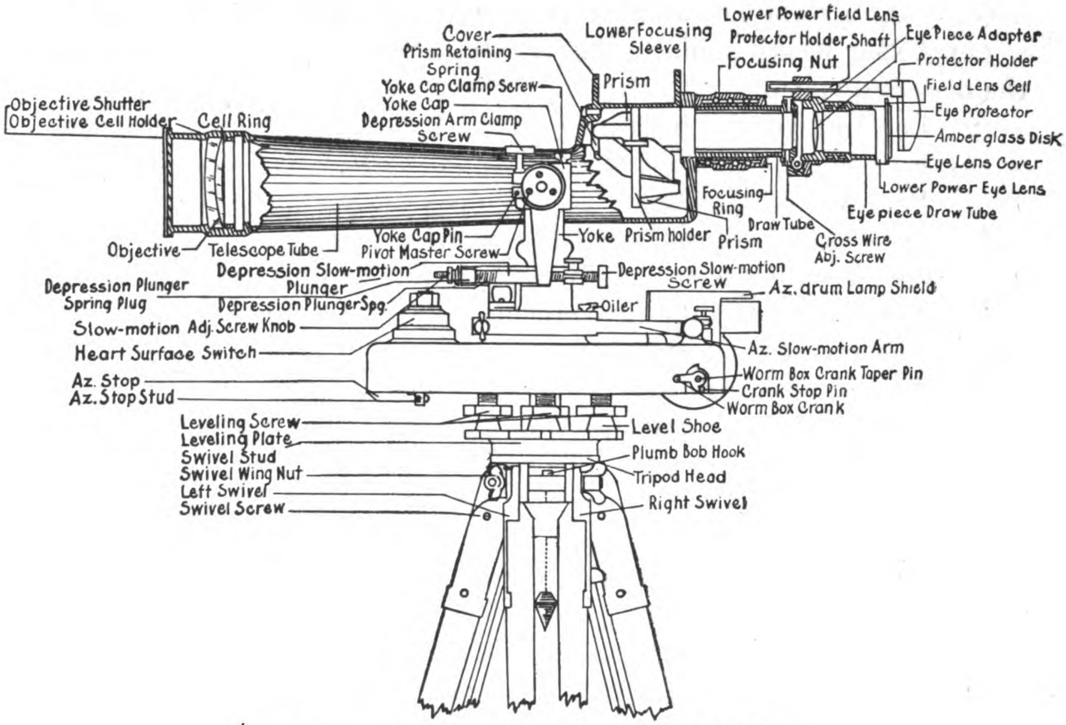



FIGURE 58.—Azimuth instrument M1910A1.

*Q.* Is a tripod always used? *A.* No; in permanent stations a "pier mount" is usually provided. It consists of a tripod head mounted in concrete or steel.

*Q*. Where are azimuth instruments generally used? *A*. In base end stations and spotting stations.

*Q*. How many men are necessary to operate the instrument? *A*. When determining azimuths, two are required, an observer and a reader; when measuring deviations (spotting), one man does both jobs.

*Q*. How are azimuths measured? *A*. The observer tracks the target keeping his vertical cross wire accurately on the designated point of the target until a signal is sounded indicating the end of an observing interval. At this instant he stops traversing the instrument and the reader reads the azimuth. This process is repeated throughout the course.

*Q*. How are deviations measured? *A*. The observer keeps the cross wire on the target until the splash occurs. The instrument is then held stationary and the angular deviation of the splash is read directly (without using the splash pointer) by means of the deflection scale etched on the reticle. If it is desired to read the deviation of the center of impact of a salvo, the splash pointer is moved to the estimated position of the center of impact and the deviation is read on the deflection scale.

*Q*. What are the necessary adjustments for reading azimuths? *A*.

(1) Exact location of the instrument over the point representing the base end station.

(2) Leveling of the instrument.

(3) Focusing of the eyepiece.

(4) Removal of parallax.

(5) Orientation to read correct azimuths.

*Q*. What are the necessary adjustments for reading deviations? *A*.

(1) The leveling of the instrument.

(2) The focusing of the eyepiece.

(3) The removal of parallax.

*Q*. Describe the adjustment of an azimuth instrument for reading azimuths. *A*.

(1) *Exact location.*—Set up and adjust the height of tripod as desired, mount the base on the tripod head, and hang a plumb-bob from the base. With the aid of the plumb-bob place the tripod and base approximately over the point representing the base end station, making the tripod head as nearly level as possible by eye. Mount and secure telescope in place on the yoke. Traverse the instrument until it reads the azimuth of a known datum point visible from the station. Loosen the azimuth clamp and turn the telescope so that it is in its normal position on the base with the eyepiece extending over the rear of the base. Lift up the instrument and tripod together

and set them down so that the telescope points in the general direction of the datum point. Center the plumb-bob over the point representing the station by shifting the tripod legs, keeping the tripod head as nearly level as possible and the telescope pointed approximately at the datum point. Make sure that the legs when finally adjusted are firmly fixed into the ground.

NOTE.—When using a pier mount this operation is greatly simplified because the exact location is already provided.

(2) *Leveling.*—See that all four leveling screws have a uniform and moderately firm bearing on the leveling plate. Release the traversing worm by rotating the worm box crank, and traverse the instrument until one of the levels on the base is parallel to two diagonally opposite leveling screws. Turn those screws simultaneously, one clockwise and the other counterclockwise, until the level bubble is centered. The bubble will follow the motion of the left thumb. Without traversing the instrument, center the bubble of the other level by means of the other two leveling screws, readjusting each bubble for any error caused in centering the other. Traverse the instrument 180° and check the level; if a bubble leaves the center, correct one half of the error by the adjusting screws on the level box and the other half by the proper pair of leveling screws. Repeat the operation until the level bubbles remain centered for any position of the telescope.

(3) *Focusing eyepiece.*—Screw the eyepiece in or out until the roughness of the cross wires can be seen most distinctly. This should be done with the telescope pointed at the sky if possible.

(4) *Removal of parallax.*—Parallax is the apparent motion of the cross wire across the image of an object as the eye is moved from side to side across the eyepiece. It is caused by improper focusing of the objective lens. To remove parallax, point the telescope at a distant object and move the objective lens in or out by means of the focusing ring, until the cross wire remains on the same point of the image as the eye is moved.

NOTE.—This operation is unnecessary on some types of instrument because they have a fixed focus.

(5) *Orientation.*—After all other adjustments have been made, reset the instrument to read the azimuth of the datum point, loosen the azimuth clamp screw, and bring the vertical cross wire on or very nearly on the datum point. Tighten the azimuth clamp screw and bring the vertical cross wire exactly on the datum point by means of the azimuth slow motion screw. Clamp the azimuth slow motion screw. Check the adjustment by traversing the instrument away

from and back to the datum point several times, checking the readings of the azimuth scale. The orientation should be checked on at least one other known datum point.

*Q*. What precautions should be taken in leveling? *A*. Have each leveling screw bear firmly but not too tightly on the leveling plate; do not force a screw if it binds, but slack off on the opposite screw. Binding of the screws will bend the spindle and make correct leveling of the instrument impossible in the future.

*Q*. What two standard types of azimuth instruments are issued? *A*. The azimuth instrument M1910A1 and the azimuth instrument M1918.

*Q*. What are the main differences between them? *A*. The M1910A1 instrument is graduated in degrees and hundredths and cannot be used to measure vertical angles; the M1918 instrument is graduated in mils and can be used to measure vertical angles from minus 300 mils to plus 500 mils.

*Q*. How should azimuth instruments be stored when not in use? *A*. In the case provided for them.

*Q*. How should azimuth instruments be cared for? *A*. No adjustment of the interior lenses should be attempted except by ordnance personnel. One eyepiece should always be kept assembled in the telescope to prevent dust or moisture from collecting on the reticle. The other eyepiece should be kept in the pocket in the carrying case. A camel's-hair brush is provided for removal of dust from the reticle and lenses. Soft tissues, silk, and cambric also may be used on the lenses.

**42. Self-contained horizontal base range finders.**—*Q*. For what purpose are self-contained horizontal base range finders used? *A*. They are used with rapid-fire batteries and for emergency range finding with larger caliber guns.

*Q*. What different types of self-contained horizontal base range finders are in use? *A*.

(1) Stereoscopic type.

(2) Coincidence type.

*Q*. What is the adopted standard for seacoast artillery? *A*. The stereoscopic height finder M1 originally designed for antiaircraft artillery.

*Q*. What is meant by a stereoscopic range finder? *A*. An instrument which gives correct ranges when the object sighted appears at the same distance, or depth, as an image or reticle, marked on a lens of the optical system.

*Q*. What adjustments are necessary when using the stereoscopic range finder? *A*.

(1) Leveling of instrument.
(2) Orientation of instrument.
(3) Collimation of trackers' telescopes.
(4) Setting of interpupillary distance.
(5) Selection of magnifying power.
(6) Selection of ray filter.
(7) Focusing of eyepieces.
(8) Adjustment of headrest.
(9) Height of image adjustment.
(10) Determination and application of range corrector setting.
(11) Setting of range height lever.

*Q*. How many operators are required for the range finder M1, and what are they? *A*. Four: elevation tracker, azimuth tracker, observer, and reader.

*Q*. What is meant by a coincidence range finder? *A*. An instrument which gives correct ranges when the object sighted appears unbroken in both the upper and lower part of the eyepiece.

*Q*. What adjustments are necessary when using a coincidence range finder? *A*.

(1) Leveling.
(2) Orientation (when equipped to read azimuths).
(3) Focusing of the eyepiece.
(4) Halving adjustment.
(5) Range (coincidence) adjustment.

Adjustments (1) and (2) are the same as for any other observation instruments.

*Q*. Describe the halving adjustment. *A*. Sight on an object such as a flagpole or spire; move the telescope in elevation until the object is seen only in the lower field; then gradually change the elevation until the image rises to the separating line. If halving is correct, the top of the object will appear above the dividing line at the instant it disappears from the lower field. If the image appears too soon, rotate the halving adjusting knob *upward*. If the image appears too late, rotate the halving adjustment knob *downward*.

*Q*. Describe the range (coincidence) adjustment. *A*. Turn the measuring knob until the scale reads the range to a known object. If the partial images do not coincide, move the correction wedge dial until the partial images coincide (come together). Check at two or more known ranges, and then leave adjustment alone.

*Q*. When is the astigmatizer used? *A*. At night when observing on small lights.

*Q*. Describe briefly the operation of the instrument. *A*. The observer and trainer bring the instrument approximately on the target by sighting over it. Thereafter the trainer keeps the instrument on the target and the observer brings the two partial images into coincidence. When coincidence is obtained (not necessarily at any given time-interval), the range is read from the range scale.

CHAPTER 7

# POINTING METHODS AND INSTRUMENTS



**43. Pointing methods.**—*Q.* What is meant by pointing? *A.* The operation of giving a gun a designated elevation and direction.

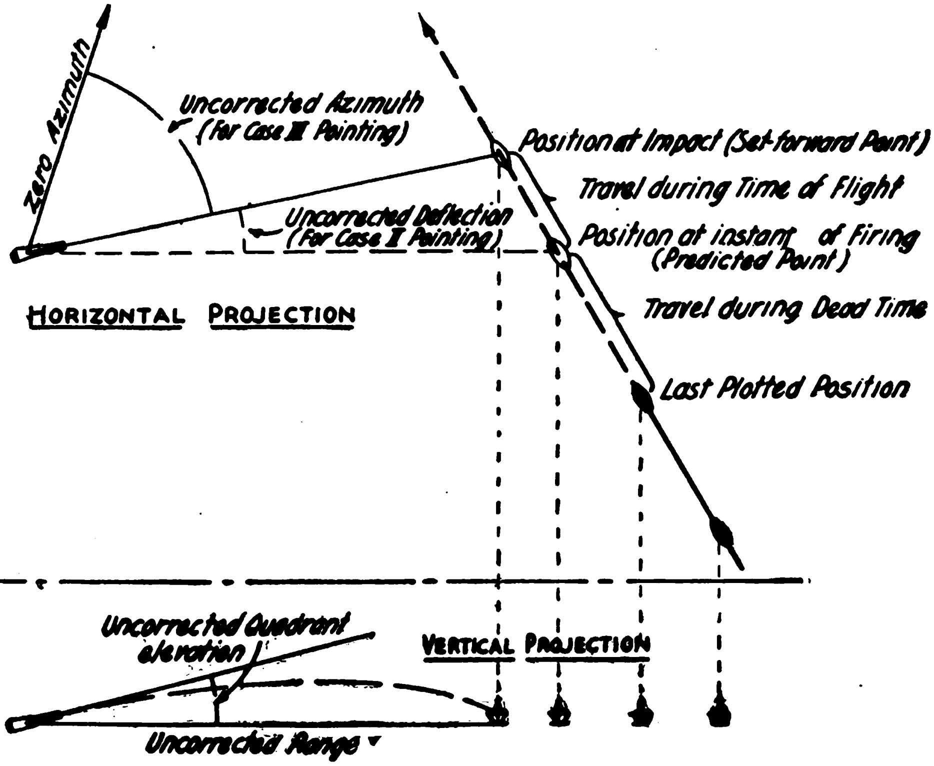



FIGURE 59.—Uncorrected firing data.

*Q.* What two general methods are used to point in elevation? *A.* The method which uses quadrant elevation and the method which uses angle of elevation.

*Q.* How is a gun pointed by quadrant elevation? *A.* By the use of a device which sets off the elevation of the gun from horizontal.

*Q.* How is a gun pointed by angle of elevation? *A.* By water lining the target with a sight and elevating the gun above the line of sight an amount sufficient to correct for the curvature of the trajectory.

*Q.* How are 155-mm guns and railway guns pointed in elevation? *A.* By quadrant elevation.

*Q*. What two general methods are used to point a gun in direction? *A*. The direct and the indirect methods.

*Q*. How is a gun pointed in direction by the direct method? *A*. The sight is pointed directly at the target and the axis of the bore is caused to diverge from the line of sight by an angular amount called the "deflection."

*Q*. How is a gun pointed in direction by the indirect method? *A*. The axis of the bore is pointed in azimuth.

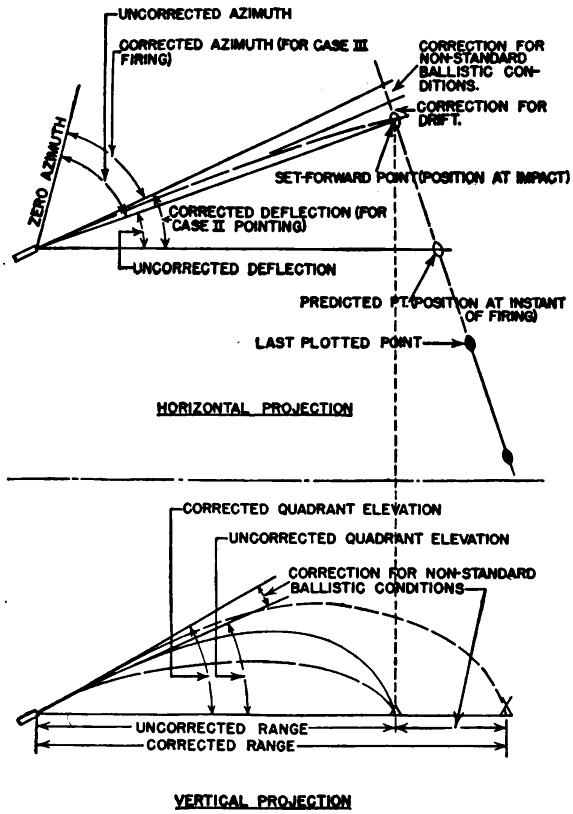



FIGURE 60.—Elements of corrected firing data.

*Q*. What two methods are used to point the gun in azimuth? *A*.

(1) By means of a panoramic telescope and a fixed aiming point other than the target.

(2) By means of an azimuth circle or dial.

*Q*. According to the combinations of pointing methods used, how many cases of pointing are there for seacoast artillery? *A*. Three.

*Q*. Name the three cases of pointing. *A*. Case I, case II, and case III.

*Q*. What is case I pointing? *A*. Pointing in which direction and elevation are imparted to the gun by means of the sight. Data are applied to the piece in the form of settings of deflection and angle of elevation.

*Q*. What is case II pointing? *A*. Pointing in which direction is imparted to the gun by means of the sight and elevation is imparted by means of an elevation scale or graduated range drum. Data are applied to the piece in the form of settings of deflection and quadrant elevation, the latter being given in terms of range when a range drum is employed.

*Q*. What is case III pointing? *A*. Pointing in which direction is given the piece by means of an azimuth circle, of a "match the pointer" indicator, or of a sight pointed at an aiming point other than the target; and elevation by means of an elevation quadrant, of a range disk, or of a "match the pointer" indicator.

*Q*. What cases of pointing are used with 155-mm and railway guns? *A*. Either case II or case III pointing.

Q. What is the rule for pointing in direction to which all seacoast artillery pointing equipment conforms? *A*. RIGHT, RAISE; LEFT, LOWER.

*Q*. What does the rule "Right, raise; left, lower" mean? *A*. If the deflection (or azimuth) is increased, the gun will be pointed farther to the right; if the deflection (or azimuth) is decreased, the gun will be pointed farther to the left.

**44. Pointing instruments.**—*Q*. What instruments are used to point 155-mm guns? *A*. A quadrant sight M1918A1 with either—

(1) A panoramic telescope M8 (formerly T2) for both case II and case III pointing; or

(2) A panoramic telescope M2A1 (formerly called panoramic sight M1917MIIA2) for case III pointing; and a telescope M1909A1 for case II pointing.

*Q*. What instruments are used to point railway guns? *A*.

(1) *For pointing in elevation*—An elevation quadrant M1917.

(2) *For pointing in direction*—A panoramic telescope of one of the three models as follows:

M1918MII.
M1922.
M8.

*Q*. What instruments are used to point the guns of your battery? *A*. ———.

*Q*. Explain how a panoramic telescope is used for case II pointing. *A*. When a deflection setting is ordered, turn the head of the telescope until the azimuth scale and micrometer read the deflection ordered. Then traverse the gun until the line of sight is on the target, being sure that the cross level bubble and the longitudinal level bubble are both centered. Keep the bubbles centered and the line of sight on the target until the gun is fired.

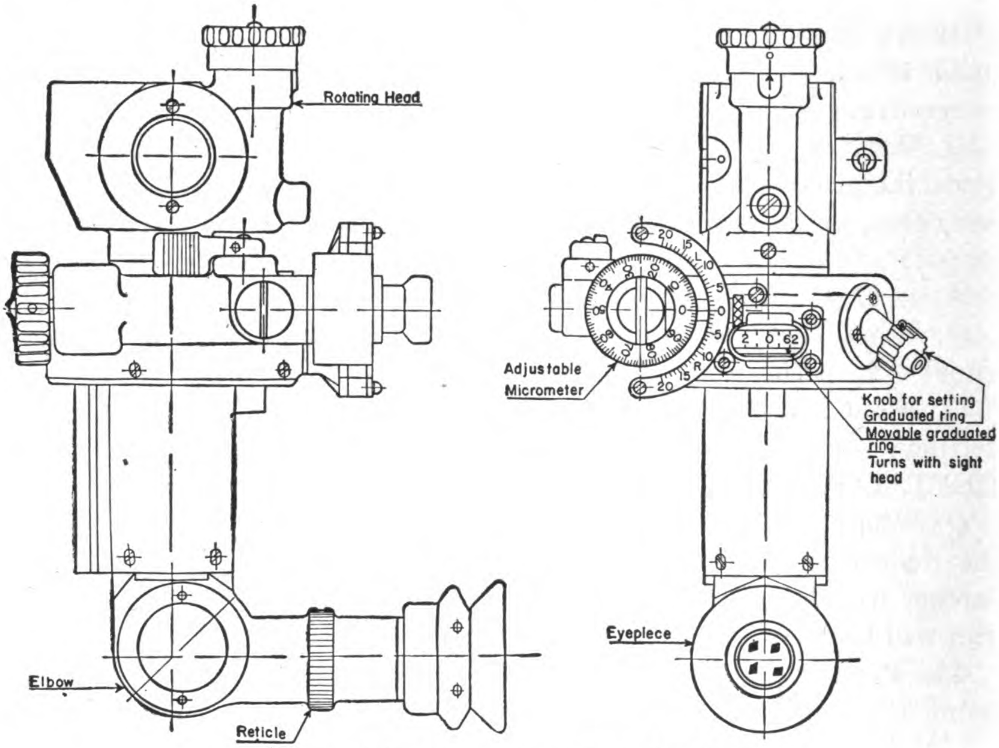



FIGURE 61.—Panoramic telescope M2A1.

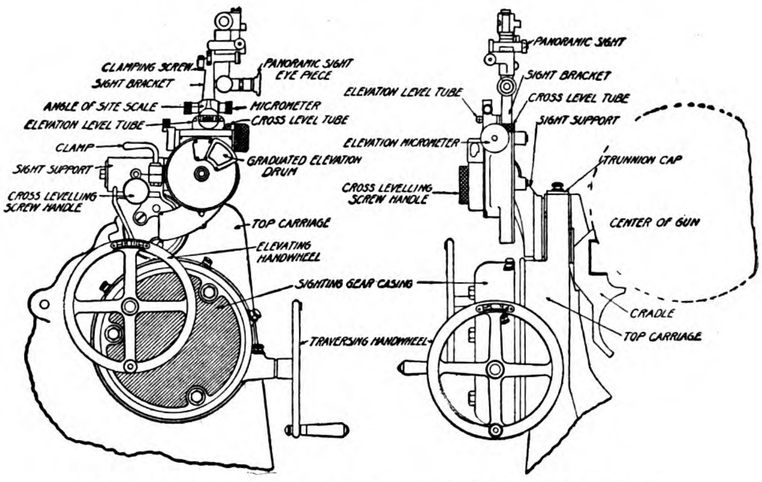
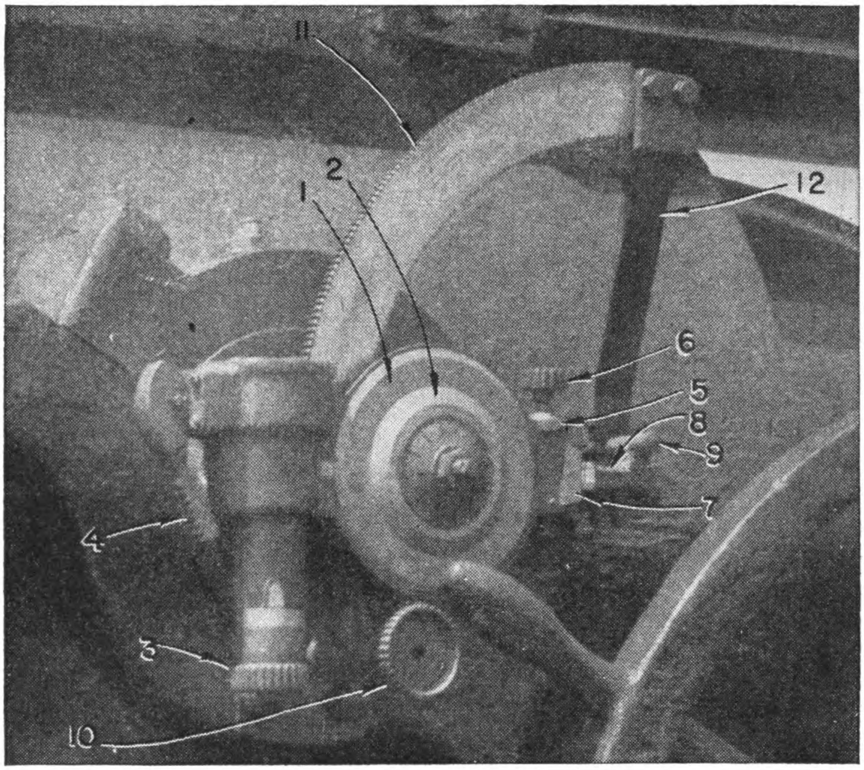



FIGURE 62.—Quadrant sight M1918A1 (Schneider).

*Q.* Show how to set a deflection of ——— and point the gun. *A.* (Practical demonstration.)

*Q.* Explain how a panoramic telescope is used for case III pointing. *A.* When an azimuth setting is ordered, turn the head of the telescope until the azimuth scale and micrometer read the azimuth ordered, and traverse the gun until the line of sight is on the aiming point, being sure that the cross level bubble and the longitudinal level bubble are both centered. Keep the bubbles centered and the line of sight on the aiming point until the gun is fired.




1. Elevation disk.
2. Outer friction disk.
3. Elevation micrometer.
4. Throw-out lever.
5. Angle of site micrometer scale.
6. Micrometer screw handle.
7. Angle of site scale.
8. Elevation level.
9. Cross level.
10. Cross level screw handle.
11. Rocker arm (elevation quadrant).
12. Rocker arm support.

FIGURE 63.—Elevation quadrant M1917.

*Q*. Show how to set an azimuth ——— and point the gun. *A*. (Practical demonstration.)

*Q*. What is the purpose of an aiming rule? *A*. To provide a moving aiming point that will eliminate pointing errors which would be made if a fixed aiming point at close distance were used. Use of the moving aiming point is equivalent to the use of a fixed aiming point at very great distance.

*Q*. Of what does the aiming rule consist? *A*. It consists of a panoramic telescope mounted on a slide on a horizontal bar. The bar is supported by two upright steel stakes in a position some convenient distance in rear of the gun. The horizontal bar is approximately perpendicular to the gun-aiming rule line.

*Q*. Explain how the aiming rule is operated. *A*. The operator keeps the aiming rule telescope set at the azimuth recorded when adjusting and keeps its line of sight on the gun telescope by sliding the aiming rule telescope along the bar.

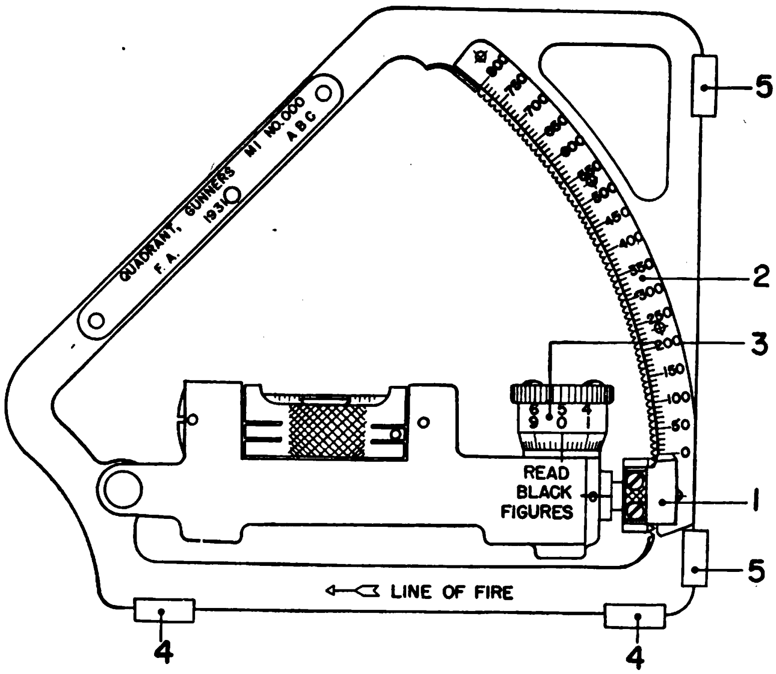



FIGURE 64.—Gunner's quadrant M1.

*Q*. Show how the aiming rule is operated. *A*. (Practical demonstration.)

*Q*. How is the gun telescope operated when using an aiming rule as an aiming point? *A*. In exactly the same way as when a fixed aiming point is used.

*Q*. What is a gunner's quadrant? *A*. An angle-measuring device used for checking the elevation of a gun or for pointing a gun in elevation.

# CHAPTER 8

# AMMUNITION



## SECTION I

## POWDERS, PROJECTILES, PRIMERS, AND FUZES



**45. Powders.**—*Q.* What kind of powder is used in cannon as a propelling charge? *A.* Smokeless, nitrocellulose.

*Q.* What is the form of its grains? *A.* Perforated cylinders.

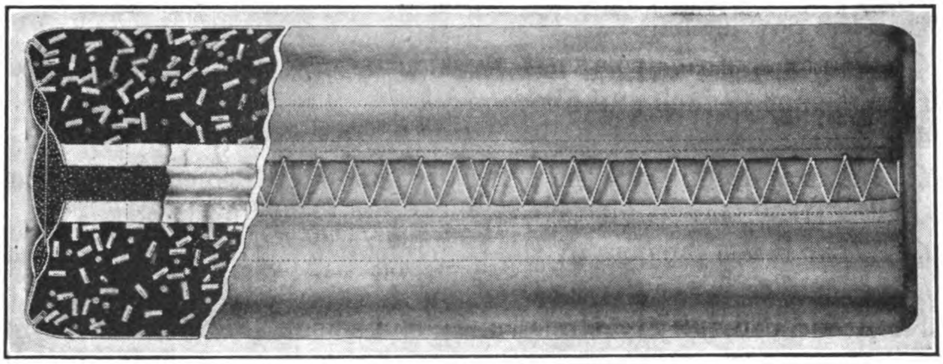


FIGURE 65.—Single-section propelling charge.

*Q.* What is the weight of the service charge for a gun of the model and caliber in your battery? *A.* ——— pounds. (See ammunition chart at end of this section.)

*Q.* What is the purpose of the igniting charge? *A.* To secure quicker ignition of the smokeless powder.

*Q.* Where is the igniting charge located? *A.* It is quilted in the rear end of each charge.

*Q.* What kind of powder is used as the igniting charge? *A.* Black powder.

*Q.* How is the powder stored? *A.* In airtight cases in magazines.

*Q.* What is the normal muzzle velocity of the gun of the model in your battery with service charges? *A.* ——— foot-seconds.

*Q.* What materials are used in the manufacture of powder bags? Why? *A.* Powder bags usually are made of special raw silk which burns without leaving any residue. (A special cotton cloth has been found suitable as a substitute material.) A spark remaining in the bore after firing might ignite the products of combustion when the breech is opened thus causing a form of explosion known as a flareback.

*Q.* Should powder be stored in the same magazine with fuzes and primers? *A.* No. Powder and projectiles must be stored separately from primers and fuzes. However primers and fuzes may be stored together.

*Q.* Are powder charges always made up in bags? *A.* No. Separate-loading ammunition has the powder in bags but in fixed ammunition the powder is in the brass cartridge case.

*Q.* Should you have a lighted match or a cigarette around powder? *A.* No.

*Q.* What is meant by the term "stacked charge"? *A.* The term "stacked charge" is applied to powder charges which have been especially prepared at the arsenal. The powder grains lie end to end within the powder bag.

*Q.* What types of armament use stacked charges? *A.* Major caliber armament 12-inch and above.

**46. Projectiles.**

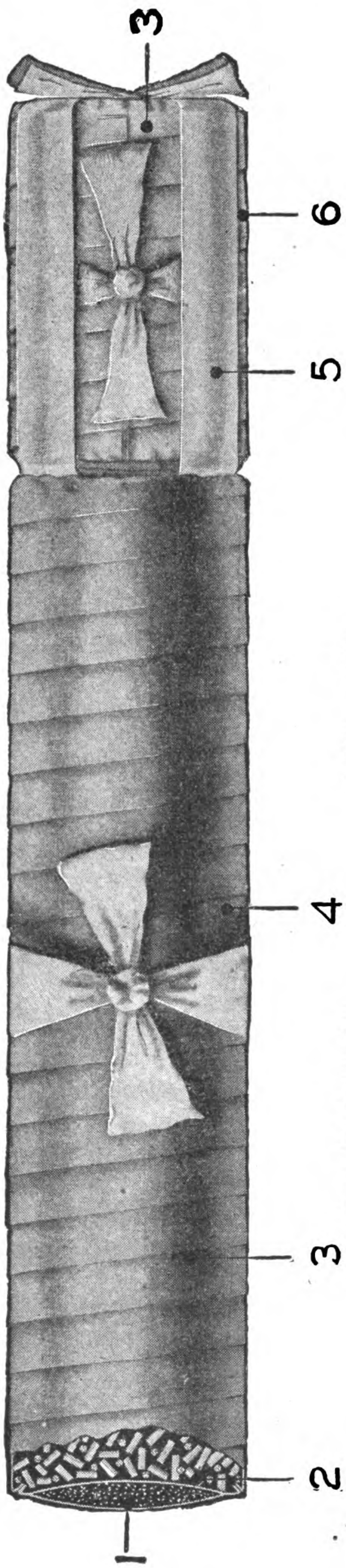
*Q.* Name and point out the principal parts of a projectile. *A.* Base, body, bourrelet, cap, cavity, ogive, point, and rotating band.

*Q.* What is the purpose of the bourrelet? *A.* To provide a smooth bearing surface for centering the forward part of the projectile in the bore. It is a carefully machined and finished surface and is of slightly less diameter than the bore of the gun, but greater than the body of the projectile.

*Q.* What parts of the projectile bear against the lands of the bore? *A.* The bourrelet and the rotating band.

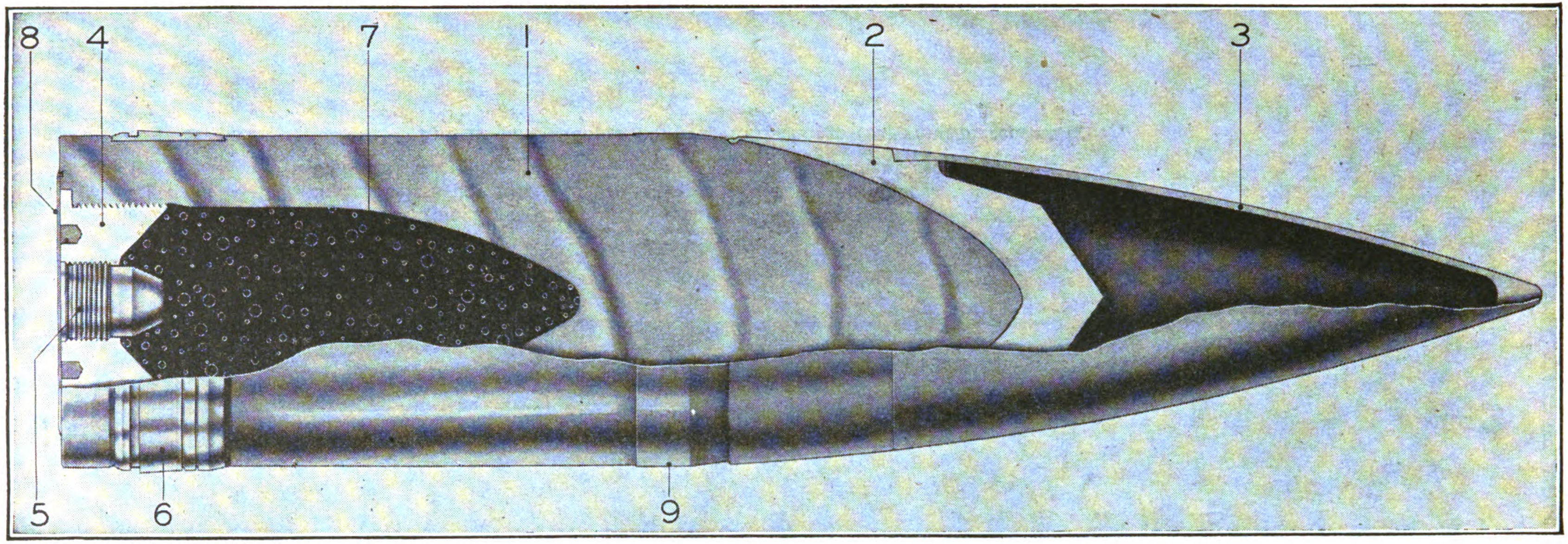
*Q.* Describe the rotating band and state its purpose. *A.* The rotating band is a cylindrical ring of copper or gilding metal pressed into a groove near the base of the projectile. The diameter of the rotating band is somewhat greater than the diameter of the bore between the lands. When the gun is fired, the rotating band engages with the rifling in the bore and thus centers the projectile in the bore, prevents the escape of gas past the projectile, and imparts a motion of rotation to the projectile.

*Q.* What projectiles are furnished for artillery? *A.* Armor-piercing projectiles, high-explosive (common steel) projectiles, target-prac-



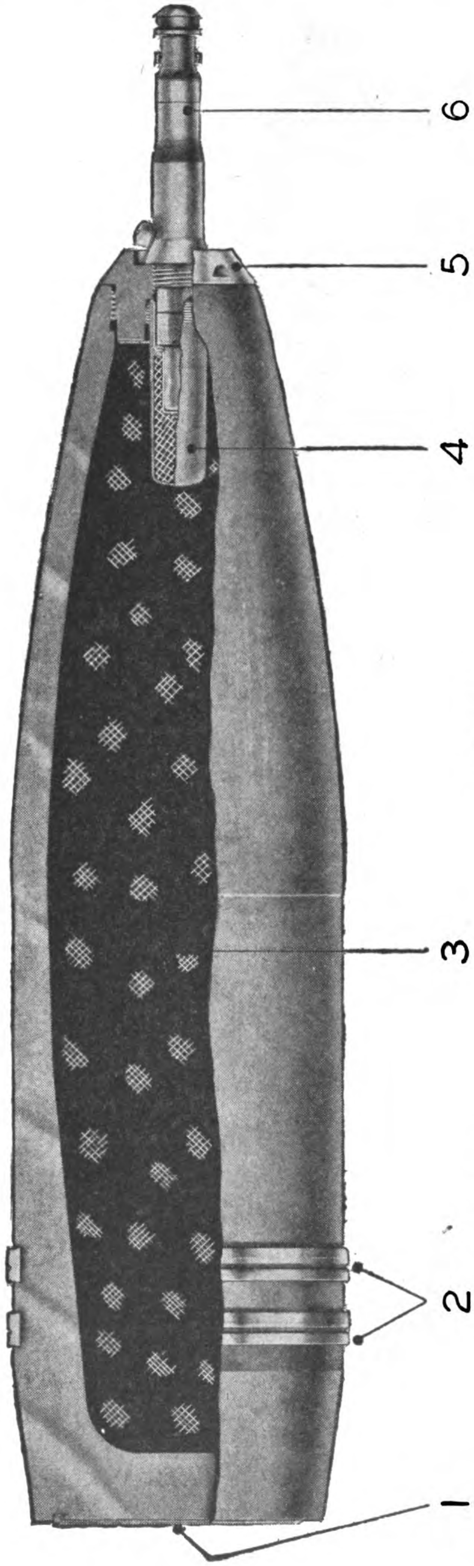

1. Igniter (black powder).
2. Smokeless powder.
3. Spiral wrapping.
4. Base section.
5. Tying straps.
6. Increment section.

FIGURE 66.—155-mm gun propelling charge (base and increment type).



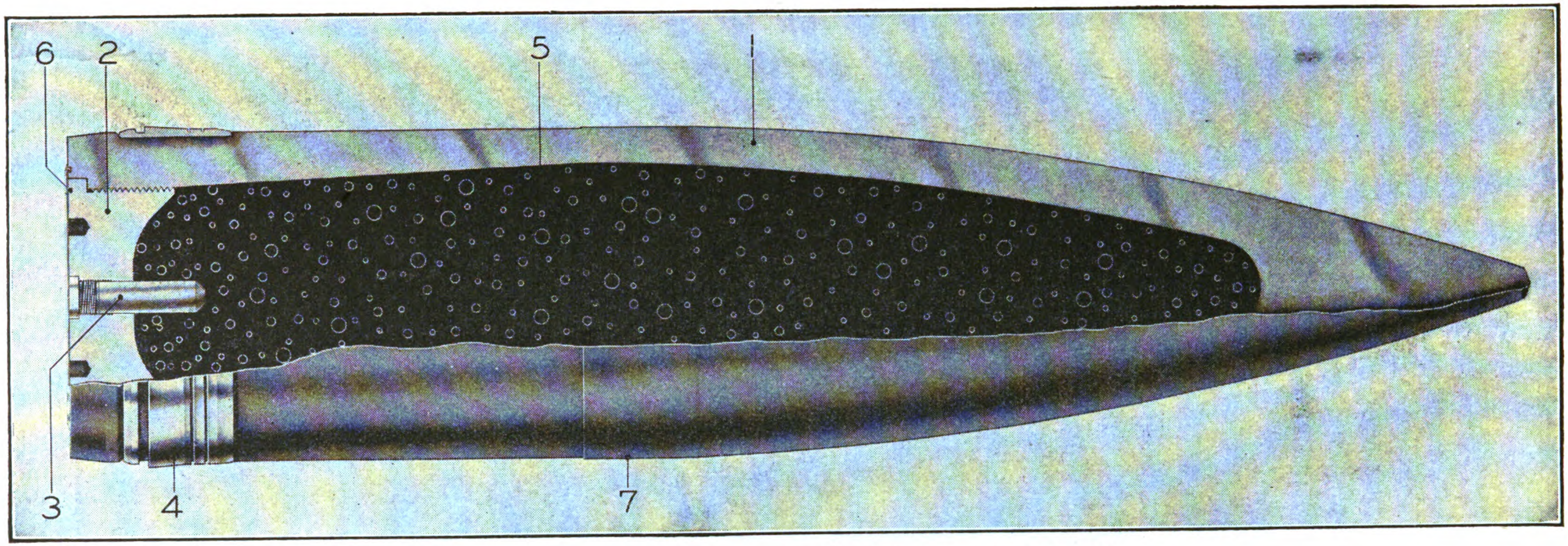

1. Steel shell.
2. Armor-piercing cap.
3. Windshield.
4. Base plug.
5. Fuze.
6. Rotating band.
7. Bursting charge (explosive D).
8. Base cover.
9. Bourrelet.

FIGURE 67.—Armor-piercing projectile.



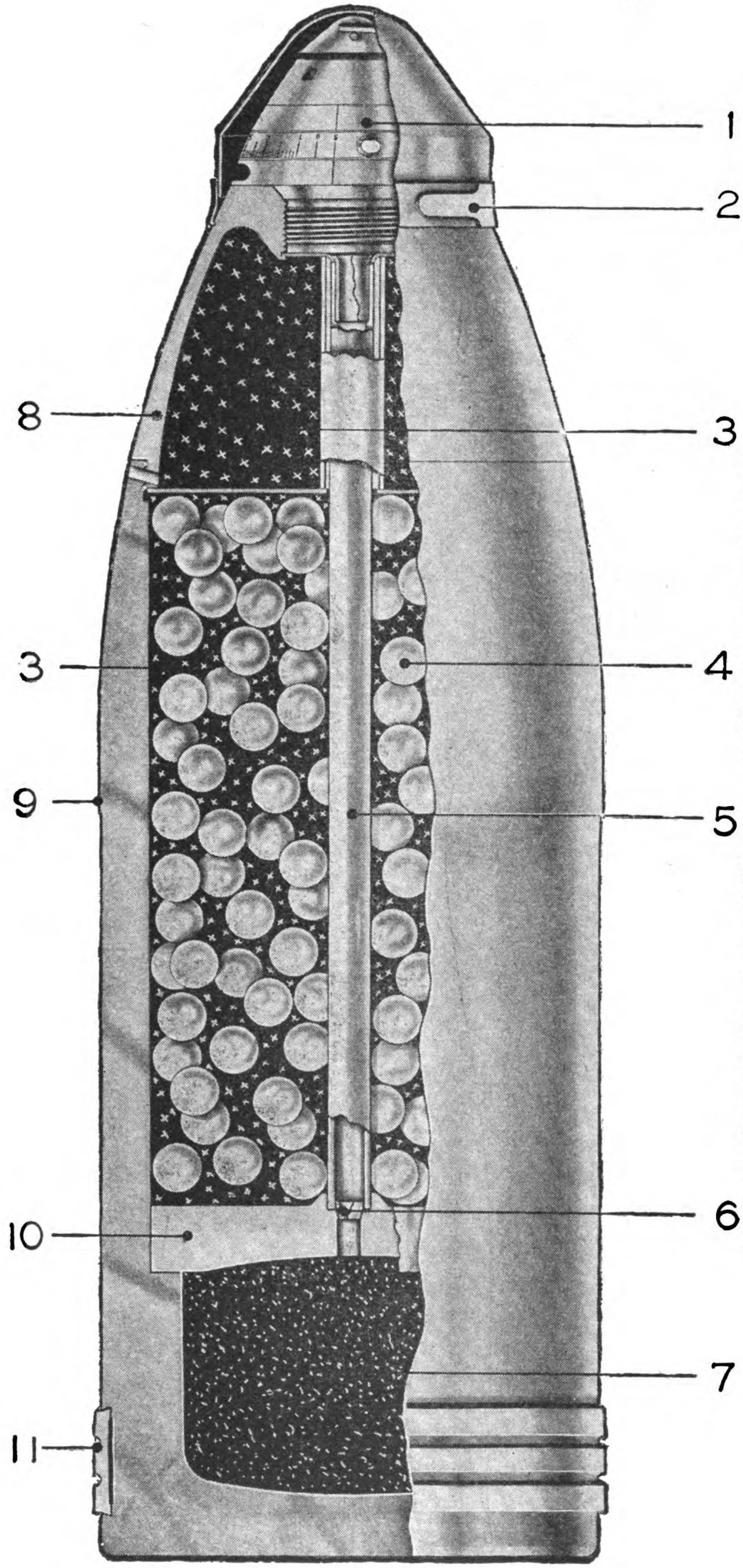

1. Base cover.
2. Rotating bands.
3. Bursting charge (TNT or amatol).
4. Booster.
5. Adapter.
6. Fuze (to be inserted at battery).

FIGURE 68.—155-mm high-explosive shell Mk. III.




1. Steel shell.
2. Base plug.
3. Fuze.
4. Rotating band.
5. Bursting charge (explosive D).
6. Base cover.
7. Bourrelet.

FIGURE 69.—High-explosive shell.




1. 45-second combination fuze, M1907.
2. Tear-off strip or soldering-strip of waterproof cover.
3. Matrix (resin).
4. Balls.
5. Central tube.
6. Fiber paper cup and cloth disk.
7. Base charge (loose black powder).
8. Head.
9. Bourrelet on shrapnel case.
10. Diaphragm.
11. Rotating band.

FIGURE 70.—155-mm shrapnel Mk. I.

tice projectiles, dummy projectiles, and subcaliber projectiles. (Armor-piercing and deck-piercing shot and shell have been declared obsolete for future manufacture and will ultimately be replaced by armor-piercing projectiles for cannon of 12-inch or greater caliber and by common steel shell for cannon of smaller caliber.)

*Q.* For what purposes are common steel shell used? *A.* Usually to attack unarmored or lightly armored parts of warships.

*Q.* What is a bursting charge? *A.* A quantity of explosive placed in a projectile in order to burst it on impact or at a given time.

*Q.* What explosive is used as a bursting charge for high-explosive projectiles? *A.* Trinitrotoluene (TNT). Some shells are loaded with amatol.

*Q.* What explosive is used as a bursting charge for armor-piercing projectiles? *A.* Usually explosive D.

*Q.* Why are projectiles painted? *A.* To prevent rust and to furnish a means of identification.

*Q.* What are the weights of the projectiles for the guns of your battery? *A.* ——— pounds. (See ammunition chart at end of this section.)

*Q.* What color are projectiles that are filled with high explosive painted? *A.* Yellow.

*Q.* How should projectiles be handled? *A.* With care. *Take particular care not to injure the rotating bands.*

**47. Primers.**—*Q.* What is a primer? *A.* A primer is a device used to ignite the propelling charge in the gun.

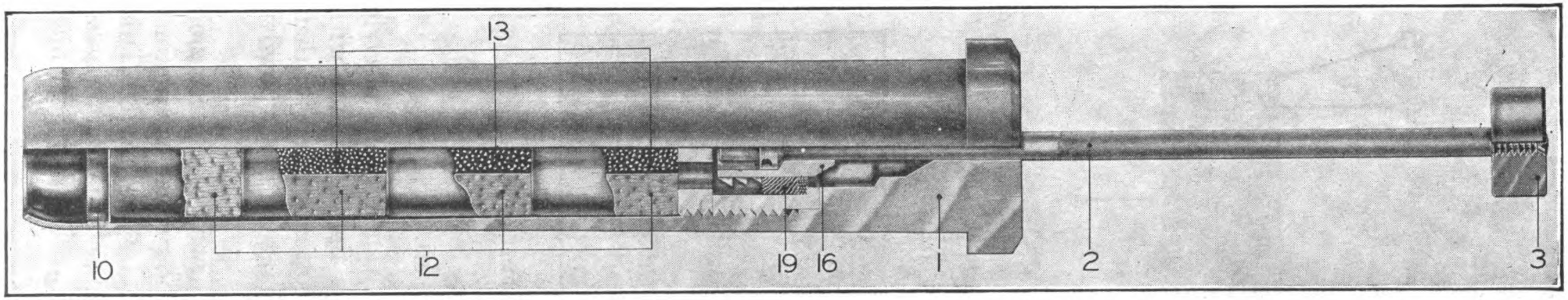
*Q.* Name the classes of primers. *A.*

(1) Drill.
(2) Friction.
(3) Electric.
(4) Percussion.
(5) Combination percussion-electric.
(6) Igniting.

*Q.* What primers do you use at your battery? *A.* See ammunition chart at end of this section.

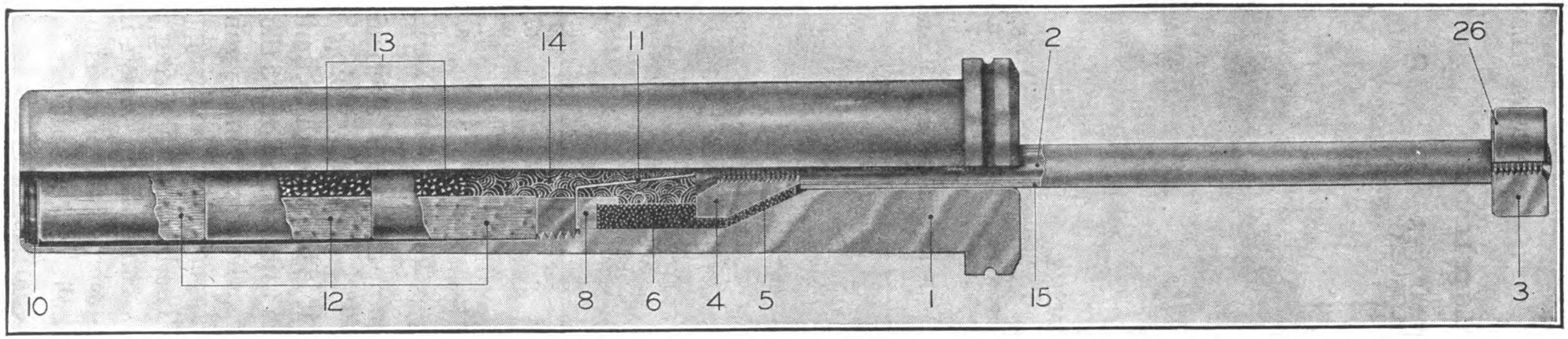
*Q.* Why are drill primers furnished in addition to electric primers and friction primers M1914? *A.* The drill primer is much cheaper and can be loaded at the post.

*Q.* What happens when the wire of the friction primer is pulled to the rear of the lanyard? *A.* The teeth at the inner end are pulled through the friction composition. This makes enough heat to ignite the composition and the flame from this ignites the priming charge of black powder which fires the charge in the gun.



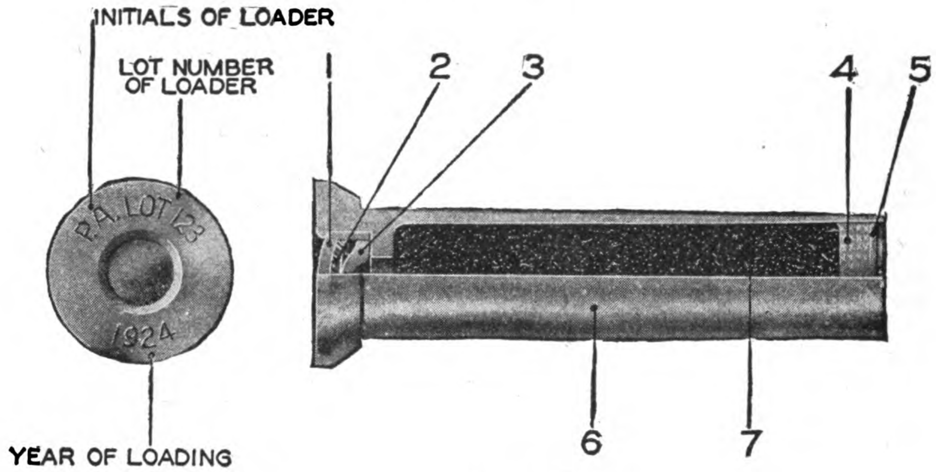

1. Body.
2. Wire.
3. Button.
10. Closing cup.
12. Primer charge, black-powder pellets.
13. Primer charge, loose black powder.
16. Gas check.
19. Friction composition.

FIGURE 71.—Friction primer M1914.



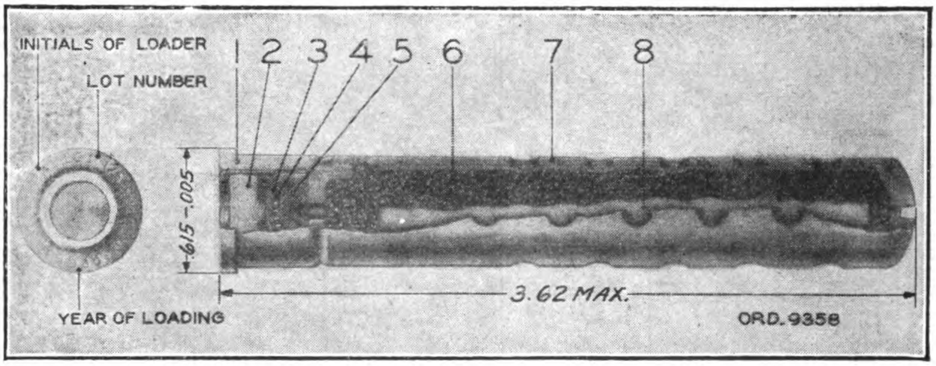

1. Body.
2. Wire.
3. Button.
4. Contact plug.
5. Plug insulator.
6. Insulator.
8. Contact sleeve.
10. Closing cup.
11. Contact wire.
12. Primer charge, black-powder pellets.
13. Primer charge, loose black powder.
14. Gun cotton.
15. Paper insulation.
26. Paper washer.

FIGURE 72.—Electric primer.




1. Percussion cup.
2. Percussion composition.
3. Anvil.
4. Wax.
5. Shellac.
6. Case.
7. Primer charge, black-powder.

FIGURE 73.—21-grain percussion primer Mk. II-A.

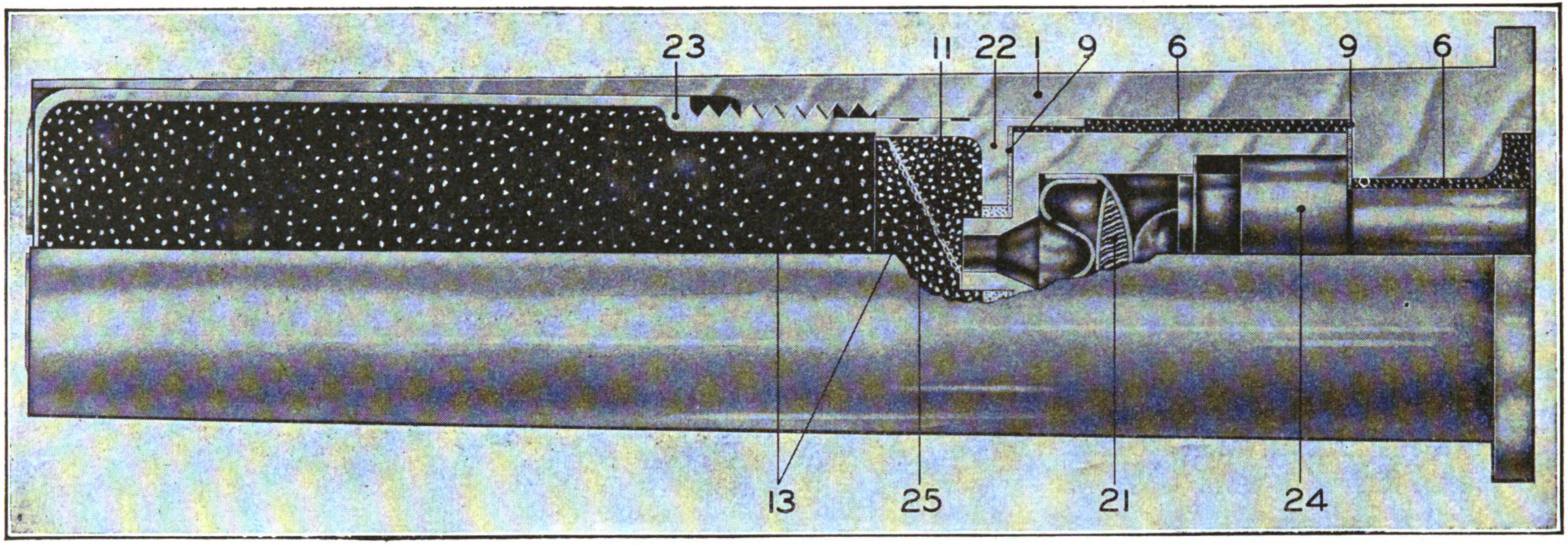



1. Head.
2. Firing plug.
3. Primer cup.
4. Percussion charge.
5. Anvil.
6. Charge (loose black powder).
7. Body.
8. Paper wrapper.

FIGURE 74.—100-grain percussion primer M1.

*Q.* What happens when electricity is sent through an electric primer? *A.* The electricity going through the fine platinum wire heats it until it is hot enough to ignite the gun cotton around it; then the flame from this cotton ignites the priming charge of black powder which then fires the charge in the gun.

*Q.* What happens when the firing pin strikes the cap of a percussion primer? *A.* The blow of the firing pin forces the primer cap against the percussion composition which is supported by the anvil. This causes the explosion of the percussion composition and the flame passes through the holes in the anvil and ignites the primer charge which then fires the charge in the gun.




1. Body.
6. Insulators.
9. Insulating washers.
11. Contact wire.
13. Primer charge, loose black powder.
21. Primer cap.
22. Ignition cup.
23. Metallic seal.
24. Plunger.
25. Guncotton.

FIGURE 75.—Combination percussion-electric primer Mk. XVM1.

*Q*. How should primers be handled? Should you take them apart? *A*. Very carefully as they are dangerous. Do not take them apart.

**48. Fuzes.**—*Q*. What is a fuze? *A*. A fuze is a device used to ignite the bursting charge of a projectile.

*Q*. When do the fuzes in seacoast projectiles ignite the bursting charge? *A*. They ignite the bursting charge upon impact or a very short time after impact. Some fuzes have delayed action to permit the projectile to penetrate before the bursting charge is ignited.

*Q*. Name the principal parts of a fuze. *A*. The body, plunger, firing pin, primer, detonator, booster, and adapter.

*Q*. Describe briefly each of the parts just named. *A*.

(1) The body is the part which houses the working parts of the fuze.

(2) The plunger is the mechanism which contains the firing pin or the primer. It is held stationary when the fuze is unarmed but when armed the plunger is free to move.

(3) The firing pin is the part of the fuze which strikes the sensitive explosive and causes the fuze to function.

(4) The primer is the part of the fuze which contains the sensitive explosive.

(5) The detonator is the small quantity of explosive which starts ignition of the booster charge.

(6) In some types the booster is a part of the fuze; in others it is inclosed in a separate casing. It is an additional charge of powder used to aid the detonator in exploding the bursting charge.

(7) The adapter is a metal bushing used to reduce the size of the opening in the base or point of the projectile and to form a seat for the fuze.

*Q*. Why is it not possible to use larger detonators and dispense with the booster? *A*. Detonators are made of very sensitive explosive compounds which would be very dangerous to handle in large quantities. It is safer to use a small detonator and obtain the required explosion by using an additional charge of less sensitive powder.

*Q*. When is a fuze said to be armed? *A*. When all the operating parts, the movement of which is necessary for the proper functioning of the fuze, are released so that the firing pin can strike the primer upon impact.

*Q*. How are fuzes used in seacoast projectiles armed? *A*. Fuzes are armed in either of two ways: inertia and centrifugal force. In the first case, the shock of discharge compresses a spring which permits the sleeve to move to the rear locking it to the primer plunger. The firing pin now projects above the front end of the sleeve, being

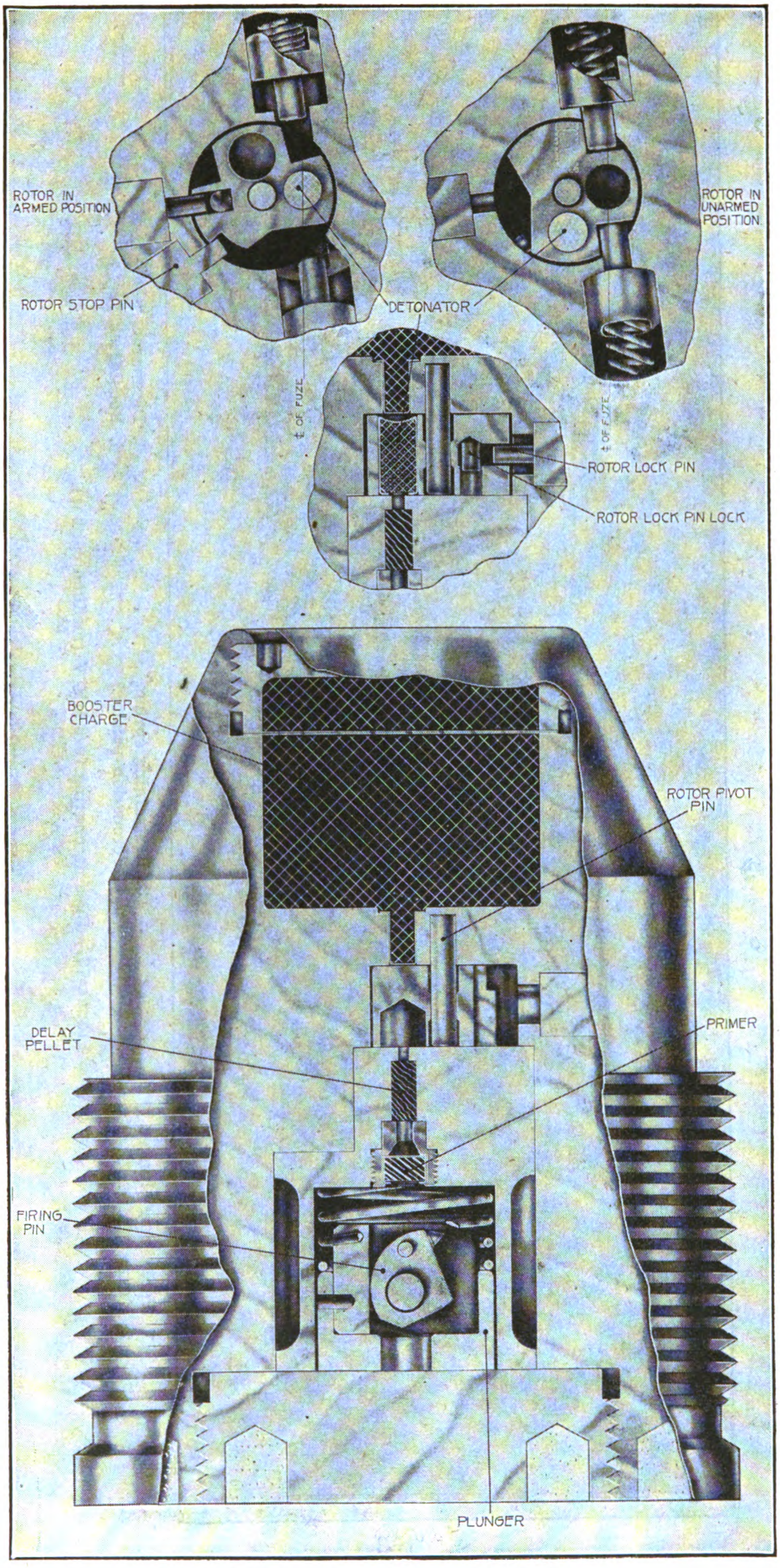
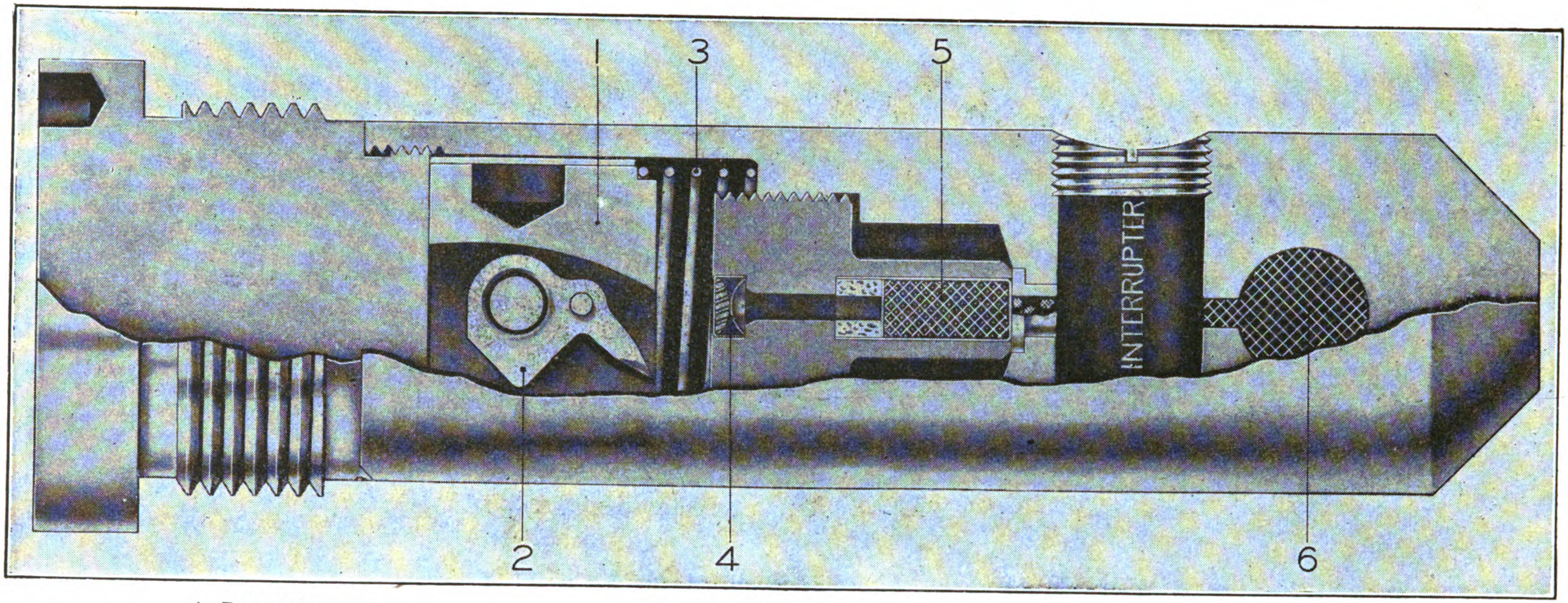
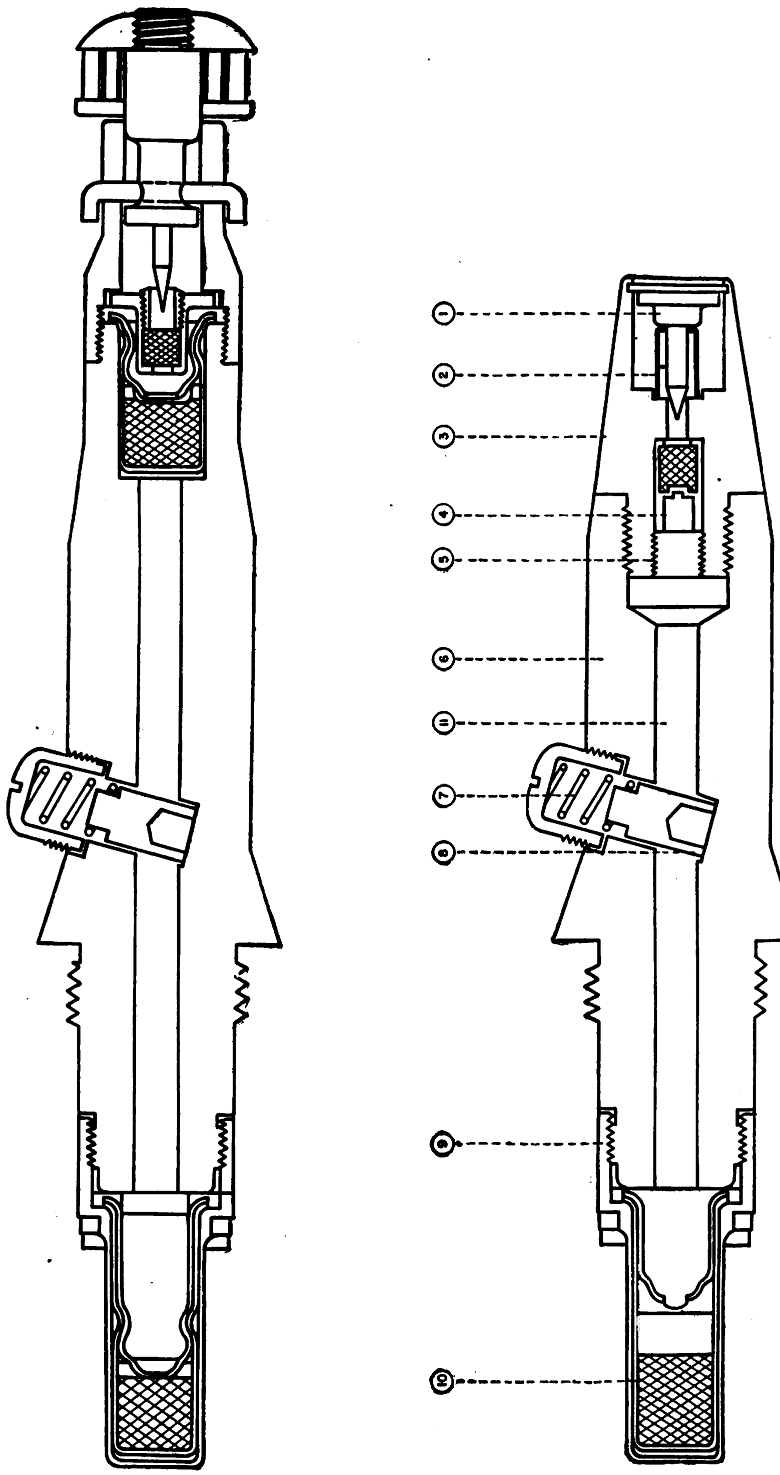



FIGURE 76.—Base detonating fuze Mk. X.



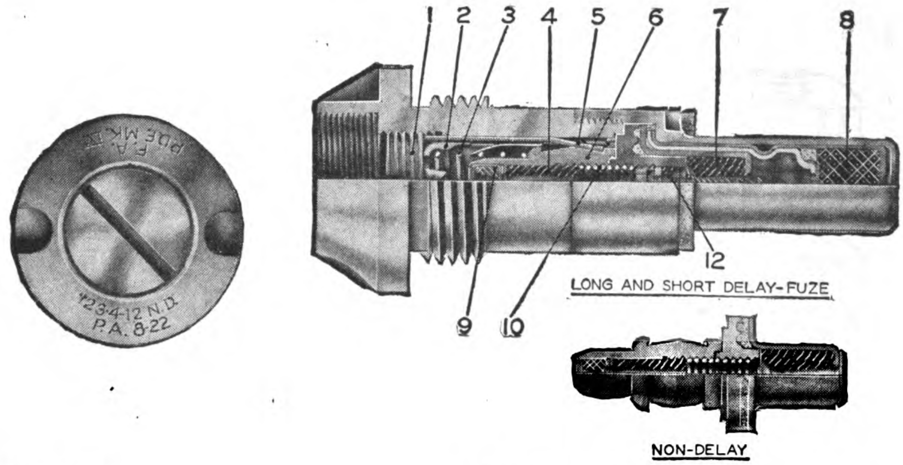

1. Percussion plunger.
2. Firing pin.
3. Restraining spring.
4. Percussion primer.
5. Detonator.
6. Booster charge.

FIGURE 77.—Base detonating fuze Mk. V (medium caliber).



1. Firing pin assembly.
2. Firing pin support.
3. Head.
4. Detonator assembly.
5. Detonator retaining screw.
6. Body.
7. Interrupter spring.
8. Interrupter.
9. Lower detonator socket.
10. Lower detonator assembly.
11. Flash hole.

FIGURE 78.—Point detonating fuze M46.




1. Firing pin.
2. Arming casing.
3. Arming spring.
4. Black-powder pellet.
5. Safety casing.
6. Percussion plunger.
7. Relay powder.
8. Detonator.
9. Percussion primer.
10. Retard spring.
12. Delay pellet.

FIGURE 79.—Point detonating fuze Mk. IV and Mk. IV-star.

held in place by a creep spring until impact. In the second case, the centrifugal force developed by the rotation of the projectile causes two side locking bolts to withdraw into recesses against the action of their springs. Upon impact the primer plunger moves forward.

*Q.* Name the fuzes used in the projectiles in your battery. *A.*——— fuze. (See ammunition chart at end of this section.)

**49. Misfires.**—*Q.* What are the two causes of misfire? *A.*

(1) Failure of the primer to fire.

(2) Failure of the powder charge to ignite.

*Q.* What precautions should be observed when the piece fails to fire? *A.*

(1) At least three attempts should be made to fire the primer.

(2) Wait 2 minutes after the last attempt before removing the primer. To remove the primer use a stick or rod, with a net and hook or eye, which will eject the primer or, in the case of the 155-mm gun, unscrew the firing mechanism. The stick should be long enough to permit the operator to stand clear of the breech while he removes the primer.

(3) If the primer *has not* been fired, no further delay is necessary. Insert a new primer and continue the firing.

(4) If the primer *has* fired, keep all persons away from in rear of the breech; train the gun on the target or on a safe point in the field of fire; wait 10 minutes before opening the breech.

## AMMUNITION CHART

*For matériel manned by coast artillery*

| Gun | Projectile | | | | Fuze | | Primer[1] | | Powder charge | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kind | Type | Model | Weight | Model | Kind | Kind | Size | Kind | Weight[2] |
| 3-inch seacoast gun M1902, M1903. | Shell | HE | 1915 | *Lb.* 15 | Mk. V | B. D | Percussion | *Grains* 300 | Fixed | *Lb.* 5 |
| | do | HE | Mk. I | 15 | M1907M | 21-second combination. | do | 300 | do | 5 |
| Subcaliber .30 | Bullet | | | *Grains* 174 | | | | | do | *Grains* 35 |
| 3-inch AA gun M1917, M1918, M1925, M1, M2, M3, M4. | Shrapnel | | Mk. I | *Lb.* 15 | Mk. III A1 | 21-second time | do | 300 | do | *Lb.* 5 |
| | do | | Mk. I | 15 | Mk. III A1 | do | do | 300 | do | *Lb. Oz.* 4 10 |
| | Shell | HE | Mk. IX | 12.7 | Mk. III A1 | do | do | 300 | do | 4 14 |
| | do | HE | M42 | 12.73 | Mk. III A2 | do | do | 300 | do | 4 14 |
| | do | HE | M42 | 12.92 | M43 | Mechanical-time. | do | 300 | do | 4 14 |
| 105-mm AA gun M3 | do | HE | M38 A1 | 32.85 | M43 | do | do | 300 | do | *Lb.* 11 |
| | do | HE | M38 | 32.85 | M2 | do | do | 300 | do | 11 |
| 6-inch seacoast gun M1897MI, M1900, M1903, M1905, M1908, M1908MI, M1908MII. | do | HE | Mk II | 90.3 | Mk. IV-star | P. D | Electric | | Separate-loading | *Lb.* 26; 29 |
| | do | AP | 1911 | 108 | Mk. V | B. D | do | | do | 29; 32 |
| | Shot | AP | 1911 | 108 | Mk. V | B. D | do | | do | 29; 32 |
| Subcaliber 1.457-inch gun | Shell | | | 1.057 | | | Ignition | 20 | Fixed | *Grains* 1,110 |

## AMMUNITION CHART

*For matériel manned by coast artillery*—Continued

| Gun | Projectile | | | | Fuze | | Primer [1] | | Powder charge | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kind | Type | Model | Weight | Model | Kind | Kind | Size | Kind | Weight [2] |
| | | | | *Lb.* | | | | *Grains* | | *Lb.* |
| 155-mm gun (G. P. F.) M1918MI. | Shell | HE | Mk. III | 95 | M 47 or Mk. IV-star. | P. D | Percussion | 21 | Separate-loading | 26.2 |
| | do | HE | Mk. III | 95.38 | M46 | P. D | do | 21 | do | 26.2 |
| | Shrapnel | | Mk. I | 95 | M1907 | 45-second combination. | do | 21 | do | 26.2 |
| | Shell | Chemical | Mk. VII | 96.79 | M46 | P. D | do | 21 | do | 26.2 |
| | | | | | | | | | | *Grains* |
| Subcaliber 37-mm gun | do | LE | Mk. I | 1.097 | Mk. I | Base-percussion. | do | 20 | Fixed | 500 |
| | | | | | | | | | | *Lb. Oz.* |
| 8-inch seacoast gun M1888, M1888MI, M1888MII. | do | HE | Mk. I | 200 | M47 or Mk. IV-star. | P. D | Electric | | Separate-loading | 70 10 |
| | Shot | AP | 1911 | 323 | Mk. V | B. D | do | | do | 82 6 |
| | Shell | AP | 1911 | 323 | Mk. V | B. D | do | | do | 82 6 |
| | Projectile | AP | Navy | 260 | Mk. II | Tracer-detonator. | do | | do | 84 8 |
| | | | | | | | | | | *Grains* |
| Subcaliber 1.457-inch gun | Shell | | | 1.057 | | | Ignition | 20 | Fixed | 1,110 |
| 10-inch seacoast gun M1888, M1888MI, M1888MII, M1895, M1895MI, M1900. | do | HE | Mk. IV | 510 | M47; M46; or Mk. IV-star. | P. D | Electric | | Separate-loading | 160 |
| | do | AP | Mk. III | 617 | Mk. V | B. D | do | | do | 155; 176 |
| | Shot | AP | 1911 | 617 | Mk. V | B. D | do | | do | 155; 176 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subcaliber 1.457-inch gun | Shell | | | 1.057 | | | Ignition | 20 | Fixed | 1,110 |
| | | | | | | | | | | *Lb.* |
| 12-inch seacoast gun M1888, M1888MI, M1888MI½, M1888MII, M1895, M1895MI, M1900. | do | HE | Mk. VI | 700 | Mk. V | B. D | Electric | | Separate-loading | 220 |
| | do | HE | Mk. X | 712 | M47; M46; or Mk. IV-star. | P. D | do | | do | 220 |
| | do | AP | 1912A | 1,070 | Mk. X | B. D | do | | do | 295; 270 |
| | Shot | AP | 1913 | 1,070 | Mk. X | B. D | do | | do | 295; 270 |
| | Shell | AP | Mk. I | 900 | Mk. X | B. D | do | | do | 270 |
| | Projectile | AP | Mk. XVI | 975 | Mk. X | B. D | do | | do | 295; 270 |
| | do | AP | Navy | 870 | | | do | | do | 248 |
| | | | | | | | | | | *Grains* |
| Subcaliber 1.457-inch gun | Shell | | | 1.057 | | | Ignition | 20 | Fixed | 1,110 |
| | | | | | | | | | | *Lb.* |
| NOTE.—75-mm gun | do | | Mk. I | 12.18 | Mk. IV (inert) | P. D | Percussion | 100 | do | 1.72 |
| 12-inch mortar M1890, M1890MI, M1908, M1912. | do | HE | Mk. VI, VIII | 700 | Mk. V | B. D. | Electric | | Separate-loading | 63 |
| | do | HE | Mk. VIA | 692.2 | M47; M46; or Mk. IV-star. | P. D. | do | | do | 63 |
| | do | HE | Mk. XI | 712 | M47; M46; or Mk. IV-star. | P. D | do | | do | 63 |
| | do | DP | 1911A | 700 | Mk. X | B. D | do | | do | 63; 89 |
| | do | DP | 1898 | 824 | Mk. X | B. D | do | | do | 58 |
| | do | DP | 1898 | 1,046 | Mk. X | B. D | do | | do | 47;60 |
| | do | DP | Mk. XXVIII | 1,046 | Mk. X | B. D. | do | | do | 47; 60 |
| | | | | | | | | | | *Oz.* |
| Subcaliber 2.95-inch gun | Shot | Solid | | 18 | | | Ignition | 100 | Fixed | 4¼, 5, or 6 (3 zones). |
| | | | | | | | | | | *Lb.* |
| 14-inch seacoast gun M1907, M1907MI, M1909, M1910, M1910MI, M1920MI, M1920MII. | Projectile | HE | Mk. XIM2A1 | 1,208 | Mk. V | B. D | Combination | | Separate-loading | 480 |
| | do | AP | Mk. VI | 1,560 | Mk. X | B. D | Electric; combination. | | do | 332; 460 |
| | do | AP | Mk. VIIIM9A1 | 1,400 | Mk. X | B. D | do | | do | 332; 460 |
| | Shell | AP | 1909 | 1,660 | Mk. X | B. D | Electric | | do | 332; 435 |

AMMUNITION CHART

*For matériel manned by coast artillery*—Continued

| Gun | Projectile | | | | Fuze | | Primer [1] | | Powder charge | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kind | Type | Model | Weight | Model | Kind | Kind | Size | Kind | Weight [2] |
| | | | | *Lb.* | | | | *Grains* | | *Grains* |
| Subcaliber 1.457-inch gun | Shell | | | 1,057 | | | Ignition | 20 | Fixed | 1,110 |
| | | | | | | | | | | *Lb.* |
| Note.—75-mm gun | do | | Mk. I | 12.18 | Mk. IV (inert) | P. D | Percussion | 100 | do | 1.72 |
| 16-inch seacoast gun M1895, M1919. | Projectile | AP | Mk. V | 2,340 | Mk. X | B. D | Electric; combination. | | Separate-loading | 650; 832 |
| M1919MII, M1919MIII, | do | AP | Mk. II M2 | 2,100 | Mk. X | B. D | Combination | | do | 832 |
| Mk. II (Navy). | do | AP | Mk. IX | 2,340 | Mk. X | B. D | Electric; combination. | | do | 650; 832 |
| | | | | | | | | | | *Grains* |
| Subcaliber 1.457-inch gun | Shell | | | 1,057 | | | Ignition | 20 | Fixed | 1,110 |
| Note.—75-mm gun | do | | Mk. I | 12.18 | Mk. IV (inert) | P. D | Percussion | 100 | do | 1.72 |
| | | | | | | | | | | *Lb.* |
| 16-inch howitzer, 1920 | Projectile | AP | Mk. II M2 | 2,100 | Mk. X | B. D | Combination | | Separate-loading | 296 |
| Subcaliber 75-mm gun | Shell | | Mk. I | 12.18 | Mk. IV (inert) | P. D | Percussion | 100 | Fixed | 1.72 |

[1] On guns not equipped with the electric firing mechanism a friction primer is used. It is also used in emergency when the electric equipment fails.

[2] The weights given for propelling charges are approximate only, as the weights vary for different powder lots. The exact weight of each charge will be found on the tag attached to it.

Note.—75-mm gun, subcaliber for:
- 12-inch barbette carriage M1917.
- 14-inch railway carriage M1920.
- 16-inch barbette carriage M1919.

## Section II

## TRANSPORTING, HANDLING, AND STORING AMMUNITION



**50. Transporting ammunition.**—*Q*. What regulations govern the handling of ammunition? *A*. TM 4-205, TM 9-2900, AR 30-995, AR 30-1270, AR 700-10, and such local regulations as may be prescribed; for example, many localities require a special placard or flag to be displayed on a vehicle transporting ammunition.

*Q*. Where may detailed regulations prescribing the transportation of explosives be obtained? *A*. From the Interstate Commerce Commission through The Quartermaster General or the Chief of Ordnance. These regulations permit the Government to prescribe their own shipping regulations, marking, packing, and storing, but the War Department regulations comply in general with the Interstate Commerce Commission regulations.

*Q*. How are the necessary labels obtained? *A*. On requisition through The Quartermaster General.

*Q*. What responsibilities must the shipping officer assume? *A*. That all regulations are complied with. In case of fire or accident the shipping officer is responsible.

*Q*. May explosives be carried as a deck load on Army transports? *A*. No.

*Q*. When transporting explosives by truck what procedure shall be followed? *A*.

(1) Comply with local and all Army Regulations.

(2) Contact local authorities and select safe routes.

(3) Take every precaution against fire.

*Q*. What precautions must be taken against fire? *A*.

(1) Inspect trucks daily; particularly wiring, lights, brakes, and gasoline tanks and lines.

(2) Keep vehicle and engine clean.

(3) Permit no smoking.

(4) Keep safety matches in a metal container in tool box.

(5) Provide each truck with a sand box, 3 cubic feet, and a shovel.

(6) Instruct all drivers in fire fighting. Ammunition requires considerable heat before it will explode, and a fire, if discovered in time, can usually be put out with safety.

(7) Do not transport detonating agents with other explosives.

(8) Lay boards over all iron parts of the truck.

(9) See that load is well braced and stayed and is covered with a tarpaulin to prevent fire by sparks.

*Q*. When ammunition is being transported by convoy what precautions should be taken? *A*.

(1) Keep a safe distance between trucks to avoid danger of collision.

(2) Stop once each hour and inspect the load.

(3) Do not stop in populous areas.

(4) Permit no unauthorized riders.

(5) If a truck breaks down transfer its load to another truck. Do not attempt to tow.

(6) In case of fire all other vehicles will proceed to a safe distance and guards will be posted at a safe distance from the fire to ward off other traffic.

*Q*. How is artillery ammunition packed in a truck for transportation? *A*. Laid on its side parallel to the sides of the truck. If more than one layer is to be placed in the truck, strips of planking should be laid to protect the rotating bands.

**51. Handling ammunition.**—*Q*. Under whose supervision should ammunition be handled? *A*. Under a competent person who understands thoroughly the hazards and risks involved.

*Q*. Name some hazardous explosives. *A*. Detonators, bulk explosives, and smokeless powder.

*Q*. What precautions should be observed by personnel engaged in handling explosives? *A*. No metal tools of any kind should be used by any personnel engaged in handling explosives. Extreme care should be taken to insure that such personnel do not have on or about their persons any metal tools, nails, matches, cartridges, firearms, or similar material and that their shoes are not shod with iron nails or other metallic substances which are liable to cause a spark. Only shoes which have soles of felt or soft leather should be worn.

*Q*. In case explosives are spilled from a container what should be done? *A*. All work must be stopped until the explosives have been swept up and the area has been neutralized.

*Q*. Where may damaged containers be repaired? *A*. In the open or in a building especially provided for this purpose, at least 100 feet from the magazine, boat, or truck containing ammunition.

**52. Storing ammunition.**—*Q*. If ammunition must be stored outside, is it necessary to protect it from the sun? *A*. Yes. It must be covered to protect it from the direct rays of the sun. However, air must circulate freely through the pile.

*Q.* What ammunition may be stored in a battery storeroom? *A.* The small quantity of small-arms ammunition required for current use.

*Q.* Where may small-arms ammunition be stored? *A.* In any magazine or warehouse which offers good protection against the weather.

*Q.* Where must all other ammunition be stored? *A.* In special magazines such as described in Technical Manuals.

*Q.* How is ammunition segregated in storage? *A.* Ammunition is placed in neat, stable piles by lot number and is raised off the floor on 2-inch battens.

*Q.* How high may ammunition be piled? *A.* This depends on the strength of the container, but piles should not exceed the height of the eaves in magazines.

*Q.* What does an acid odor in a powder magazine indicate? *A.* Danger—powder is decomposing.

*Q.* What testing instruments are placed in powder and ammunition magazines? *A.*

(1) Maximum and minimum thermometer.
(2) Hygrometer.
(3) Litmus paper.

*Q.* How is air circulation provided in ammunition storage? *A.* By dunnage or by cleats on the boxes.

*Q.* In case of doubt as to the condition of ammunition in storage who is notified? *A.* The local ordnance officer.

CHAPTER 9

# DEFINITIONS



SECTION I

## ELEMENTARY DEFINITIONS FOR SEACOAST ARTILLERY



**53. Definitions.**

*Adjustment of fire.*—The process of determining and applying corrections to the firing data to bring the center of impact to the adjusting point and to keep it there.

*Aerial observation.*—Observation of fire from aircraft.

*Aiming point.*—The point on which the gun pointer sights when pointing the gun.

*Altitude.*—The vertical distance above or below a specified datum level, usually sea level at mean low water. It is sometimes called height of site.

*Angle of departure.*—The vertical angle between the line from the gun to the target and the axis of the bore when the projectile leaves the muzzle.

*Angle of elevation.*—The vertical angle between the line from the gun to the target and the axis of the bore when the piece is pointed in elevation.

*Angle of jump.*—The angle between the line of departure and the line of elevation. Its component in the vertical plane is called the vertical jump and its component in the horizontal plane is called the lateral jump.

*Axial observation.*—Observation of fire from a point on or near the gun-target line. Observation is said to be axial when the observing angle is 5° or less.

*Axis of the bore.*—The center line of the bore of the cannon.

*Axis of trunnions.*—The axis about which a cannon is rotated in elevation.

*Azimuth.*—The horizontal angle, measured in a clockwise direction, from a selected reference line (usually grid south) passing through the position of the observer, to the horizontal projection of the line of sight from the observer to the objective.

*Azimuth difference.*—The difference, due to displacement, between the azimuths of a point as measured from two other points; or the angle subtended at the point in question by a line connecting the two other points. It is also called parallax.

*Backlash.*—The lost motion or play in a mechanical system.

*Base line.*—A line of known length and direction between two observation stations or two spotting stations, the position of which with respect to the battery are known.

*Battery manning table.*—A table containing a list of names detailing the personnel of a battery to their posts.

*Battle chart.*—A chart used in a group or a higher command station, showing the water area covered by the armament of that command.

*Bilateral observation.*—Observation of fire from two observation stations.

*Cant.*—The angle made with the horizontal by the axis of the trunnions.

*Center of dispersion.*—*See* Dispersion.

*Center of impact.*—The point whose deviation is the mean of the deviations of the several shots of a series.

*Conduct of fire.*—The employment of technical means to place accurate fire on a target. Fire is usually conducted by the battery which is the normal fire unit.

*Corrected azimuth.*—The azimuth from the directing point to the target corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

*Corrected deflection.*—The deflection corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

*Corrected elevation.*—The firing table elevation corresponding to the corrected range.

*Corrected range.*—The range corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

*Datum level.*—A spherical surface which represents mean sea level or other specified reference level from which altitudes are measured.

*Datum point.*—A fixed point, the azimuth and range of which have been accurately determined from one or more observation stations or other positions.

*Deflection.*—The horizontal angle between the line of sight to the target and the axis of the bore when the piece is pointed in direction.

It is usually expressed in reference numbers and is set on the sight. The deflection due to travel alone is called the uncorrected deflection.

*Deviation.*—The distance of a point of impact or center of impact from the center of the target. If a set of axes is drawn through the target, the *Y* axis being along the gun-target line and the *X* axis perpendicular to the *Y* axis, then the *Y* coordinate of the point of impact is called the longitudinal (or range) deviation and the *X* coordinate is called the lateral deviation. The shortest distance from the center of the target to the point of impact is called the absolute deviation.

*Direct pointing.*—Pointing a gun in direction or in both range and direction by means of a sight directed at the target.

*Directing point.*—The point in or near a battery for which the firing data are computed. If a gun of the battery is the directing point, it is called the base piece or directing gun.

*Dispersion.*—The scattering of shots fired with the same data. The area over which the shots are scattered is called the zone of dispersion. The center of that area is called the center of dispersion.

*Displacement.*—The displacement of one point from another is the distance between these points. Gun displacement is the horizontal distance in yards from the pintle center of the gun to the directing point or directing gun of the battery.

*Drift.*—The divergence of a projectile, due to its rotation and the resistance of the air, from the vertical plane containing the line of departure. It may be expressed in either linear or angular units.

NOTE.—The drift listed in firing tables includes lateral jump.

*Elevation.*—*See* Angle of elevation; Quadrant elevation.

*Elevation difference.*—The angular units of quadrant elevation corresponding to a particular gun difference for a particular range.

*Elevation table.*—A table of ranges with corresponding quadrant elevations, used in graduating, and in checking the graduations of, the range disk of a fixed cannon. The quadrant elevations listed are firing table elevations corrected for height of site.

*Field of fire.*—That portion of the terrain or water area covered by the fire of a gun or battery.

*Fire control.*—The exercise of fire direction and conduct of fire.

*Fire-control installation.*—The equipment which is employed in the fire control of any unit.

*Fire direction.*—The exercise of the tactical command of one or more units in the selection of objectives and in the concentration or distribution of fire thereon at the appropriate times.

*Fire discipline.*—The efficiency of the personnel in action which involves accuracy and alertness resulting from organization, drill, and coordinated effort.

*Fire for effect.*—Any fire conducted against a hostile target.

*Firing azimuth.*—The azimuth at which the gun is pointed for firing.

*Firing data.*—All data necessary for firing a gun at a given objective.

*Firing elevation.*—The firing table elevation corresponding to the firing range.

*Firing range.*—The range at which the gun is pointed for firing.

*Firing tables.*—A collection of data, chiefly in tabular form, intended to furnish the ballistic information necessary for conducting the fire of a particular model of cannon with specified ammunition.

*Fixed armament.*—Seacoast artillery weapons that are emplaced in permanent firing positions.

*Flank observation.*—Observation of fire from a point where the observing angle is greater than 75°.

*Fuze.*—A device attached to a projectile which controls the time of burst of the projectile.

*Gun difference.*—The difference, due to displacement, between the range from a gun to the target and the range from the directing point to the target.

*Gun displacement.*—*See* Displacement.

*Gun parallax.*—The azimuth difference between the line from the directing point to the target and the line from the gun to the target.

*Gunner's quadrant.*—An instrument used on the quadrant seat of a gun to measure the vertical angle between the axis of the bore and the horizontal.

*Gunnery.*—The practice of firing guns. It includes a study of the flight of the projectile and of the technical considerations involved in the conduct of fire.

*Height of site.*—*See* Altitude.

*High-angle fire.*—Fire delivered at quadrant elevations greater than the elevation corresponding to the maximum range. In high-angle fire the range decreases as the quadrant elevation is increased.

*Horizontal base system.*—A system of position finding in which the target is located from two observation stations.

*Indirect fire.*—Fire conducted with indirect pointing.

*Indirect pointing.*—Pointing a gun in direction by the use of a sight and an aiming point other than the target or by the azimuth circle on the carriage, and in elevation by range drum or quadrant.

*Jump.*—*See* Angle of jump.

*Lateral deviation.*—*See* Deviation.

*Lateral jump.*—*See* Angle of jump.

*Leveling.*—The process of adjusting the gun and mount or an instrument so that all vertical or horizontal angles will be measured in true vertical or horizontal planes.

*Line of departure.*—The prolongation of the axis of the bore as the projectile leaves the muzzle of the gun. It is the tangent to the trajectory at the origin.

*Line of elevation.*—The prolongation of the axis of the bore when the gun is pointed.

*Line of position.*—The line of position (line of site) of a point is the straight line connecting the origin with that point. The point of origin is usually a gun or a position-finding instrument.

*Line of sight.*—The line of vision; the optical axis of an observation instrument.

*Line of site.*—*See* Line of position.

*Longitudinal deviation.*—*See* Deviation.

*Low-angle fire.*—Fire delivered at quadrant elevations at and below the elevation corresponding to the maximum range.

*Maximum ordinate.*—The difference in altitude between the gun and the highest point of the trajectory.

*Meteorological datum plane.*—The plane assumed as a basis or starting point for the data furnished to the artillery concerning atmospheric conditions. Its altitude is that of the meteorological station.

*Meteorological message.*—A coded message containing the data, relative to atmospheric conditions, which are required by artillery units.

*Mobile armament.*—Weapons that may be moved to and emplaced in temporary firing positions. In seacoast artillery this class consists of railway, truck-drawn, and tractor-drawn artillery.

*Muzzle velocity.*—The velocity of a projectile at the muzzle. It is also called the initial velocity.

*Normal of a scale.*—The reference number that represents a true setting of zero.

*Observing angle.*—The angle between the observing line and the gun-target line.

*Observing line.*—The line joining the observer and the observing point.

*Observing point.*—The point on which the observer sights.

*Orientation.*—(1) The determination of the horizontal and vertical location of points and the establishment of orienting lines.

(2) The adjustment of the azimuth circle of a gun or of an instrument to read correct azimuths.

*Orienting line.*—A line of known direction over one point of which it is possible to place an angle measuring instrument.

*Parallax.*—*See* Azimuth difference.

*Pintle center.*—The vertical axis about which a gun and its carriage are traversed.

*Point of impact.*—The point where the projectile first strikes the ground or other material object.

*Position finding.*—The process of determining the position of a target with relation to the battery and the determination of a future position upon which to direct the fire.

*Predicted point.*—The point at which it is expected the target will arrive at the end of the dead time.

*Predicting.*—The process of determining the expected position of the target at some future time.

*Predicting interval.*—The interval between successive predictions of future positions of the target.

*Primary armament.*—Seacoast artillery weapons of 12-inch or greater caliber, and submarine mines.

*Probable error.*—The error which is as likely as not to be exceeded. A value which will in the long run be exceeded half the time and not exceeded half the time.

*Quadrant elevation.*—The vertical angle between the horizontal and the axis of the bore when the gun is pointed in elevation.

*Range.*—The horizontal distance from the gun, observation station, or directing point of a battery to the target, splash, datum point, or other specified point.

*Range deviation.*—*See* Deviation.

*Range difference.*—The difference, due to displacement, between the ranges from any two points to a third point.

*Relocation.*—The process of determining the range and the azimuth from one station to the target (or other point) when the range and the azimuth from another station to the target (or other point) are known.

*Round.*—All of the component parts of ammunition necessary in the firing of one shot.

*Salvo.*—One shot per gun, fired simultaneously or in a certain order with a specified time interval between rounds.

*Seacoast artillery.*—All artillery weapons used primarily for fire upon hostile naval vessels. It includes both fixed and mobile armament.

*Secondary armament.*—Seacoast artillery weapons of less than 12-inch caliber.

*Self-contained base system.*—A system of position finding in which the target is located in azimuth and range from a single station using a self-contained range finder.

*Self-contained range finder.*—An instrument used to obtain ranges by either the stereoscopic or the coincidence principle.

*Sense.*—The direction of a point of impact (or center of impact of a salvo) with respect to the target, that is, over or short, right or left.

*Set-forward point.*—A point on the expected course of the target at which it is predicted the target will arrive at the end of the time of flight.

*Sight.*—A device by which the gun pointer gives the gun the proper direction for firing. It is also called a telescope.

*Sound ranging.*—The process of locating a target by means of the sounds emitted.

*Spotting.*—The process of determining the position of a point of impact or burst with respect to the adjusting point.

*Subareas.*—Subdivisions of the water area in the field of fire, used to assist in the indication, identification, and assignment of targets.

*Time interval.*—The interval of time between two successive observations made on a moving target during continuous tracking.

*Time of flight.*—The elapsed time from the instant a projectile leaves the muzzle to the instant of impact or to the instant of burst.

*Trajectory.*—The curve described by the center of gravity of the projectile in flight.

*Trial shots.*—Shots fired at a fixed point or target during trial fire.

*Uncorrected deflection.*—*See* Deflection.

*Unilateral observation.*—Observation from a station so located that the angle battery-target-station is between 5° and 75°.

*Vertical base system.*—A system of position finding for moving targets which uses only one observation station equipped with a depression position finder.

*Vertical jump.*—*See* Angle of jump.

*Zone.*—When used with reference to mortar fire or to fire from guns or howitzers using more than one size powder charge, it refers to the area in which projectiles will fall when one particular size powder charge is used and the elevation is varied from the minimum to the maximum.

*Zone of dispersion.*—*See* Dispersion.

## Section II

## PARTICULAR DEFINITIONS PERTAINING TO AMMUNITION SUPPLY



**54. General.**

*Credit.*—An allocation of a definite quantity of supplies which is placed at the disposal of the commander of an organization for a prescribed period of time.

*Distributing point.*—A place, other than a depot or railhead, where supplies are issued to regiments and smaller units. Distributing points are designated by the class of supplies therein, and by the identity of the unit establishing them; such as "Class I distributing point, 1st division," or "Ammunition distributing point, 1st Infantry."

*Dump.*—A temporary stockage of supplies established by a corps, division, or smaller unit. When supplies are ordered issued from dumps, the latter become distributing points. Dumps are designated by the identity of the unit establishing them and by the class of supplies therein, such as "1st infantry ammunition dump" or "1st division class I supply dump."

*Railhead.*—A supply point on a railroad where loads are transferred from rail transportation to some other type of transportation. Railheads are designated in the same manner as distributing points; for example, "Class I railhead, 1st division," or "Ammunition railhead, 1st and 2d divisions."

*Requisitions.*—Requests for supplies, normally submitted on the prescribed form, to a higher commander. When approved by the higher commander, a requisition becomes an order for issue of supplies by the proper supply agency to the supply officer of the unit which submitted the requisition.

*Shipping ticket.*—A form which accompanies a shipment of supplies to a supply officer and which he must sign and return to the shipping officer to accomplish transfer of accountability.

*Supply point.*—A general term used to include depots, railheads, dumps, and distributing points.

*Train.*—That portion of a unit's transportation, including personnel, operating under the immediate orders of the unit commander primarily for supply, evacuation, and maintenance. It is designated by the name of the unit; such as "1st infantry train."

**55. Ammunition.**

*Ammunition train.*—Transportation and personnel of the battalion organized to supply ammunition to the batteries and to carry a reserve supply of ammunition.

*Periodic ammunition (expenditure) reports.*—Reports of the expenditure of ammunition by the unit concerned, normally covering the 24-hour period immediately preceding the time of rendition of the report. These ammunition reports are the basis for the establishment of additional ammunition credits for the unit concerned.

*Unit of fire (formerly called "day of fire").*—The quantity in rounds or tons of ammunition, bombs, grenades, and pyrotechnics which a designated organization or weapon may be expected to expend on the average in one day of combat.

## SECTION III

## PARTICULAR DEFINITIONS PERTAINING TO SUPPLIES AND SUPPLY FUNCTIONS



**56. Supplies.**

*Automatic supply.*—A process of supply under which deliveries of specific kinds and quantities of supplies are moved in accordance with a predetermined schedule.

*Classes of supplies.*—There are five classes of supplies:

*Class I.*—A class of supplies consisting of those articles which are consumed at an approximately uniform daily rate irrespective of combat operations or terrain, and which do not necessitate special adaptation to meet individual requirements; such as rations and forage.

*Class II.*—A class of supplies consisting of those authorized articles for which allowances are established by Tables of Basic Allowances; such as clothing, gas masks, arms, trucks, radio sets, tools, and instruments.

*Class III.*—A class of supplies consisting of engine fuels and lubricants, including gasoline for all vehicles and aircraft, Diesel oil, fuel oil, and coal.

*Class IV.*—A class of supplies consisting of those articles which are not covered in Tables of Basic Allowances and the demands for which are directly related to the operations contemplated or in progress (except for articles in classes III and V); such as fortification materials, construction materials, and machinery.

*Class V.*—A class of supplies consisting of ammunition, pyrotechnics, antitank mines, and chemicals.

*Daily automatic supply.*—Supplies are dispatched daily to an organization or installation.

*Forage.*—Food for animals. To collect supplies for men and animals.

*Issue.*—A delivery of supplies. Specifically, the delivery of supplies of any kind by a supply department to responsible persons authorized to receive them on behalf of their organizations. Also the supplies so delivered.

*Memorandum receipt.*—A receipt given to a supply officer by a person drawing supplies from him, or a receipt given by the supply officer to a person returning supplies to him.

*Railhead distribution.*—Issue of class I supplies to regimental (or similar unit) transportation at the railhead.

*Ration.*—The prescribed allowance of the different articles of food for the subsistence of one person or one animal for one day.

CHAPTER 10

# MOTOR TRANSPORTATION



SECTION I

## NOMENCLATURE OF MAJOR PARTS OF MOTOR VEHICLES



**57. Major parts of motor vehicles.**—*Q.* Into what general groups may the parts of any motor vehicle be divided? *A.* Power plant, transmission system, control system, chassis, running gear, and body.

*Q.* Point out the principal parts of the power plant to include the crankcase, cylinders, valves, and various parts pertaining to fuel, carburetion, ignition, lubrication, and cooling systems. *A.* (Practical demonstration.)

*Q.* Point out the principal parts of the transmission system to include the clutch, transmission, driveshaft, universal joints, differential, torque arms, and axles. *A.* (Practical demonstration.)

*Q.* Point out the principal parts of the control system, chassis, and running gear to include—frame, springs, brake drums, brake rods, wheels, steering knuckle, drag link arm, emergency, and foot brakes. *A.* (Practical demonstration.)

*Q.* Why are instruments installed on the dash? *A.* For the purpose of indicating and controlling the operation of the engine and vehicle.

*Q.* What instruments are usually installed? *A.* Ammeter, oil pressure gage, speedometer, thermometer (engine temperature), choke, light switch, hand throttle, spark control, and ignition switch.

*Q.* What does the ammeter indicate? *A.* The amount of current that is being consumed by the ignition and light system of the vehicle

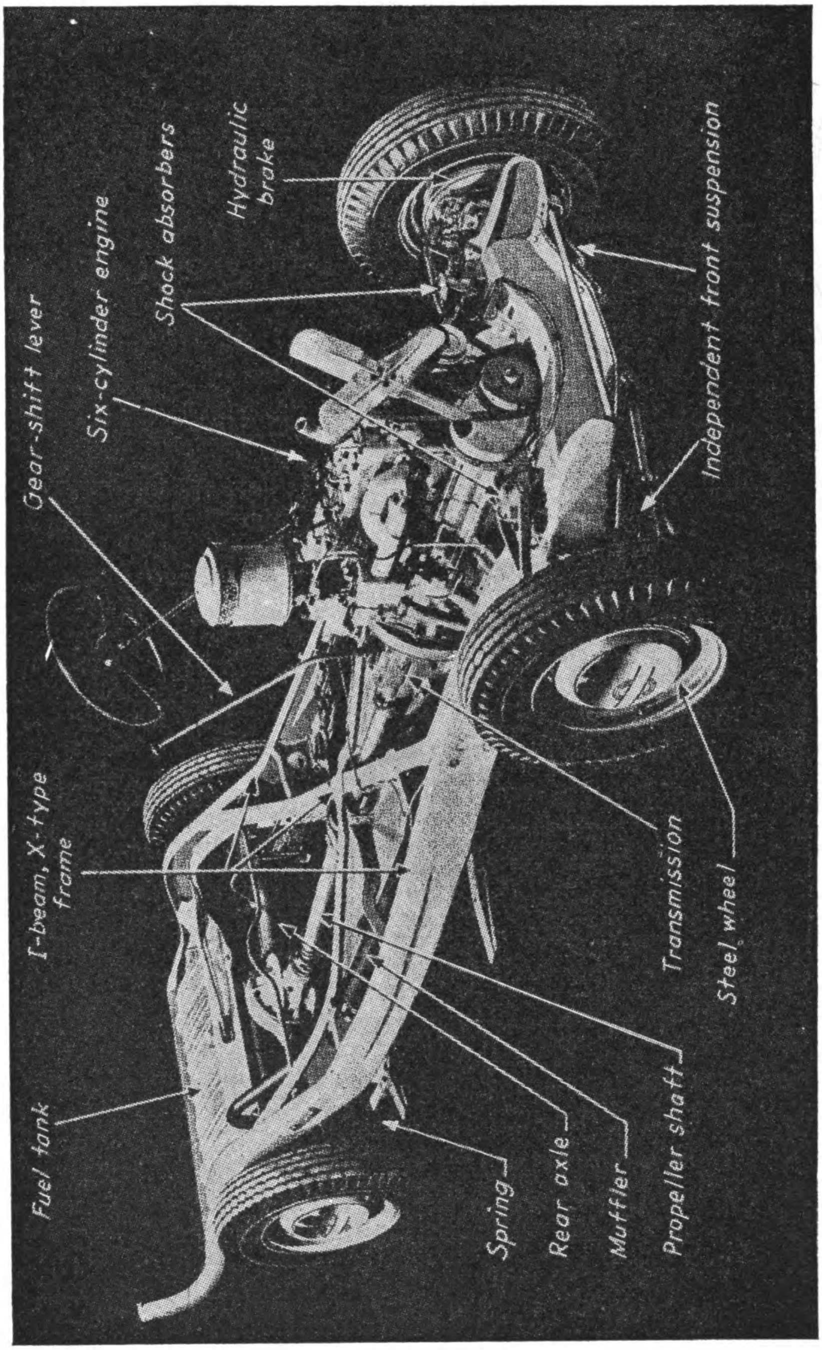



FIGURE 80.—Typical gasoline engine-driven passenger car chassis showing various parts.

from the battery, or the amount of current that the generator is supplying to the battery.

*Q.* What does the oil gage indicate? *A.* Oil pressure only. The quantity of oil is indicated by the dip stick. Lack of oil or oil pressure is very serious.

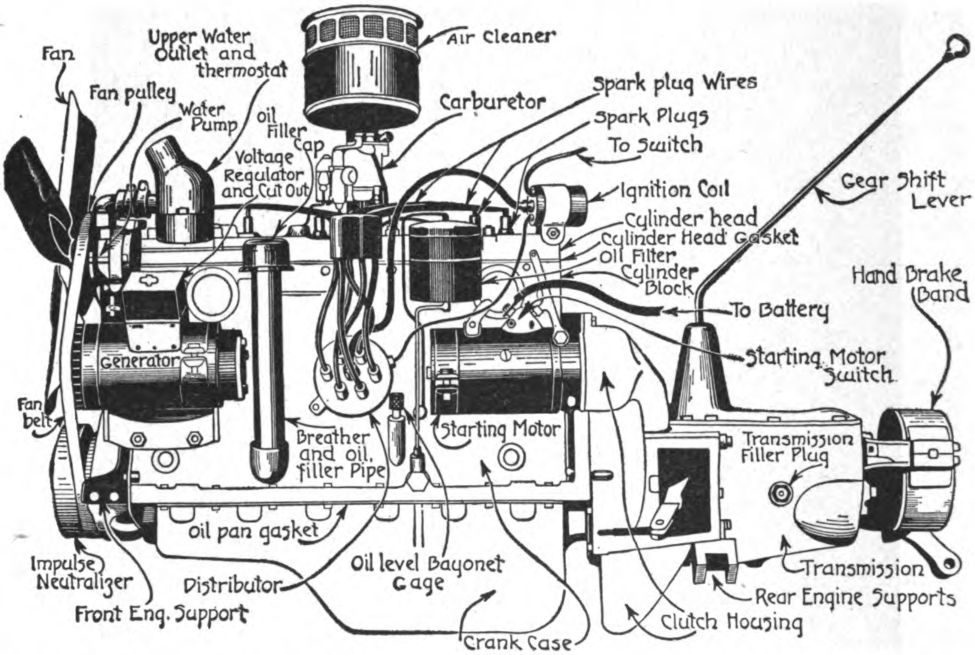



FIGURE 81.—Typical engine and transmission assembly showing external parts, equipment, and accessories.

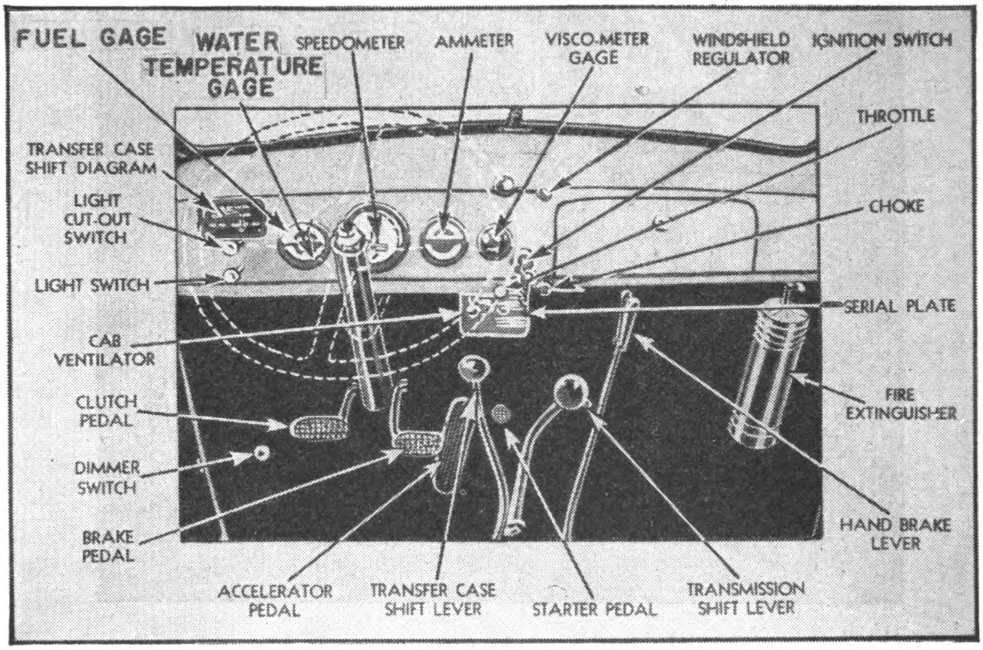



FIGURE 82.—Interior view of truck cab showing instruments and controls.

*Q.* Does the oil pressure gage indicate that the engine is being lubricated? *A.* No; it only indicates that the pump is forcing oil some place at the pressure indicated by the gage.

## Section II

## PRACTICAL OPERATION OF MOTOR VEHICLES



**58. General.**—*Q.* What are the qualifications for a good driver? *A.* Good physical condition and common sense.

*Q.* Define common sense in connection with driving? *A.* Alertness, judgment, and caution on the road. A good driver will obey all traffic regulations and carry out the rules of good maintenance driving. He will respect the rights of other drivers and of pedestrians.

*Q.* Mention the most important rules to be observed on the road. *A.*

(1) Have vehicle under control at all times.

(2) Never exceed prescribed speed limits nor the speed limit of your vehicle.

(3) Keep a safe distance in rear of a vehicle in front so you can stop if that vehicle stops suddenly.

(4) Keep on the right side of the road.

(5) Do not try to pass a car parked or moving on your side of the road if a car is approaching from the opposite direction except when operating on a road having three or more lanes.

(6) Do not try to pass a car on a hill or curve unless you can see the road far enough ahead to assure yourself that no car is coming in the opposite direction.

(7) Sound the horn before passing a car going in the same direction.

(8) Give proper hand signal before stopping or turning.

(9) Go slowly on sharp curves.

(10) Do not pass street cars taking on or discharging passengers except where safety zones are provided.

(11) Slow down when roads are slippery.

*Q.* List a few rules whose observance will help to prevent accidents. *A.*

(1) Obey all traffic regulations and special instructions. This includes using the proper hand and horn signals.

(2) Never depend on what the other operator or pedestrian may do.

(3) Never operate a vehicle with faulty brakes, steering mechanisms, or lights.

*Q.* What precaution is taken before stopping or turning a corner? *A.* Signal to drivers of other vehicles by extending his arm in the proper signal. Before turning corners or sharp curves, slow down, sound the horn, and be prepared to stop to avoid collisions with other cars which may be hidden from view. The same precautions are taken at street intersections or crossroads which are not clearly visible for some distance in each direction.

*Q*. What precaution should be observed when filling the radiator when engine is very hot? *A*. The engine should be stopped and allowed to cool off before adding water. If time will not allow this, let the engine run while water is added slowly (preferably warm water).

*Q*. What precautions should the driver take against fire? *A*.

(1) Never refuel while engine is running.

(2) Be careful not to let the fuel tank overflow as hot exhaust pipe and manifold can readily ignite the fuel.

(3) Keep old oily rags, waste, and papers from under the seat.

(4) Keep engine clean.

(5) Do not smoke while driving or on the vehicle.

*Q*. What should be done in case a vehicle catches fire? *A*. If the vehicle is inside a building, push it out if possible. Use the fire extinguisher that is carried on every government vehicle, playing it directly on source of fire. Do not use water on a gasoline or oil fire: it only tends to spread it. If the fire extinguisher is not sufficient to extinguish the fire, use dirt, sand, or mud; in some cases it can be smothered by using such articles of clothing as may be available. If fire should break out in the load of the vehicle, remove load until the source of the fire can be reached.

*Q*. What precautions are necessary in cold weather? *A*.

(1) Protect the water in the radiator from freezing.

(2) Watch condition of battery, as it does more work and is less efficient in cold weather.

(3) Use chains or tractioneers when necessary.

(4) Keep off soft or partially frozen ground.

*Q*. How should radiator be protected in cold weather? *A*. Unless filled with antifreeze solution, the radiator and water jackets should be completely drained, when the vehicle is not in use, and a "drain" sign hung on the radiator. Sometimes it will be necessary to protect the lower front-half of the radiator with tin or cardboard, or canvas.

*Q*. What data are usually found on the dash plate? *A*. Make and model of vehicle, maximum speed, tonnage that the vehicle was designed to carry, engine number, serial number, and date of manufacture.

*Q*. How should a vehicle be loaded? *A*. The load should be distributed equally, fore and aft, and to the right and left, of the center of gravity of the vehicle. Heavy items are placed on the bottom of the load. It should be systematically loaded to facilitate delivery. Any load beyond the capacity of the vehicle should be refused. The load should be properly secured by lashing or some other means. Red flags or lanterns must be attached to all loads protruding beyond the truck body.

*Q*. How can the driver tell if the vehicle is overloaded? *A*. By noting the set of the springs. The candidate will be required to—

(1) Start the engine of a truck, tractor, or car.
(2) Start in first gear, shift into second and third gears.
(3) Shift back into second gear.
(4) Stop the vehicle.
(5) Shift into reverse gear, and back the vehicle; and
(6) Shift into neutral and stop engine.

**59. Trucks.**—*Q*. What inspections are required to be made by the driver before leaving and after returning to the garage? *A*.

(1) Oil level in crankcase.
(2) Water in radiator.
(3) Gasoline supply.
(4) Condition of tires and battery.
(5) Inspection for leaks in cooling and oiling systems.
(6) Mechanical condition of vehicle, especially brakes, steering, lights, and horn. Any faults and unusual noise observed during operation should be reported to dispatcher immediately.

*Q*. Give several common faults in driving which are damaging to the vehicle? *A*.

(1) Racing the engine at any time.
(2) Inadequate use of the gears.
(3) Excessive or improper appliance of the brakes.
(4) Riding, slipping, or quickly engaging the clutch.
(5) Turning front wheel, while standing.
(6) Excessive use of the choke.
(7) Excessive speed in first or second gears.
(8) Continuing to drive with minor maladjustments.

*Q*. What is the proper way of applying the foot or service brake? *A*. It must be applied, except in case of emergency, with evenly increasing pressure; as the vehicle comes to a stop the pressure should be progressively reduced to give a smooth stop. Sudden stops are hard on the vehicle and on the brakes and may cause rear end collisions.

*Q*. How should air brakes be applied? *A*. The best possible stop will be made when the brakes are applied at the very start as hard as the speed and condition of the road will permit, and then eased off as the speed is reduced, so that at the end of the stop but little pressure remains in the brake chambers. In easing the brakes off, do not "fan" the brake valve, repeatedly releasing and applying the brakes, as this wastes air pressure.

*Q.* What inspection of air brakes should be made before starting the vehicle? *A.* Observe the air pressure gage, showing the pressure stored in the reservoir. It must read 40 pounds or over before the air brakes can develop full effectiveness.

*Q.* What is the purpose of the hand brake? *A.* To hold the vehicle in a parked position. In emergency to relieve the foot brake. Caution must be exercised in applying the hand brake because if it is of the propeller shaft type a sudden application may strip the rear end gears and the vehicle will be out of control.

*Q.* What is the purpose of the choke? *A.* To restrict the air passage at the inlet of the carburetor, thereby giving a rich mixture for starting and warming up the engine.

*Q.* What is the proper use of the choke? *A.* To assist in starting when the engine is cold or the vehicle has been left idle for some time. Excessive use will flood the engine, making starting temporarily impossible and interfering with proper lubrication.

*Q.* What throttle setting should be used for starting? *A.* This depends upon the vehicle. Most carburetors are designed so that the proper setting for starting is determined by a throttle stop. By stepping on the accelerator a few times before starting the engine will be primed and the engine should start when the starter is engaged.

*Q.* What throttle setting should be used until the engine warms up? *A.* A setting corresponding to about 20 mph vehicle speed. The engine should not carry a load during this period.

*Q.* What is the proper use of the accelerator? *A.* The accelerator should be depressed slowly. Tramping on the accelerator floods the engine, wastes gasoline, and fouls the spark plugs.

*Q.* What precautions must be taken with the ignition switch? *A.* It must be left locked whenever the vehicle is parked to prevent damage to the coil and battery.

*Q.* How is the proper gear selected? *A.* A gear is selected that will allow the engine to run without lugging. If the engine cannot reach its governed speed, gears should be shifted. When descending grades a gear must be selected that will not force the engine to run faster than its governed speed.

*Q.* What damage might result from the improper selection of gears? *A.*

(1) Engine bearings might be damaged or cylinder head gasket blown.

(2) The driver might be forced to shift down two gears and thus delay the convoy.

(3) If on a down grade the truck might run away or the engine may turn up so fast that it will be damaged.

*Q*. What is the proper way to shift gears? *A*. Bring the engine to full governed speed in each gear as the shift is accomplished.

*Q*. Explain double-clutching and its purpose. *A*. Double-clutching is accomplished by engaging the clutch while the transmission hesitates in neutral when the gears are being shifted up or down, then

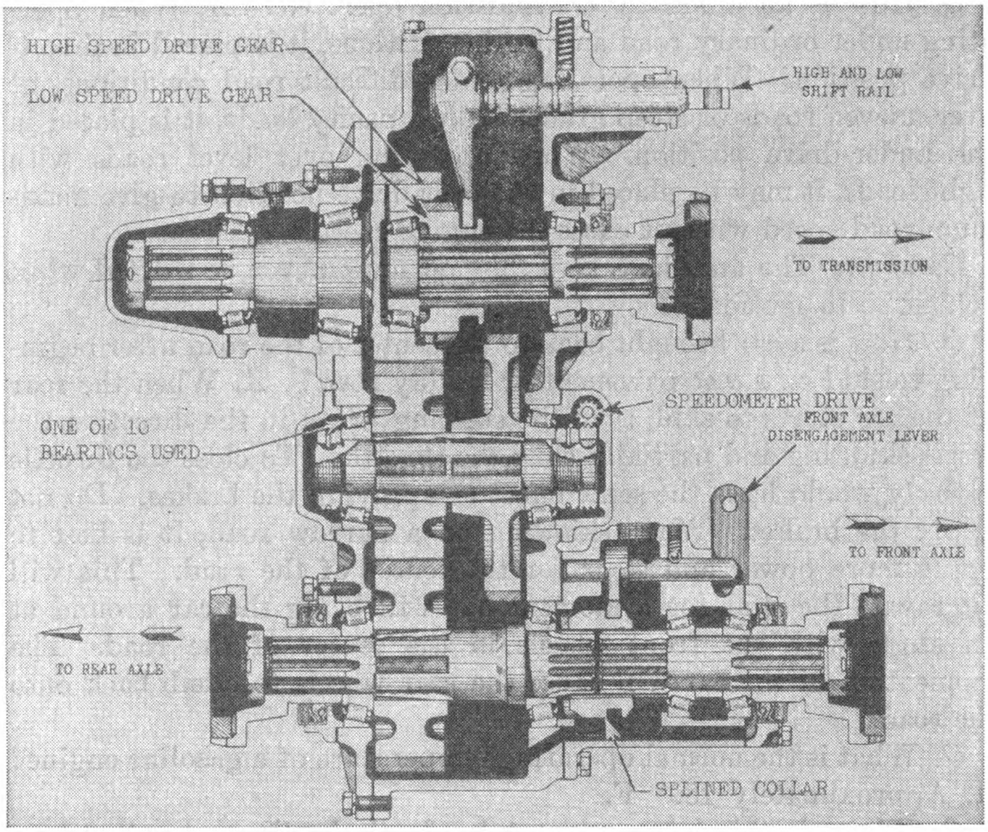



FIGURE 83.—Typical two-speed transfer case showing relation to driving and driven units and disengaging feature for front axle.

shifting to the next gear in the normal manner. During the hesitation period the foot is removed from the throttle if the shift is from a lower to a higher gear; if from a higher to a lower gear the engine is speeded up to the speed that it should be running in the lower gear selected. Double-clutching is useful in shifting from a lower to a higher gear on trucks that are hard to shift. It is useful in changing to a lower gear preparatory to descending a grade. Double-clutching has its limitations, and the driver must not wait until it is too late to shift. (All drivers should be required to shift from a higher to a lower gear without clashing gears.)

*Q.* Can front-wheel drive clutches be used while the vehicle is in motion? *A.* Yes. Levers must not be forced. In some instances the front wheels may have to be turned to allow shifting dogs to come into line. (Drivers of all vehicles should be required to master these special shifting devices.)

*Q.* What is an auxiliary transmission? *A.* An over-, under-, and direct-drive gearing used in conjunction with the transmission.

*Q.* How is an auxiliary transmission operated? *A.* When operating under ordinary road and load conditions, it is placed in direct-drive position. When operating under difficult road conditions, or over uneven roads or steep grades with capacity loads, it is placed in the under-drive position. When operating over level roads with light loads, it may be placed in the over-drive position to give maximum road speed without excessive engine speed.

***Caution:*** The auxiliary transmission must never be shifted while vehicle is in motion.

*Q.* How is a car brought back to the center of the road after beginning to skid on a wet pavement or muddy road? *A.* When the rear of the car starts to skid, turn the steering wheel in the direction the car is skidding and partially close the throttle. To close the throttle entirely would have the same effect as applying the brakes. Do not apply the brakes. When skidding on a narrow road, it is best to apply more power and steer for the center of the road. This will aggravate the skid for a moment but will bring the car around at an angle with the front wheels in the center of the road. The momentum of the car will cause the rear wheels to climb back onto the road.

*Q.* What is the normal operating temperature of a gasoline engine? *A.* Approximately 180° F.

*Q.* Where is this temperature taken? *A.* In the water that surrounds the cylinders and combustion chambers of the engine.

**60. Tractors.**—*Q.* How is the Diesel engine of the tractor started? *A.* It depends upon the make of the tractor. There are three general methods:

(1) The use of a small gasoline starting engine which is cranked by hand and this in turn cranks the Diesel engine.

(2) The employment of a compression release valve on the Diesel engine in conjunction with a supplementary ignition system which

starts the Diesel engine with gasoline, employing a conventional electric starter or hand crank.

(3) The employment of an electric starter of sufficient power to crank the Diesel engine directly.

*Q.* How is a tractor put into motion? *A.* With the engine running and the master clutch disengaged, select the gear to be used. When ready to start, move the master clutch forward slowly until the load is taken up and the tractor in motion, then push it forward firmly and without jerking. At the same time the clutch is pushed forward, open the throttle enough to keep the engine from stalling.

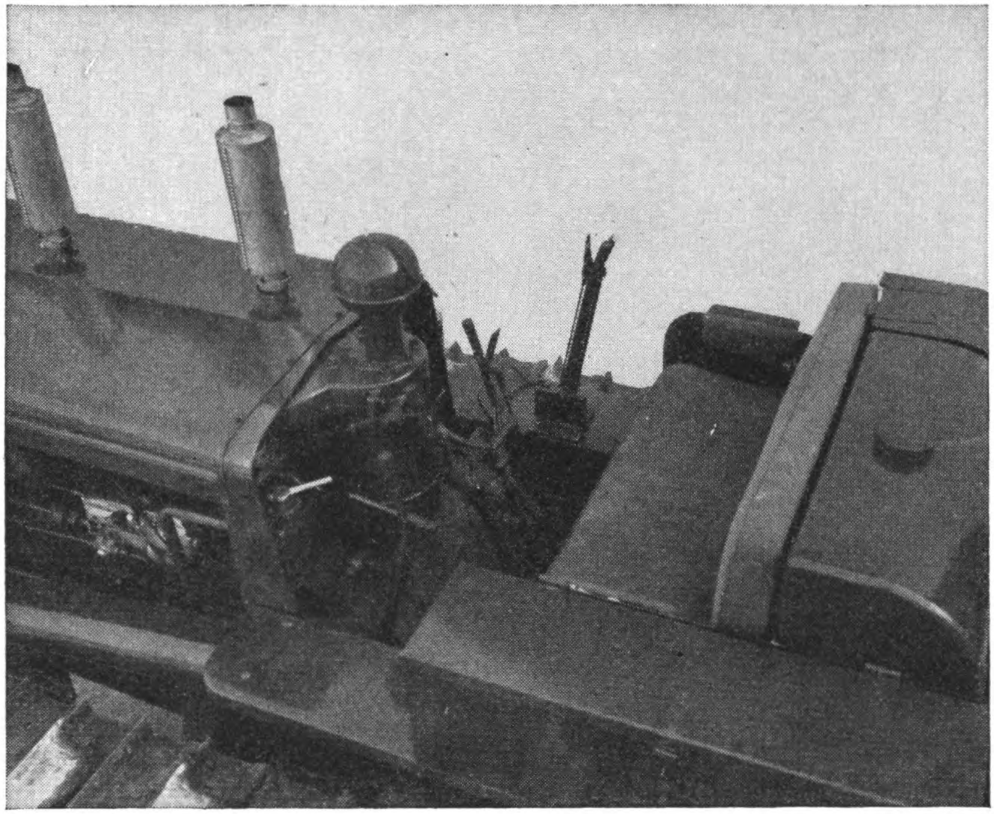


FIGURE 84.—10-ton artillery tractor, showing driver's compartment, dash, and controls.

*Q.* Should the gears be shifted while the tractor is in motion? *A.* No.

*Q.* How are tractors steered? *A.* By means of a steering-clutch hand lever. To turn the tractor to the right, the right end of the steering lever is pulled toward the driver. This disengages the steering clutch on the right side and that track will not pull, all the power being transferred to the left track. When a short turn is desired, there are two brake pedals that work in conjunction with the steering clutch. Pull the steering lever to the right, pushing on the right foot pedal. This brake stops the right-hand clutch from turning and the tractor will make a short turn.

*Q*. How is the tractor winch operated? *A*.

(1) With the tractor clutch released and the winch shifter lever disengaged the power take-off is engaged. Power is now available at the winch, but the drum does not turn since the shifter lever is disengaged. The tractor transmission does not have to be shifted to neutral unless it is desired to use the tractor as a deadman.

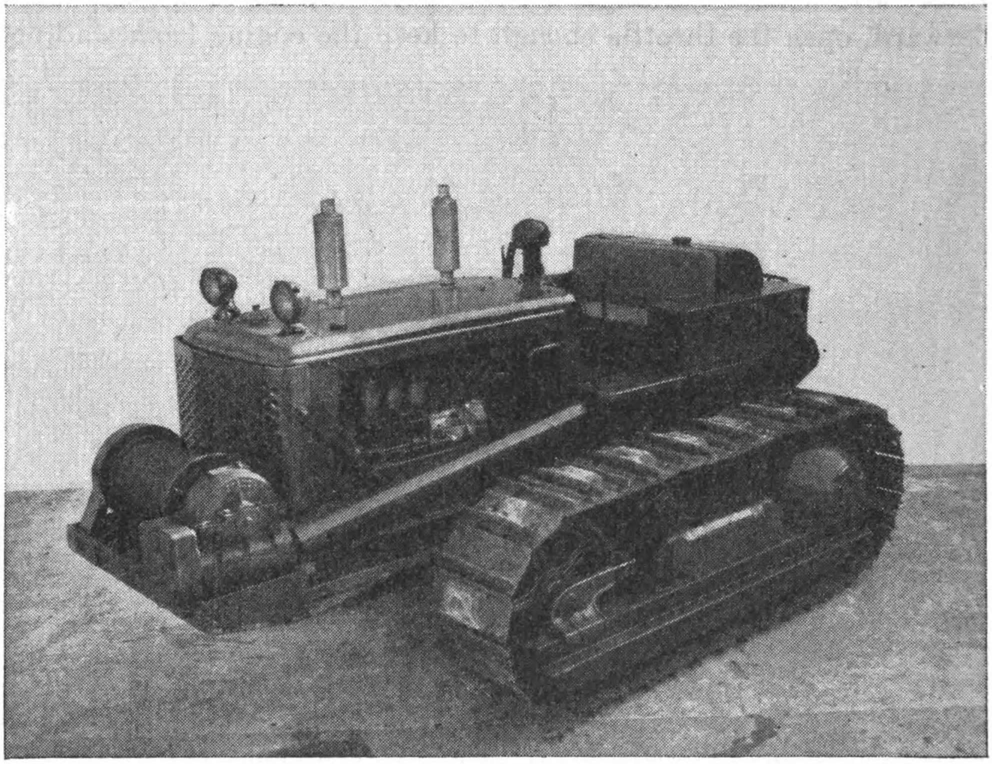


FIGURE 85.—10-ton artillery tractor, left side showing power take-off to winch.

(2) The cable may now be unreeled from the winch and attached to the load. The tractor may be maneuvered into any desired position meanwhile.

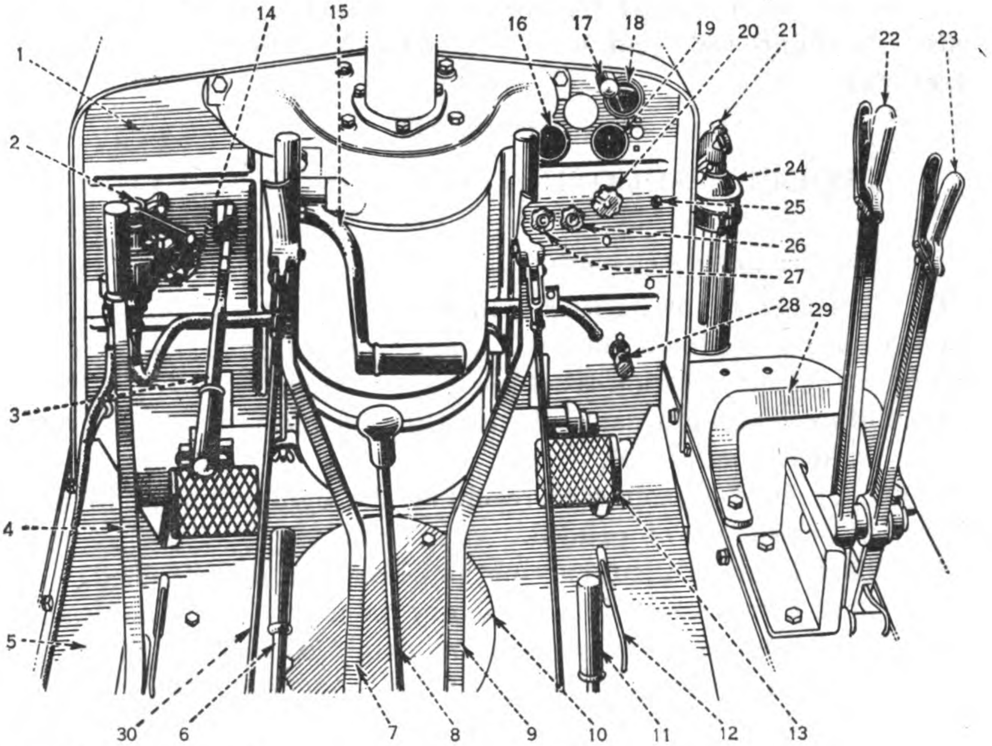
(3) The tractor clutch is released, and the winch shifter lever is engaged. The winch will now turn, or by using the tractor transmission a combination of towing and winching can be obtained. The winch has only one forward speed.

*Q*. What safety devices are incorporated into the winch? *A*.

(1) An automatic back off brake prevents the load from getting away should the power fail for any reason.

(2) On some models a sheer pin is included in the winch drive which prevents overloading.

*Q.* What precautions should be taken while using the winch? *A.* (1) Winching must proceed in a calm orderly manner. The senior present should decide what is to be done, issue orders, and assign tasks. The tendency on the part of others present to give advice should be prohibited.




1. Dash and cowl assembly.
2. Hand air brake valve (for trailer only).
3. Compression release lever.
4. Engine clutch lever.
5. Engine clutch cover.
6. Hi-lo shift lever.
7. Left steering clutch lever.
8. Gear shift lever.
9. Right steering clutch lever.
10. Engine clutch inspection cover.
11. Power take-off.
12. Ratchet brake lock.
13. Clutch brake.
14. Electric brake load control.
15. Engine speed control (throttle).
16. Air brake gage.
17. Dash lamp.
18. Oil gage.
19. Ammeter.
20. Lighting switch.
21. Fire extinguisher bracket.
22. Winch brake lever.
23. Winch shifter lever.
24. Fire extinguisher.
25. Ignition switch.
26. Primer button.
27. Choke button.
28. Starting switch.
29. Foot rest.
30. Trailer brake control.

FIGURE 86.—10-ton artillery tractor—controls and dash.

NOTE.—Unnumbered parts are the same as corresponding parts shown with numbers.

(2) The winch shifter lever should only be used for unreeling cable.

(3) The winch brake which is used to ease off loads should be used with caution.

(4) The operator should never dismount from his tractor leaving the power take-off engaged.

*Q.* What is the maximum speed of the 10-ton tractor? *A.* 8 mph. This speed cannot be maintained, however, and the average speed with load is 5 mph.

*Q.* Point out and state the purpose or function of the parts indicated in figure 86 (controls and dash). *A.* (Practical demonstration.)

## SECTION III

## TROUBLE SHOOTING AND MINOR REPAIRS



**61. Trouble shooting and minor repairs.**—*Q.* What is the most usual cause of engine trouble? *A.* Ignition. In the field, dirt and water in fuel run ignition trouble a close second.

*Q.* Before making a detailed investigation of engine trouble what tests should be made? *A.*

(1) That clean gasoline is reaching the cylinders. If in doubt the cylinders should be primed.

(2) That the spark is occurring and all wires are attached.

(3) That compression is satisfactory as tested with the crank.

(4) That ignition timing is approximately correct.

*Q.* How can a check be made that gasoline is reaching the cylinders? *A.* Disconnect the gasoline line at the carburetor, turn the engine over, and see if gasoline is pumped from the line.

*Q.* How can it be determined if a spark is occurring? *A.* Turn on ignition, remove one of the spark plug wires, and hold it by its insulation a short distance from the engine; turn the engine over and note if spark occurs.

*Q.* How can it be determined if ignition timing is approximately correct? *A.* Remove a spark plug but leave its wire attached and remove valve cover. Through spark plug hole note when piston is at top dead center and at the same time note when both valves are closed. Continue to turn engine over slowly and note when spark occurs. To be correct, spark should occur at or near top dead center with both valves closed.

*Q.* If the four basic tests are positive but the engine still refuses to start what may be the trouble? *A.*

(1) Engine flooded.

(2) Choke not working.

(3) Carburetor frozen.

(4) Engine too cold.

(5) Valve sticking open.
(6) Valve spring broken.
(7) Spark plugs dirty or with too wide a gap.
(8) Poor gasoline.
(9) Wiring out of order.
(10) Wet ignition system.
(11) Battery too weak.
(12) Throttle levers disconnected.
(13) Carburetor jet plugged.
(14) Condenser weak.
(15) Oil too heavy.
(16) Blocked muffler.

*Q.* What does light blue smoke from the muffler indicate? *A.* Burning of oil for some reason.

*Q.* What does steam from the exhaust indicate? *A.* A water leak due to a blown gasket or cracked engine.

*Q.* What does black smoke from the exhaust indicate? *A.* Too rich a mixture. Engine will be sluggish when this condition exists.

*Q.* How does the driver generally locate trouble? *A.* By inspections, generally during operation.

*Q.* What repair parts should the driver carry? *A.* Tape, wire, tire patching outfit, extra spark plug, and such extra parts as past experience has shown are liable to frequent failure.

*Q.* What should the driver do when his vehicle is being repaired? *A.* He should assist the mechanic and point out past troubles.

*Q.* Before performing any repairs what should be done? *A.* The motor vehicle instruction book should be consulted.

*Q.* What are indications of steering trouble? *A.*
(1) Play or rattle in a steering gear.
(2) Shimmy.
(3) Peculiar or rapid tire wear.
(4) Hard steering.

*Q.* What does backfiring indicate? *A.*
(1) A lean mixture.
(2) Carburetor or fuel trouble.
(3) Overheating of engine.
(4) Stuck valves.
(5) Retarded spark.

*Q.* Name some clutch troubles which should be reported? *A.* Slipping, grabbing, noisy clutch, clutch that will not release.

*Q.* When do brakes need adjustment or repair? *A.* When they will not stop the vehicle within 30 feet from 20 mph on a dry, smooth, level road.

*Q*. When should repairs be made to a vehicle? *A*. As soon as they can be done competently.

*Q*. What is needed to find trouble on a motor vehicle? *A*. A set of testing equipment such as is furnished for the use of each battery.

*Q*. Name some repairs and adjustments that a tractor operator is forbidden to make. *A*.

(1) Timing adjustments of any kind.

(2) Removal or adjustment of injectors.

(3) Clutch adjustments.

*Q*. Why must the injectors, fuel pumps, and fuel lines on a Diesel engine be repaired only by ordnance personnel? *A*. The fuel is metered under very high pressure (over 1,200 pounds per square inch), and any maladjustment of the fuel system will cause serious trouble.

## Section IV

## DUTIES OF DRIVER IN CARE, SERVICE, REPAIR, AND MAINTENANCE OF MOTOR VEHICLES



**62. Trucks.**—*Q*. What defines the duties of the driver? *A*. FM 25-10, Technical Manuals of the 10-series, AR 850-15, Circulars 1-10, OQMG, and the motor vehicle manual issued with each vehicle.

*Q*. How are drivers selected? *A*. On the basis of their standing in an examination on the course of instruction laid down in FM 25-10.

*Q*. What are the responsibilities of the driver? *A*.

(1) Operation and maintenance of motor vehicles in accordance with instructions.

(2) Care and condition of vehicles, tools, and equipment.

(3) Loads and loading.

(4) Reports and records.

*Q*. With what should the driver be thoroughly familiar? *A*.

(1) Fire precautions and fire fighting methods.

(2) Accident prevention.

(3) Purpose of the major units of the motor vehicle.

(4) Motor vehicle controls.

(5) Inspections.

(6) Maintenance.

(7) That part of the motor vehicle manual that pertains to the driver.

*Q.* What may be used to fight a gasoline fire? *A.* Sand or a special extinguisher of the foam, $CO_2$, or carbon tetrachloride type. *Never use water.*

*Q.* How is the vehicle fire extinguisher used? *A.* By removing it from its bracket, unlocking it, and pumping. The stream of liquid must be directed at the top or to the windward side of the flame since the liquid releases a gas which is heavier than air. ***Caution:*** This gas is harmful to breathe.

*Q.* Where are motor vehicle keys kept when the vehicle is in the garage? *A.* They are kept in the vehicles or on a plainly marked board nearby so that vehicles may be moved quickly in case of fire.

*Q.* May the driver remove gasoline from his fuel tank? *A.* No. The regulations forbid the use of gasoline for cleaning purposes. Gasoline for all authorized purposes may be obtained on a regular issue slip.

*Q.* For what accidents are drivers responsible? *A.* All accidents that occur to their vehicles while in motion, when parked in an unauthorized place, or when being worked on by themselves.

*Q.* Define first echelon maintenance. *A.* First echelon maintenance includes all the maintenance functions required to be performed by the driver and his assistant, using only the tools and spare parts on his truck. It is divided into three parts: inspection, preventive maintenance, and repairs.

*Q.* What inspections are required to be made by the driver? *A.*

(1) *During operation.*—(*a*) Note abnormal readings of dash gages.

(*b*) Note unusual engine sounds.

(2) *At the halt.*—(*a*) Check for fuel, oil, and water leaks.

(*b*) Check tires, tracks, and traction devices.

(*c*) Check for overheating of mechanical units such as brake bands, transmission, etc.

(*d*) Check lights, horn, windshield wiper, etc.

(*e*) Inspect cargo.

(3) *After operation.*—(*a*) Check all items noted in (2) above.

(*b*) Check for loose parts or linkages.

(*c*) Check tools and equipment.

(4) Report results of inspection in each case to the truckmaster.

*Q.* For what type of maintenance is the driver responsible? *A.* Scheduled, operating, and precautionary maintenance.

*Q.* What is scheduled maintenance? *A.* Cleaning, lubrication (except when done by a service department), tire care, battery care (except when done by a battery expert), minor repairs, checking of fuel, air, oil, antifreeze, and water.

*Q.* What constitutes operating maintenance? *A.* Loading, speed, proper use of controls, emergency repairs.

*Q.* What constitutes precautionary maintenance? *A.* Minor repairs performed as the result of inspections.

*Q.* What repairs and adjustments may the driver make? *A.* Except for repairing tires and emergency roadside repairs the driver is not permitted to make any repairs or adjustments except under the supervision of the truckmaster.

*Q.* What maintenance must be performed by the driver on an air-brake system? *A.* Drain the reservoir, daily in cold weather and weekly in warm weather, by opening the drain cock on the bottom. This allows any water collected in the reservoir to run out. *Be sure to close the drain cock after the water has been removed.*

*Q.* How is the proper spark setting determined? *A.* If the engine runs with full power without knocking, the spark setting is satisfactory.

*Q.* What care must be taken of the clutch? *A.*

(1) The clutch must not be slipped; gears should be used instead.

(2) When the clutch needs adjustment a prompt report should be made to the motor sergeant.

(3) The clutch must not be let out suddenly, or damage to the whole vehicle will result.

(4) The clutch must be properly lubricated but must not be over-lubricated or it will slip.

*Q.* What general precautions should be taken by the driver when working on his vehicle? *A.*

(1) He should not start the engine unless the controls are in neutral.

(2) When working under a truck, he should not depend upon jacks. The vehicle should be firmly blocked.

(3) To lessen the danger of fire he should remove the battery in case of doubt or major repair.

(4) He should work in a well-ventilated place.

*Q.* How does the driver get needed repairs done to his vehicle? *A.* He turns in a bad order report to his truckmaster. The report may be either written or oral.

*Q.* What records must the driver keep? *A.* Accident report, trip ticket, bad order report, and in some cases an issue slip and vehicle log. These records are kept as directed by the truckmaster.

*Q.* What kind of oil should be added to the crankcase? *A.* The kind recommended in the instruction manual accompanying the vehicle.

**63. Tractors.**—*Q.* What type of tractor is furnished tractor-drawn artillery? *A.* 10-ton heavy-duty Diesel tractors. Some units have their tractors supplemented with heavy-duty 6 by 6 trucks so that more speed may be attained.

*Q.* Where may instructions for the care and operation of tractors be found? *A.* In the instruction manual that is issued with each tractor.

*Q.* What is the most important thing to be observed in the operation of Diesel tractors? *A.* That the correct grades of clean lubricating and fuel oil are used. The clearances of these engines are very small and dirt will cause disaster.

*Q.* Who is responsible for the proper lubrication of the tractor? *A.* The operator under supervision of ordnance personnel. Complete special lubrication equipment is furnished with each tractor because lubrication is required daily.

*Q.* Should the tractor trucks be lubricated? *A.* No. Lubricant forms a grinding compound with dust and sand, which will wear the tracks out. The track pins are glass hard and highly polished and are thus self-lubricating.

*Q.* Should Diesel engine lubricating oil be used in the air cleaner? *A.* No. It may foam and cause trouble.

*Q.* What type of clutch is used in the new tractors? *A.* The multiple disk dry plate type. Care must be taken that no lubricant seeps onto the plates, or slipping and chattering will result.

*Q.* Who is responsible for the mechanical maintenance of the tractor? *A.* The Ordnance Department. This does not relieve the operator of responsibility, and the service obtained from it depends upon his care in its operation and maintenance. When no ordnance personnel is available the regulations prescribe that quartermaster personnel will aid in repairing tractors.

*Q.* What does the hour meter on the tractor indicate? *A* It converts the number of revolutions of the crankshaft into hours of use at normal rates. This is an aid in servicing the tractor.

*Q.* What happens during the Diesel intake and compression strokes? *A.* A charge of air is drawn or forced into the cylinder and highly compressed.

*Q.* What happens during the power stroke? *A.* Fuel is injected into the highly compressed air. The air is very hot because of the high compression and this causes the fuel to burn which expands the mixture and forces the piston down.

*Q*. What happens on the exhaust stroke? *A*. The hot gases are released into the exhaust manifold. In some Diesel motors the intake and compression strokes are combined and the power and exhaust strokes are combined. Such a motor is known as a two-cycle motor.

*Q*. Name five conditions of operation when special precautions must be taken to protect tractors. *A*.

(1) On hard-surfaced roads.

(2) In water or mud.

(3) In sand.

(4) In dusty localities.

(5) In cold weather.

*Q*. When operating on hard-surfaced roads what precautions must be taken? *A*. The grouser cover plates must be firmly attached and the speed must be held down so that the track shoes do not slap the road too hard. The track should be tightened slightly.

*Q*. When operating in mud or water what special precautions should be observed? *A*. Track rollers should be lubricated every 5 hours. Lubricant in the gear boxes should be inspected frequently; if water is found to be present the lubricant should be changed. Vent holes in the clutch housings should be plugged in accordance with the manufacturer's instructions.

*Q*. When operating tractors in dusty places what precautions must be taken to protect them? *A*. The air cleaner should be serviced every 5 hours in accordance with manufacturer's instructions. Since the Diesel engine is easily harmed by small amounts of dust, frequent inspections of the air cleaner, air manifold, and all its connections and gaskets must be made by the operator. The precautions taken for sand and water must also be taken for dusty conditions.

*Q*. When operating tractors in cold weather what precautions must be taken? *A*.

(1) The proper grades of lubricants and fuel must be used.

(2) To insure easy starting the engine must be kept in the best possible mechanical condition.

(3) To prevent condensation the fuel tank must be filled at the end of each day's work.

(4) Before starting, check the crankcase pan, fuel pump, and fuel lines for ice.

(5) If the temperature is below 0° F., the warm oil should be drained from the crankcase at the end of each day's run. It should

be heated and replaced in the morning just before starting the motor.

(6) Follow the manufacturer's instructions concerning draining the radiator and engine block and concerning the use of an antifreeze. Alcohol cannot ordinarily be used as an antifreeze in Diesel motors because of their high operating temperatures.

(7) Follow the manufacturer's instructions for cold weather use of the crank, starter, or starting engine.

(8) Check to see whether the tracks have frozen to the ground. If so, they must be broken loose before starting the tractor. If stopped on wet snow when the temperature is near the freezing point the weight of the tractor may cause it to freeze to the ground.

## Section V

## CONVOY AND MARCH RULES AND DISCIPLINE



**64. Convoy and march rules and discipline.**—*Q.* What is a convoy? *A.* A group of two or more military motor vehicles moving as a unit under competent military authority.

*Q.* What is the purpose of a convoy? *A.* The efficient transportation of personnel and matériel especially with respect to time required and condition upon arrival.

*Q.* What is the assigned minimum distance for trucks in convoy? *A.*

(1) Open formation: 100 yards.

(2) Closed formation: twice the speedometer reading in yards.

(3) At halt: 2 yards.

(4) Between sections: 3 to 5 minutes driving time.

*Q.* Describe drivers' arm signals. *A.*

(1) *Turn right.*—Extend the left arm outward at an angle of 45° above the horizontal.

(2) *Turn left.*—Extend the left arm outward horizontally.

(3) *Slow or stop.*—Extend the left arm outward to an angle of 45° below the horizontal.

(4) *Pass and keep going.*—Extend the left arm horizontally and describe small circles toward the front with the hand.

*Q.* What should the driver do if he has any trouble when the convoy is on the march? *A.* If it is a major trouble he should pull to the side of the road and signal the following vehicle to pass. He should then report his trouble to the maintenance officer, who is at the rear of the convoy. If left behind, the driver will remain with his truck as a guard. If it is a minor trouble, he will report it to the section mechanic or maintenance officer at the next halt.

*Q*. What should the driver do during halts of a convoy? *A*.

(1) He should make the inspections prescribed.

(2) He should keep to the right of his vehicle.

*Q*. What are the duties of the assistant driver during a convoy? *A*.

(1) He assists the driver in backing, parking, etc.

(2) He watches to the rear.

(3) He takes his turn at driving.

(4) He assists in first echelon maintenance.

*Q*. How is gasoline obtained on convoy? *A*.

(1) In an emergency, from 10-gallon cans carried with the convoy.

(2) At halts, from tankers or some type of filling station.

*Q*. Describe the commands and signals commonly used in a motorized unit. *A*.

(1) *Start engine*.—Simulate cranking.

(2) *Ready to start*.—Senior in truck stands on running board, faces leader, and extends arm vertically, fingers extended and joined, palm toward the leader.

(3) *Stop engines*.—Cross arms in front of body at the waist and then move them sharply to the side. Repeat several times.

(4) *Increase speed*.—Carry closed fist to the shoulder and rapidly thrust it vertically upward several times to the full extent of the arm.

(5) *Close up*.—Extend the arms horizontally straight to the front, palms in. Move the hands together and then resume the first position. Repeat several times.

(6) *Open up*.—Extend the arms horizontally straight to the front, palms out. Move the hands outward and then resume the first position. Repeat several times.

(7) *Danger*.—Use three long blasts of a whistle or automobile horn repeated several times or three equally spaced shots with a rifle or pistol. The person giving the signal points in the direction of impending danger. This signal is reserved for warning of air or mechanized attack, or other immediate and grave danger. Other signals may be found in FM 25-10.

*Q*. What are the driver's principal duties during a convoy? *A*.

(1) Attention to orders and to his driving.

(2) Constant inspection before, during, and after operation.

## SECTION VI

## HANDLING OF TRUCKS AND TRACTORS UNDER ADVERSE CONDITIONS



**65. General.**—*Q*. What equipment is furnished each truck and tractor to handle it under adverse conditions? *A*. One tool set (complete with tools) and pioneer equipment motor vehicle set No. 1. This set consists of a shovel, pickmattock, an ax, and a bracket to carry them with. One set of chains and in some cases traction devices are also furnished.

*Q*. What other equipment is available? *A*. The maintenance section has a block and tackle set, a wrecking set, towbars, and rope. Tractors and gun trucks are equipped with power-driven winches, and all vehicles are equipped with towhooks and pintles.

*Q*. In case your vehicle gets stalled, what should be done? *A*. Investigate the reason for the stalling and, if possible, take the necessary steps to get out of the position. If a wrecker is needed, await the wrecker.

*Q*. What four abilities must a motor vehicle have to get out of or keep going in a difficult situation? *A*.

(1) *Power*.—All new trucks issued to the service have enough power.

(2) *Momentum*.—This depends on the speed of the vehicle. In some cases too much speed causes the vehicle to lose part of its traction, resulting in spinning of the wheels. If this occurs the vehicle may become badly stalled.

(3) *Traction*.—All of the multiwheel vehicles are designed to give great traction.

(4) *Flotation*.—This is the ability of the vehicle to ride the ground surface.

*Q*. How should a difficult hill be negotiated? *A*. On approaching, a sufficiently low gear should be selected to negotiate the hill, and maximum practicable momentum should be obtained. If in column do not start up the hill until the truck ahead has negotiated it. In case of failure, back down in gear. ***Caution:*** Check to see if brakes hold before shifting to reverse gear, and take steps to enable the truck to climb the grade; for example, lower gear, use of traction devices, or tow from a tractor.

*Q*. What is a prolonge? *A*. It is a rope with a hook or loop on one end used to maneuver a vehicle by manpower. Prolonges are usually used in pairs.

*Q*. How should very steep, dangerous slopes be descended? *A*. Straight down, with all personnel except the driver dismounted. Gears should be used, and if brakes are also needed care must be exercised to prevent locking of the wheels. The ignition should not be turned off. Outside assistance may be needed; for example, block and tackle, winch, or prolonges.

*Q*. What is the best way to negotiate mud? *A*.

(1) Maintain momentum.

(2) Use highest gear possible.

(3) Apply power gently to prevent wheel slippage.

(4) Use traction devices.

(5) Use care in selecting track.

*Q*. In case a vehicle becomes stalled in mud what should be done? *A*.

(1) If loaded with personnel, have them dismount and push. Sometimes backing up and selecting another way out will solve the problem.

(2) Use a tow. ***Caution:*** Because of the danger of slipping under the vehicle, personnel should be cautioned against pushing on the side of a moving vehicle that has slipped into a ditch or old wheel ruts.

*Q*. In case of operating alone what is done if the vehicle becomes stalled? *A*.

(1) Traction may be improved by means of wheel mats, brush, or boards.

(2) The truck may be dug out.

(3) If the vehicle has dual wheels a rope may be used between the wheels; the truck will wind the rope up like a windlass.

(4) A pole may be inserted between the wheels that are slipping. This method is very effective on track-laying vehicles.

*Q*. How is sand negotiated? *A*.

(1) By the use of traction devices.

(2) By using the same track.

(3) By making roads from chicken wire or brush.

*Q*. In case skidding occurs what should be done. *A*. The accelerator should be released gradually and the front wheels turned in the same direction that the rear wheels are skidding. Where necessary, prolonges may be used to prevent skidding in very slippery places.

*Q*. How are shallow streams forded? *A*. Slowly in a low gear.

*Q*. What precautions should be observed in crossing bridges? *A*.

(1) The speed and load signs should be observed.

(2) When the capacity of the bridge is not sufficient, the towed load can be pulled across separately.

(3) Track-laying vehicles should be started across so that they do not have to turn.

(4) Brakes should not be used.

*Q.* When towing over difficult terrain what precautions must be taken? *A.* If possible, apply the brakes on the tow before applying those of the vehicle. Most vehicles designed for towing now provide means to do this.

*Q.* If a turn is too sharp for a towed load what may be done? *A.* The tow may be uncoupled and negotiated around the bend with winch or block and tackle.

*Q.* In case a vehicle overturns what is done? *A.* Remove the load and await a maintenance crew with block and tackle and wrecking set.

*Q.* What is the best way to keep a vehicle from becoming stalled or mired? *A.* Follow a reconnoitered route and make a careful inspection of all doubtful places before attempting to negotiate them.

**66. Trucks.**—*Q.* In applying chains what precautions must be taken? *A.* They must be adjusted properly. In the case of all-wheel drive vehicles they must be placed on all wheels, or broken axles will result.

*Q.* How is a narrow ditch crossed? *A.*

(1) Small ditches, less than the diameter of the tire, or wider shallow ditches should be crossed at an angle. Since this puts a strain on the vehicle the load should be lightened if possible, and personnel should assist at the critical point.

(2) Wide ditches must be filled or bridged before crossing. They are crossed at right angles.

**67. Tractors.**—*Q.* How is the tractor steered going down grade when the load is pushing the tractor? *A.* The operation of the steering clutches and brakes is reversed. Example: To turn to the right, release the steering clutch on the left but do not apply the brake; this allows the left track to travel faster, being pushed by the load, while the right track is held back by the engine. Caution must be exercised not to jackknife the tractor and load. Jackknifing may be prevented by judicious use of the gun brakes.

*Q.* What is the proper way to drive a tractor over an obstruction such as a log? *A.* As the tractor climbs the obstruction, ease up on both steering clutches in such a way as to balance the tractor on the crest of the obstruction. Then engage one clutch slightly ahead of the other so as to move forward at an angle. If the tractor is being operated without a load it may be necessary to use the brakes. After the load has cleared the obstruction, turn and proceed in the original direction.

## SECTION VII

## OPERATION OF VEHICLE NOT IN CONVOY



**68. Operation of vehicle not in convoy.**—*Q*. When a driver is to make a trip not in convoy, what orders does he receive? *A*. He receives a properly filled out "Driver's trip ticket and performance record," plus such verbal instructions as may be necessary.

*Q*. What is the purpose of a "special order" directing a driver to complete a certain trip? *A*. In peacetime, the driver of a vehicle not in convoy on an extended trip needs a special order so that he may obtain rations, supplies, fuel, ferriage, etc.

*Q*. How does the driver obtain rations on a trip not in convoy? *A*. He may take rations in kind, ration with some other organization, or be furnished cash in advance in lieu of rations.

*Q*. How does the driver obtain spare parts or get his vehicle repaired? *A*. If possible, at the nearest Army post; if not, he may have the work done by a local authorized dealer for the type of vehicle he is driving. To provide for the latter case he should be provided before starting with the proper forms showing the method of billing. The regimental transportation sergeant will instruct the driver as to the proper procedure.

*Q*. How are fuel and lubricants obtained by the individual driver? *A*. From Army posts enroute by simply signing issue slips. By the use of tax exemption certificates they may be obtained from private dealers. These certificates must be carried by the driver. In some cases courtesy cards are furnished by oil companies.

*Q*. In case of accident what does the driver do? *A*.

(1) Renders aid to any injured.

(2) If possible, he carefully fills out accident report and obtains names and addresses and statements from all available witnesses.

(3) Notifies local police.

*Q*. What should the driver do in case the person who ordered the vehicle cannot be found? *A*. He waits a reasonable time at the spot where he was told to report and then reports back to the dispatcher.

*Q*. Should the individual driver pass a moving convoy? *A*. Not unless ordered to do so by competent authority.

*Q*. How are locations found in the United States? *A*. By following marked routes with the aid of a road map.

*Q*. In case the driver feels sleepy what should he do? *A*. Pull to the side of the road and take a rest unless there is an assistant driver to take over.

# CHAPTER 11

# COMMUNICATION



## SECTION I

## USE AND CARE OF TELEPHONES



**69. Sending, receiving, and recording messages.**—*Q*. For the best results, where should the telephone transmitter be placed with respect to the mouth? *A*. Not more than 1 inch from the mouth but not touching it.

*Q*. How should words be pronounced over the telephone? *A*. Use a moderate tone of voice. Speak slowly and distinctly without slurring any words or syllables. Avoid using words which are difficult to pronounce or with meanings not generally known. When necessary to repeat, make the pronunciation more distinct but never shout or raise the pitch of the voice.

*Q*. How are numerals sent? *A*. Singly. Thus, 4,370 is sent "four, three, seven, zero." Zero is never pronounced "O." A numeral involving a decimal, like 246.34, is sent thus: "two, four, six, point, three, four." An exact hundred, such as 200, is sent: "two hundred;" 4,500, "four five hundred." Even thousands are sent in the same manner, for example, 4,000 is "four thousand."

*Q*. What is the procedure when the receiver repeats the message back to the sender? *A*. Listen carefully to the message. If any part of the message is incorrectly repeated, call "error" and repeat that portion of the message. When the message has been correctly repeated back to the sender, the sender should call "check."

*Q*. What is the procedure if the sender discovers that he has incorrectly sent part of a message? *A*. He immediately calls "error" and identifies the portion of the message in error. He then gives the correct message. With short messages it is best for the sender to repeat the entire message.

*Q*. How are numerals pronounced? *A*.

| *Numeral* | *Pronounced* | *Principal sounds* |
|---|---|---|
| 0 | ZE–RO. | Long O. |
| 1 | WUN. | Strong W and N. |
| 2 | TOO. | Strong T and long OO. |
| 3 | THUH–R–EE. | Slightly rolling R and long EE. |
| 4 | FOWER. | Long O, strong W, and final R. |
| 5 | FI–YIV. | I changing from long to short and long V. |
| 6 | SIKS. | Strong S and KS. |
| 7 | SEV–VEN. | Strong S and V, and well-sounded EN. |
| 8 | ATE. | Long A and strong T. |
| 9 | NI–YEN. | Strong N, long I, and well-sounded YEN. |

*Q*. What is meant by the "phonetic alphabet?" *A*. Certain letters of the alphabet have similar sounds and are often confused in telephone conversations. To avoid this difficulty, the following pronunciation of letters over the telephone is prescribed:

| Letter | Spoken as | Letter | Spoken as | Letter | Spoken as |
|---|---|---|---|---|---|
| A | Affirm. | J | Jig. | S | Sail. |
| B | Baker. | K | King. | T | Tare. |
| C | Cast. | L | Love. | U | Unit. |
| D | Dog. | M | Mike. | V | Victor. |
| E | Easy. | N | Negat. | W | William. |
| F | Fox. | O | Option. | X | Xray. |
| G | George. | P | Prep. | Y | Yoke. |
| H | Hypo. | Q | Queen. | Z | Zed. |
| I | Inter. | R | Roger. | | |

The words of the phonetic alphabet are used in place of the letters they represent just as in spelling a word. Expressions such as "A as in Affirm" or "A for Affirm" are not used. For example, in transmitting the words BARTS CHURCH the word BARTS is apt to be misunderstood. The phonetic spelling is as follows: "BARTS, Baker-Affirm-Roger-Tare-Sail." The phonetic alphabet is also used in the transmission by telephone of coded messages. For example, the code group "XISV" is transmitted as "X-ray-Inter-Sail-Victor."

*Q*. Give some pointers which will increase the efficiency of receiving messages. *A*.

(1) Keep the mind on the message; a person cannot receive correctly when he is thinking of something else.

(2) Keep the receiver close against the ear.

(3) Do not interrupt the sender except in cases where not to do so would be of serious disadvantage to the correct reception of the message.

(4) Repeat all messages received. Where messages are long, repeat each sentence as it is sent. When any part of a message is not understood, call "Repeat," and continue to have the message transmitted until it is understood.

*Q.* How is the telephone answered when it rings? *A.* First, give the official designation or name of the station; second, give the official designation of the person answering.

*Q.* What is a flash message? *A.* A message used to indicate the approach of aerial targets. The indication of the target is preceded by the word "flash," repeated three times, and the report is given twice without waiting for an acknowledgment.

*Q.* Do flash messages follow a particular form? *A.* Yes, they must follow a form and no unnecessary words should be used.

*Q.* What information is continued in a flash message? *A.*

(Front)

**FORM FOR FLASH MESSAGE**

**(AAAIS)**

Organization-------------
Serial No. -------- Date---------------------- How sent-------------
Time sent--------- To----------------------

| Observation post<br>1 | Number of airplanes<br>2 | Type of airplanes<br>3 | Time seen or heard<br>4 | Altitude<br>5 | Sector in which flying<br>6 | Direction of flight<br>7 |
|---|---|---|---|---|---|---|
| | One----- | Heavy bombardment. | --------- | Very low- | --------- | North. |
| | Two----- | Observation.-- | --------- | Low----- | --------- | NE. |
| | Three---- | Pursuit------- | --------- | Medium - | --------- | East. |
| | ---------- | Light bombardment. | --------- | High----- | --------- | SE. |
| | | | | | | South. |
| OP------ | Several--- | Airplane------ | --------- | ---------- | --------- | -------- |
| | | | | | | SW. |
| | Many---- | -------------- | --------- | ---------- | --------- | -------- |
| | | | | | | West.<br>NW. |

NOTE.—Very low—below 500 yards. Low—500 to 2,000 yards. Medium—2,000 to 4,000 yards. High—above 4,000 yards.

Both sender and receiver check off items where possible and save time.

*Q.* How are altitudes classified? *A.* High—above 4,000 yards. Medium—2,000 to 4,000 yards. Low—500 to 2,000 yards. Very low—below 500 yards.

*Q*. What record is made of a flash message? *A*. The sender of the message, the operators who transmit it, and the units which receive it usually record the message by checking the proper words and filling any appropriate blank spaces on a message form.

**70. Laying wire, making connections, and tests.**—*Q*. What common types of wire are used in field installations? *A*. Two types, both twisted pair; type W-110 and W-110B.

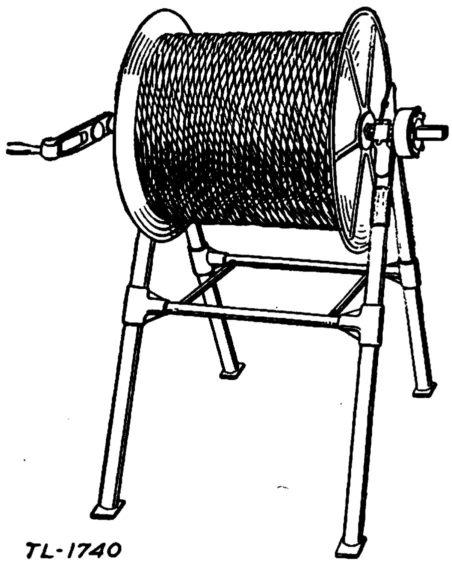



FIGURE 87.—Reel unit RL-31 with reel DR-5.

*Q*. Describe each type. *A*. Type W-110 wire has rubber compound insulation covered with weatherproof braid. There are 7 strands, 5 steel and 2 copper. Its weight is 132 pounds to the mile. Resistance is 130 ohms per mile. Type W-110B is similar to W-110 but has 4 steel and 3 copper strands. Its weight is 132 pounds to the mile. Resistance is 95 ohms per mile. (The candidate should be able to identify either type of wire by looking at it. Arrange a pile of short pieces of different types of wire and let the candidate make his own selection.)

*Q*. What means are provided for laying wire? *A*. The wire is carried or laid by any one of the following means, depending upon the conditions of the roads, terrain, and traffic, and character of hostile fire: motor trucks; especially constructed horse- and motor-drawn carts and reels; reel carts, hand-drawn or towed behind communication carts; breast reels; spools or coils carried by hand. If issued on wooden spools, wire may be laid by inserting an iron bar through the spool and paying off from it, or the wire may be rewound onto a spool of special design, provided for the purpose.

*Q*. What is the present standard reel? *A*. The reel unit RL-31.

*Q.* Describe the reel unit type RL-31. *A.* It is a portable wire-laying and recovery device. It may be used in any one of several ways, as follows:

(1) Carried litter fashion between two men.

(2) Pushed or dragged along the ground by one man, wheelbarrow fashion, the reel rims acting as wheels.

(3) Mounted inside or on the extended tail gate of any vehicle which provides the required space. Foot fittings are provided for mounting.

(4) Set up on the ground for unreeling or reeling in the wire.

(5) Mounted outside any vehicle by attachment to the outside of the tail gate. The unit has a removable brake which may be mounted to either end of the axle. Wire is reeled in by means of a crank which may be placed on the end of the axle.

*Q.* What is the capacity of the reel unit type RL-31? *A.* One 1-mile reel (type DR-5) or one or two half-mile reels (type DR-4) of wire type W-110 or W-110-B.

*Q.* In laying wire should the lines be pulled as tightly as possible or laid loosely? *A.* The lines should be laid loosely in order that the wire may lie flat on the ground, and so as to provide sufficient slack for repairing breaks. At suitable intervals, lines should be attached to objects such as trees or posts in order to leave sufficient slack, and to prevent the wire from being pulled into traffic lanes.

*Q.* How should a traffic line be crossed in laying wire? *A.* Where possible, the lines should cross roads through culverts. The wires are passed through the culvert and tied up at the entrance and exit to prevent immersion in the water. (See fig. 112.) When it is necessary to carry the wires overhead, they should clear the crown of the road by at least 18 feet for paved roads and 14 feet for other roads. When a line crosses a road between poles or other vertical supports, the wires should be tied at the base and top of the support on each side of the road. The strain which occurs along the line is met by the tie at the base. (See fig. 113.) If neither of the above methods can be used, the line wires should be buried in a trench, crossing the road at right angles. The wires must be laid snug and well secured at both ends of the trench to prevent their being pulled out. (See fig. 114.)

*Q.* In laying the wire, at what intervals should it be tested? *A.* When laying wire in the field, it should be tested through each splice just after making the splice. In the case of wire on a reel, a test should be made before the reel is taken out of storage.

*Q.* Given two pieces of field wire, describe and illustrate how to make a standard field wire splice. *A.* To obtain a uniform stagger in making the splice, measure back one plier's length (about 6 inches)


FIGURE 88.—Method of tying wire at ground level; (*a*) correct, (*b*) incorrect.

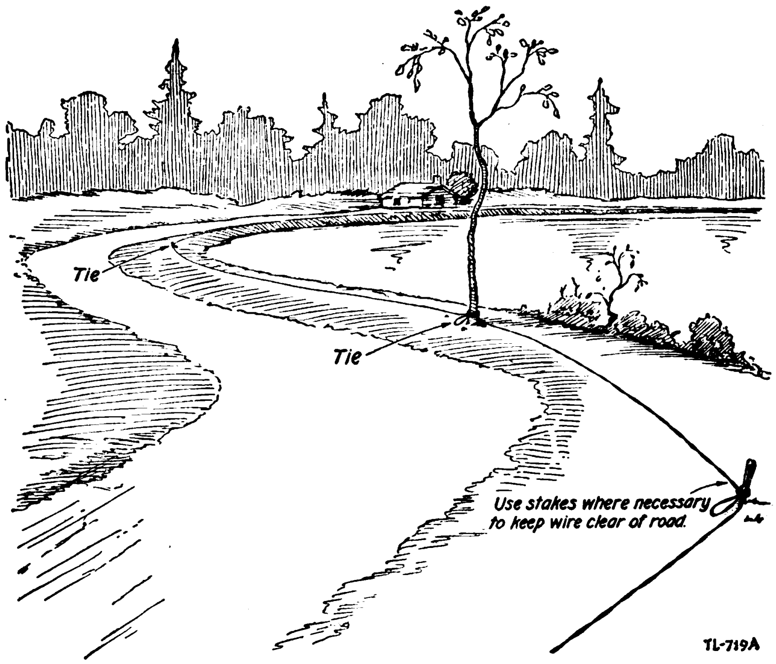



FIGURE 89.—Method of tying wire along curve in road.

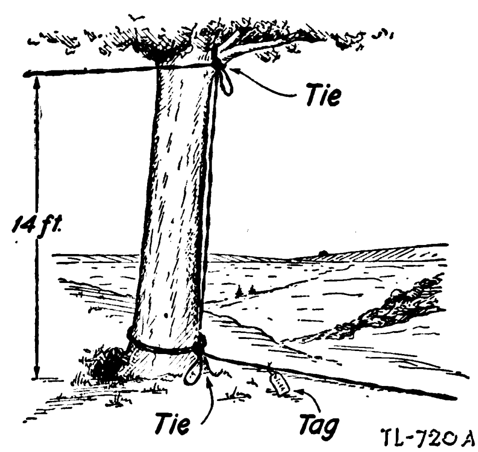



FIGURE 90.—Method of tying wire at junction of surface line with overhead construction.

from the end of one conductor and cut it at this point. Cut one wire of the other pair in the same manner. Crush the insulation on each conductor, starting at about 6 inches from the end and extending back to 2 inches from the end. Use the heel of the pliers for crushing. Score or ring the crushed insulation, at a point about ½ inch from where the crushing began, with the cutting edge of pliers. Using the pliers skin the crushed insulation off each conductor, being careful not to damage the strands. Clean the strands with the back of the screw driver blade of the electrician's knife. Now tie the long and short conductors together, using a square knot so that the knot occurs about ¼ inch from the insulation. Strip the weatherproof braid from the insulation about ½ inch on each side of the knot. Insert a 6- to 8-inch piece of 19-gage bare copper seizing wire in the knot and pull the knot tight. Bend the seizing wire at the middle and make 2 or 3 turns on either side of the knot to bind the ends of the knot. Cut the free ends of the conductors flush with end of insulation. Wrap the seizing wire to left and right of the knot until 2 turns are taken over the insulation. Cut off the excess wire and press ends of seizing wire into the insulation. Apply 2 layers of rubber tape followed by 2 layers of friction tape.

*Q*. When joints cannot be taped, what should be done to prevent short circuits and grounds? *A*. The joints should be staggered and raised off the ground.

*Q*. What telephones are furnished for field use? *A*. Signal Corps field telephones EE–5, EE–8, and EE–8A.

*Q*. How are these telephones classified, that is, as local or common battery types? *A*.

EE–8. Either local or common battery.
EE–8A. Either local or common battery.
EE–5. Local battery only.

*Q*. Name the principal circuits of a local battery telephone. *A*. The primary circuit, which consists of the transmitter, battery and primary winding of the induction coil. The secondary circuit, which consists of the receiver, condenser, and secondary of the induction coil. The signaling circuit, which consists of the generator and ringer. These circuits are basic in all local battery telephones. Certain telephones, such as the EE–8 and EE–8A, will have additional circuits, but in any case these additional circuits supplement the above basic circuits.

*Q*. How is the signaling circuit connected? *A*. The circuits of both the generator and the ringer are bridged in parallel across the line terminals.

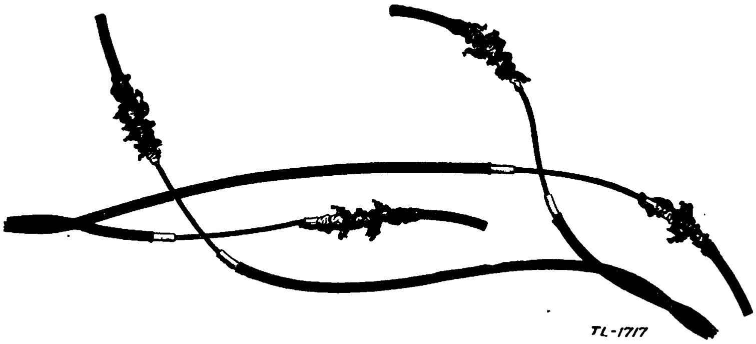



FIGURE 91.—Wires skinned and ready for square knot.

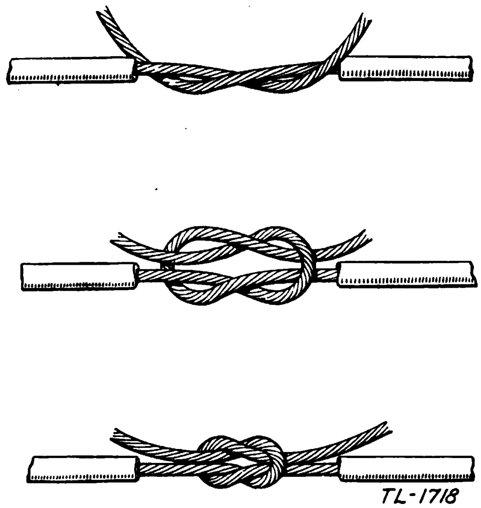



FIGURE 92.—Tying square knot.

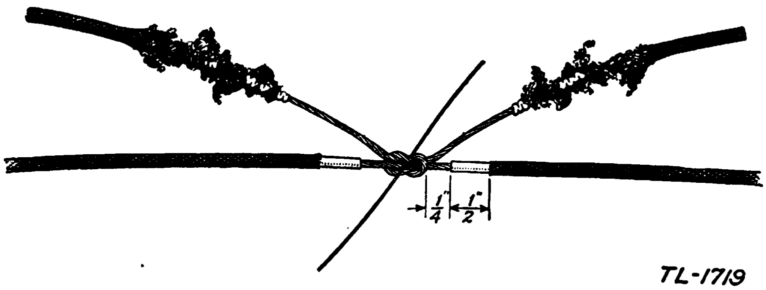



FIGURE 93.—Seizing wire inserted through knot.

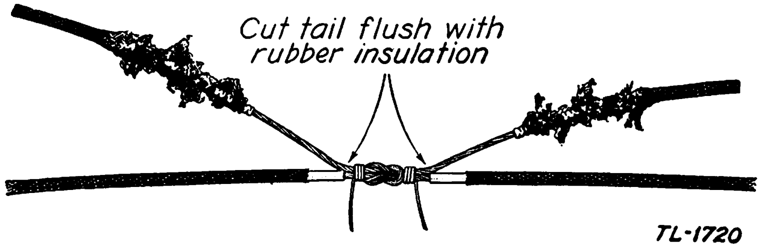



FIGURE 94.—Wrapping seizing wire.

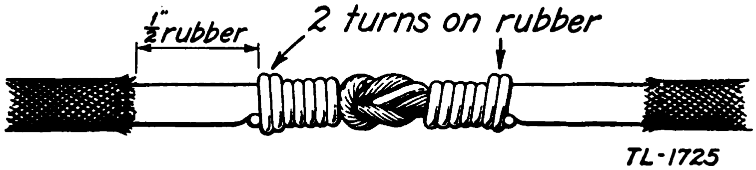



FIGURE 95.—Splice on one conductor after seizing is completed.

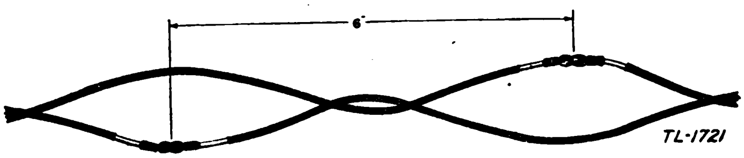



FIGURE 96.—Splice ready for taping.

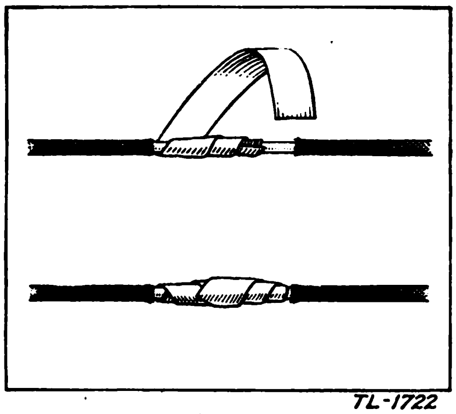



FIGURE 97.—Applying rubber tape.

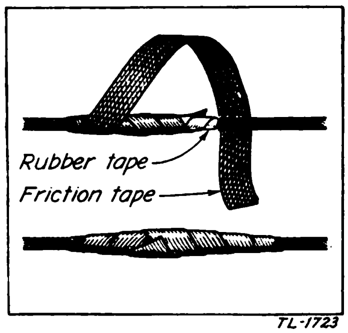



FIGURE 98.—Applying friction tape.

*Q*. Does the battery current flow through the signaling circuit? *A*. No. The circuit through the generator is always open except when the crank is turned. A condenser in the ringer circuit prevents the battery current from flowing through the ringer.

*Q*. Does the current from the generator flow through the receiver and transmitter? *A*. The handset switch must be operated in order to complete the circuit through the transmitter. Hence the generator current will not ordinarily flow through the transmitter. The re-

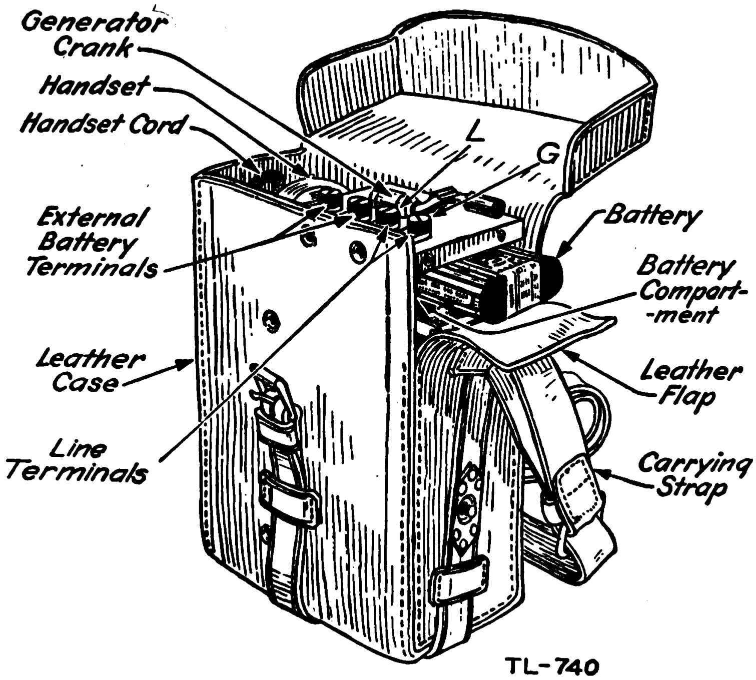



FIGURE 99.—Field telephone, type EE–5.

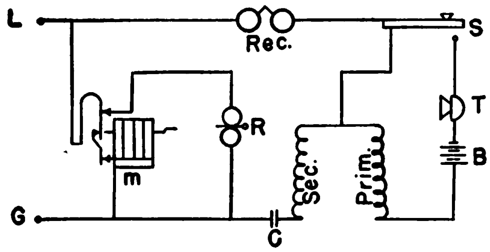



FIGURE 100.—Circuit diagram, type EE–5 telephone (modified).

ceiver is always connected across the line, so that generator current could flow through it. However the resistance of the receiver circuit to low frequency currents is very high. The generator produces alternating current at 20 cycles or less per second. Hence very little of the generator current will go through the receiver circuit.

*Q*. How are the batteries installed in the EE–8 and EE–8A telephones? *A*. Remove the handset from the carrying compartment. Place two batteries BA–30 in the battery compartment (see fig. 101), being sure that the bottoms of the batteries rest on the springs and that the tops of the batteries rest against the contacts at the top of the compartment.

*Q*. How is the battery installed in the EE–5 telephone? *A*. One battery BA–9 ($4\frac{1}{2}$ volts) is inserted in a spring clip just below the top of the frame (see fig. 99). The battery is covered by the leather flap formed by one side of the case. Two screws which hold this flap to the frame must be removed to insert the battery, after which the screws should be replaced.

*Q.* How is the station opened when using an EE-8 or EE-8A telephone? *A.* Open the case and remove the handset from the carrying compartment. Place the batteries in the battery compartment. Connect the ends of the line to the terminals marked L1 and L2. With a screw driver turn the screw switch to the proper

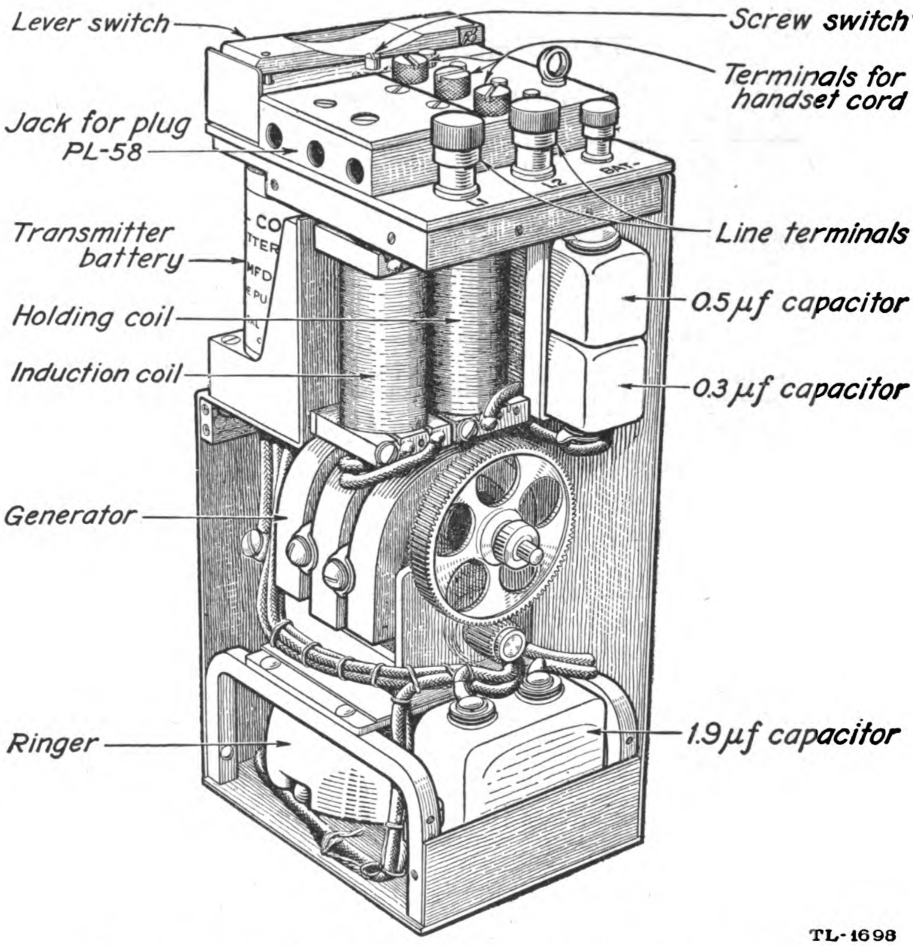



FIGURE 101.—Field telephone, type EE-8, with side plates removed.

position, depending on whether the telephone is to be operated by local battery or by common battery. There are about 1½ turns of the screw switch between the local battery and common battery positions. If using local battery, call the switchboard, using the generator. If using common battery, removal of the handset from its position on the lever switch will call the switchboard. Report the designation of the station and request a ring back. If using common battery, it will be necessary to replace the handset on the lever switch before the switchboard can ring back.

*Q*. How is the station opened when using an EE-5 telephone? *A*. Open the cover of the telephone. Remove the crank from the clamp on top and screw it on the magneto shaft which extends out of the side of the case. Remove the handset from the carrying compartment. Connect the ends of the line to the terminals marked *L* and *G*. Call the switchboard by turning the crank. Report the designation of the station and request a ring back.

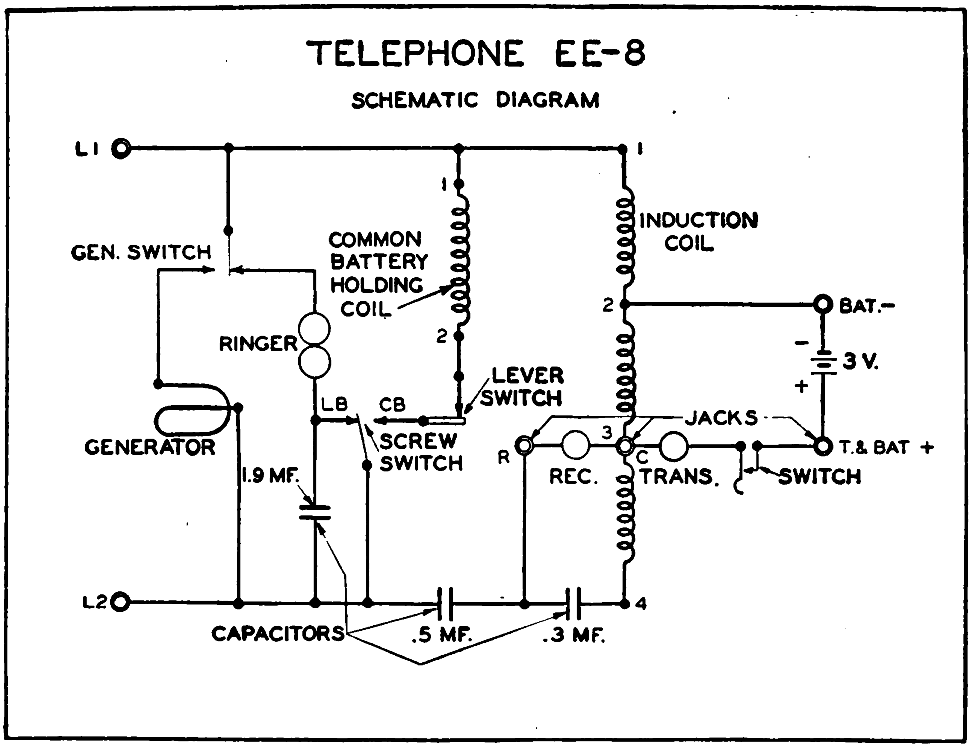



FIGURE 102.—Circuit diagram, type EE-8 telephone.

*Q*. How is the station closed? *A*. Report the fact of closing to the switchboard. Disconnect the line from the terminals. With the EE-5 remove the crank and place it in its carrying position. If the telephone is not going to be used again *immediately*, remove the battery or batteries. Wrap the cord about the handset and replace the handset in the carrying compartment. If the batteries were left in the telephone, be sure that the cord does not operate the handset switch.

*Q*. Demonstrate hooking up two telephones to a length of wire and establish communication. (Local battery only.) *A*. (Practical demonstration proved by actual communication.)

*Q*. Is it necessary to operate the handset switch in order to listen? *A*. No, and furthermore the operation of the handset switch when listening only is bad practice as it exhausts the battery rapidly.

*Q.* How may the battery in a local battery telephone be tested? *A.* If the battery terminals are touched to the tongue, there should be a salty taste noted. Another test is to blow lightly into the transmitter while holding the transmitter switch closed. A distinct sound should be heard in the receiver. In this test, the line should be disconnected from the telephone.

*Q.* When should a telephone be tested? *A.* Always before it is taken out for service. Thereafter, the tests are made periodically as prescribed. The fact that circuits are in constant use is indicative that they are operating satisfactorily. A telephone which is ordinarily very busy and which suddenly becomes quiet should be tested at the earliest opportunity. Communication should never be interrupted to make a routine test.

*Q.* Name the different types of field switchboards. *A.* BD-14, BD-71, BD-72, BD-9, and BD-11. All types except the BD-14 are monocord switchboards.

*Q.* Describe the BD-71 and BD-72 switchboards. *A.* The switchboard is inclosed in a plywood case mounted on four collapsible steel legs. The unit includes switchboard units, cords, operator's telephone with head and chest sets, lights, switches and night alarm, batteries BA-30, repeating coils, and terminal strips. Outside of the fact that the BD-71 has only 6-line capacity compared to the 12-line capacity of the BD-72, there is no practical difference between the two switchboards.

*Q.* Describe the BD-9 and BD-11 switchboards. *A.* The BD-9 has a capacity of 4 lines and the BD-11 of 12 lines. The unit consists of a frame on which the individual drops are mounted. Operator's telephone, terminal strips, repeating coils, and similar items are all separate from the switchboard. A fiber carrying case is provided for the protection of the switchboard when not in use.

*Q.* Demonstrate hooking up a telephone, a length of wire, and a BD-71 or BD-72 switchboard. *A.* (Practical demonstration proved by actual functioning.)

*Q.* Demonstrate hooking up an operator's telephone, battery, night alarm, and one line with telephone connected to a BD-9 or BD-11 switchboard. *A.* (Practical demonstration proved by actual functioning.)

*Q.* What is the purpose of the ground wire? *A.* Protection against lightning. An air spark gap is incorporated in each unit. The ground wire grounds one side of the lightning arrester.

*Q.* Is it desirable for the operator to keep his telephone connected to two lines which are in use? *A.* No. The extra load which his telephone puts on the lines will impair transmission between the two telephones which are in use.

*Q.* How does the switchboard operator know when someone is calling the switchboard? *A.* Ringing current on the calling line operates the shutter coil and allows the shutter to drop to the horizontal position. If the night alarm switch is closed, the shutter cam

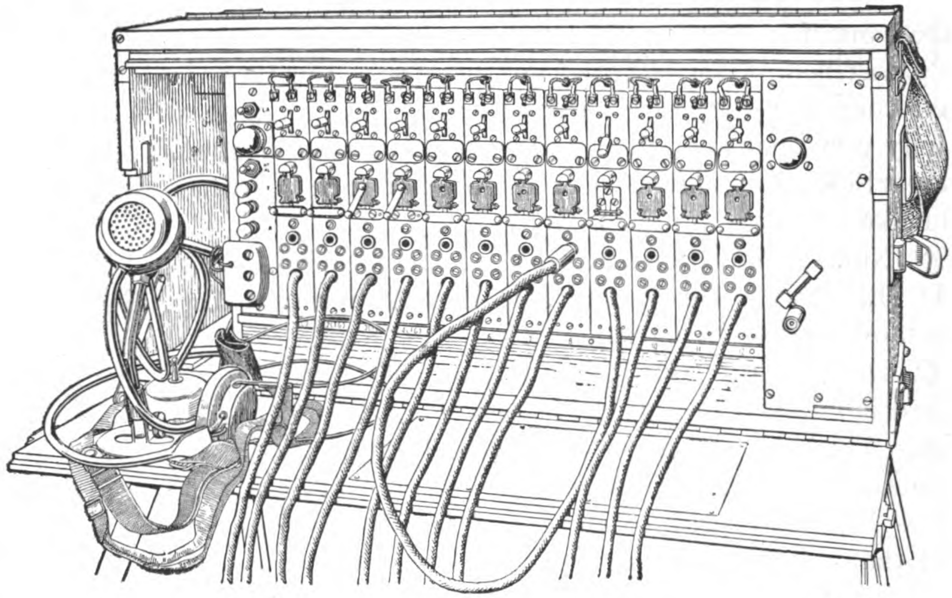



FIGURE 103.—BD-72 switchboard, front view, open.

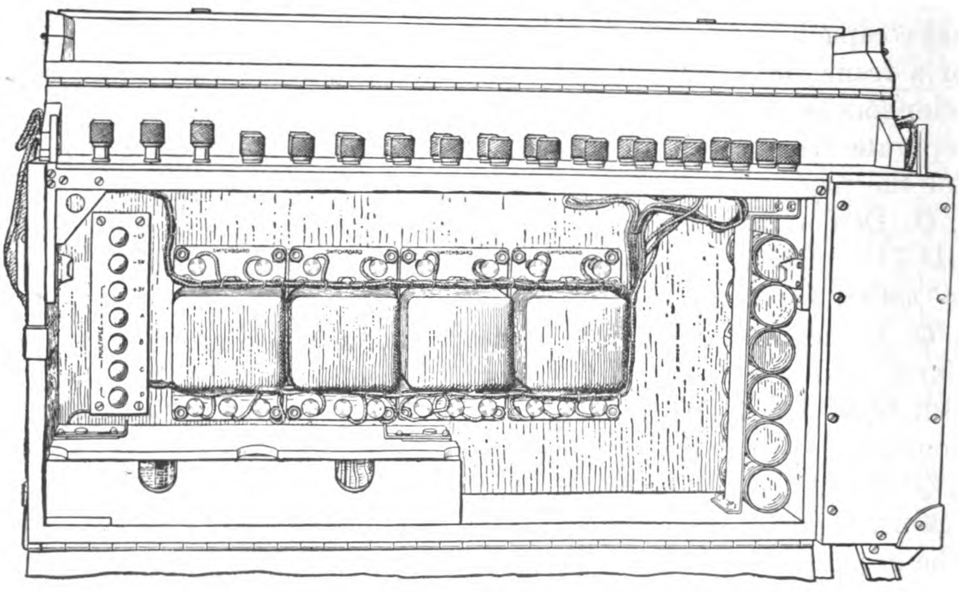



FIGURE 104.—BD-72 switchboard, rear view, open.

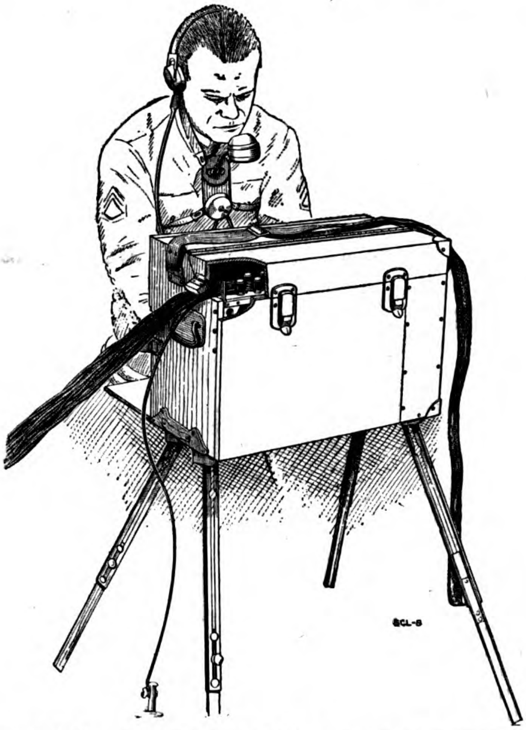


FIGURE 105.—Switchboard BD-71 set up for operation.

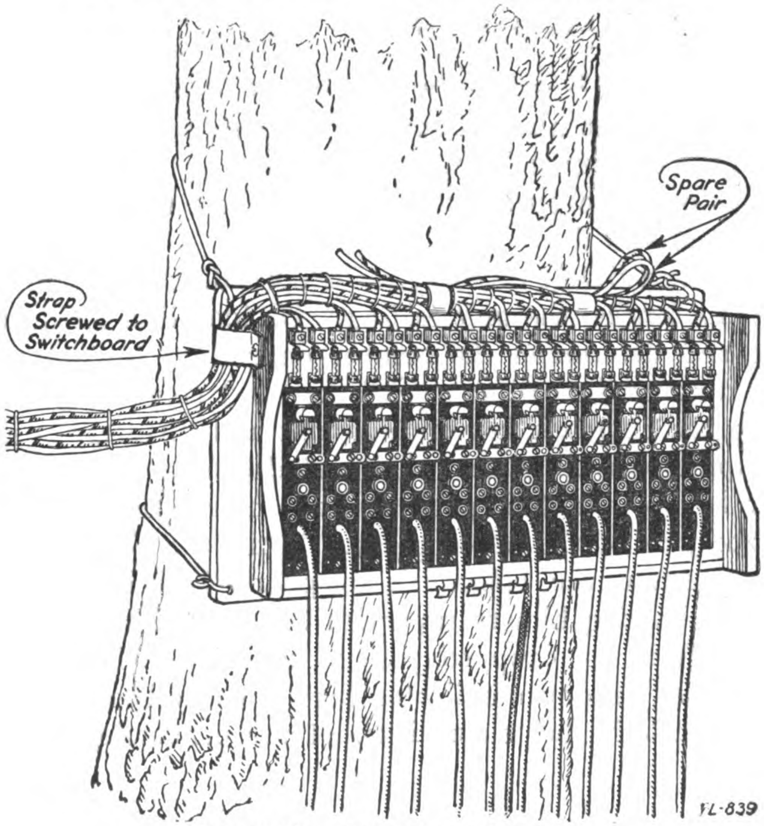



FIGURE 106.—Switchboard BD-11.

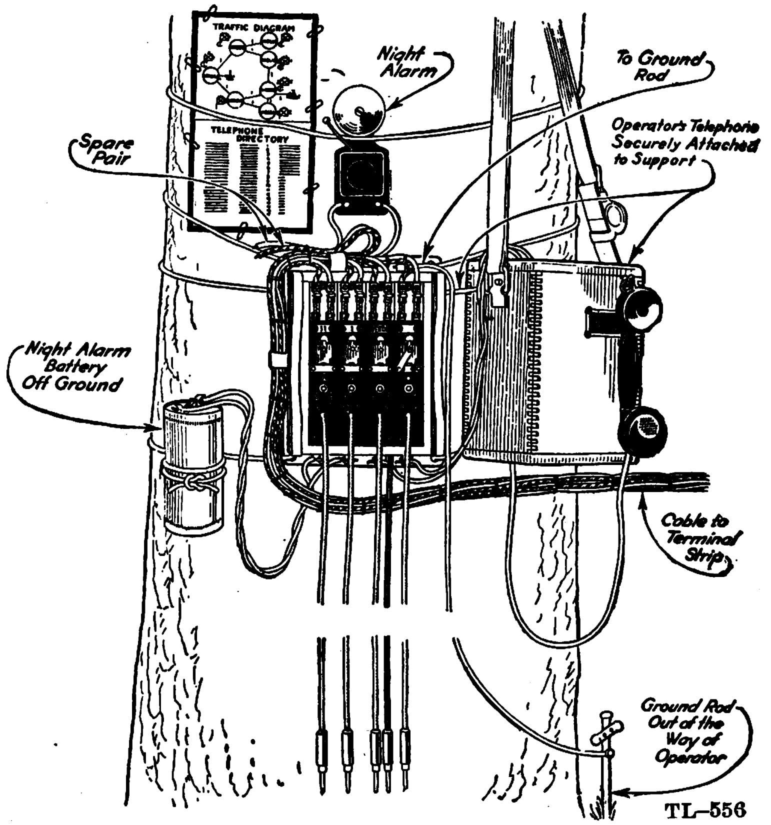



FIGURE 107.—Switchboard BD-9 set up for operation.

will close the night alarm circuit and cause the alarm to operate as long as the shutter is down.

*Q*. What does the operator do when he sees the shutter drop on one of the units? *A*.

(1) If using a BD-71 or BD-72 switchboard, the operator depresses the ring-talk key on the unit calling. He identifies the switchboard by name and determines the number desired by the party calling. He then restores the calling party's key and rings the called party by raising the ring-talk key on that unit and turning the generator handle rapidly several times. He next depresses the called party's ring-talk key to the talk position and inserts the calling party's plug in the jack of the called party. While the ring-talk key is in the talk position the operator's telephone is bridged across the connection, allowing him to supervise the call. The calling party's shutter is left in the dropped position until the call has been completed. A shutter down indicates that the call has not been completed and that further supervision of the connection is necessary.

(2) If using the BD–9 or BD–11, the operator inserts his plug in the calling party's jack, identifies the switchboard by name, and determines the number desired by the calling party. He places the operator's plug in the jack of the called party and turns the generator of the operator's telephone. He then inserts the called party's plug in the jack of the calling party. The operator leaves his plug in the jack until he finishes supervising the call at which time he removes his plug and restores the shutter on the calling party's unit.

*Q*. Why must the switchboard be upright when in operation? *A*. The shutter drops by gravity. If the board is not upright or inclined slightly forward, the shutter cannot drop.

*Q*. What are some of the troubles which may occur in a telephone system, and what are the tests and remedies? *A*. See table at end of this section.

*Q*. Describe and demonstrate how to test a telephone. *A*. Install the battery. Holding the receiver to the ear, blow steadily into the transmitter while alternately operating and releasing the handset switch. The blowing should be very audible as long as the handset switch is at the "on" position. Holding the receiver to the ear, operate the generator. The handle should be easy to turn and the impulses should be heard in the receiver. The ringer should not operate. Short circuit L1 and L2 and turn the generator again. It should now be hard to turn as though a drag had been placed on it, the impulses should be heard in the receiver, and the ringer should not operate. Remove the short. Connect the telephone to another telephone known to be serviceable. Turn the generator on the other telephone. The ringer of the telephone being tested should operate.

*Q*. What repairs are telephone operators authorized to make? *A*. With the exception of changing batteries, cleaning contacts which are accessible without taking down the telephone, and changing the headset or handset, the operator is not authorized to make any repairs.

*Q*. How can most telephone troubles be avoided? *A*. Most of the troubles in telephone communication can be avoided if telephones are carefully used and cared for and are examined and tested before being taken out for service each day. In addition, the batteries must be in good condition, and care must be taken to see that all joints make good contact, including all splices in the lines.

| Trouble | Possible cause | Tests and remedies |
| --- | --- | --- |
| Home station cannot ring distant station. | (1) Improper line connection at telephone. | (1) Examine connections. Clean and tighten if necessary. |
| | (2) Open circuit in line. | (2) Examine line for breaks. |
| | (3) Generator out of order. | (3) Test the telephone at the home station. Repair or replace as may be necessary. |
| | (4) Receiving circuit open or damaged receiver. | (4) Test the telephone at the distant station. Repair or replace as may be necessary. |
| | (5) Ringer at the distant station not functioning. | (5) Test the telephone at the distant station. Repairs or replace as may be necessary. |
| | (6) Short circuit in line. | (6) A shorted line is usually distinguished by the generator turning hard. Examine the connections and the line. Remove the short when discovered. |
| Distant station cannot ring home station. | See above. | See above. |
| Home station can signal distant station but cannot hear distant station talk. | (1) Operator at distant station not operating the handset switch. | (1) Operate the handset switch properly. |
| | (2) Battery at the distant station dead. | (2) Test the battery. If weak or exhausted, replace. |
| | (3) Battery contacts corroded. | (3) Examine contacts and battery terminals. Clean if necessary. |
| | (4) Broken transmitter cord at distant station. | (4) Disconnect handset and touch battery terminals with receiver and transmitter cords, being sure that the handset switch is operated at the same time. A click should be heard in the receiver if the transmitter cord is all right. Replace cord if necessary. |
| | (5) Handset switch at distant station does not make contact. | (5) Test as in (4) above Clean and adjust if necessary. |

| Trouble | Possible cause | Tests and remedies |
|---|---|---|
| | (6) Carbon in transmitter at distant station packed. | (6) Usually distinguishable by sizzling or crackling noise in receiver. Replace telephone. |
| | (7) Broken receiver cord at home station. | (7) Disconnect handset. Touch receiver and common cords to terminals of a battery simultaneously. If a click is heard the receiver circuit is all right. Replace cord if necessary. |
| Distant station can signal home station but cannot hear home station talk. | See above. | See above. |
| Station cannot signal switchboard. | (1) Fuse on switchboard burned out (BD-9, BD-11 only). | (1) Examine fuses and replace if necessary. |
| | (2) Shutter stuck on its hinge. | (2) Trip shutter by hand. If the shutter will not drop of its own accord, clean hinge. |
| | (3) Armature holding shutter is out of adjustment or bent. | (3) BD-9 or BD-11: Hold tip of red (operator's) plug against terminals of section being tested. Ring operator's telephone. If the armature vibrates but does not release the shutter, adjust armature until it does.<br>BD-71 or BD-72: Put the plug of an unused circuit across the terminals of the unit being tested. Put ring-talk key to ring position and operate the generator. If the armature vibrates but does not release the shutter, adjust armature until it does. |
| | (4) Coil of shutter release magnet burned out. | (4) Test as in (3) above. If the armature does not vibrate, the coil is probably burned out. Replace entire unit. |

| Trouble | Possible cause | Tests and remedies |
|---|---|---|
| Night bell fails to operate when a shutter drops. | (1) Battery dead. | (1) Test battery and replace if necessary. |
| | (2) Loose or dirty connections. | (2) Check through all connections. Clean and tighten where necessary. |
| | (3) Bell contacts corroded. | (3) Examine bell. Clean the contacts if necessary. |
| | (4) Shutter dropping does not close bell circuit. | (4) Adjust the contacts so the circuit will be completed. |
| | (5) Bell coils open. | (5) Connect a receiver in series with a battery and the bell coils. When the circuit is closed there should be a click in the receiver if coils are all right. Replace if necessary. |

## SECTION II

## INSTALLATION AND OPERATION OF BRIGADE, REGIMENTAL, OR BATTALION TELEPHONE SYSTEM AND NET



**71. Installation and operation of systems and nets.**—*Q.* How are military wire circuits classified according to their use? *A.* As trunk or local lines.

*Q.* What is a trunk line? *A.* A line which connects two telephone switchboards or centrals.

*Q.* What is a local line? *A.* A line which connects a switchboard to an individual telephone or one between two individual telephones.

*Q.* How are wire circuits classed according to construction? *A.* As metallic or ground return.

*Q.* What is the difference between the two? *A.* In the metallic circuit two wires are used to provide a complete path for the current; in ground return circuits the earth replaces one wire.

*Q.* Are grounded circuits satisfactory? *A.* No, because of earth currents, cross talk and the ease with which the enemy can pick up messages.

*Q.* What kinds of wire may be used? *A.* Bare wire, insulated single-conductor, insulated twisted-pair and cables may be used.

*Q.* What kind of wire is generally used for mobile artillery systems? *A.* Twisted-pair, insulated, stranded field wire. Usually W–110 or W–110–B wire.

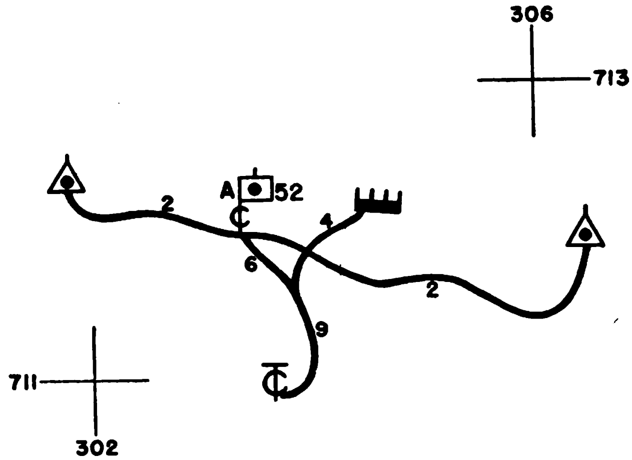



FIGURE 108.—Line route map.

*Q.* What is a line route map? *A.* A map, map substitute, or overlay on which are shown the actual routes of wire circuits. It contains also information as to the location of each headquarters or establishment served by the system, locations of telephone centrals, test stations, and long locals. Beside showing the actual route of each wire line, the map shows the type of line construction and the number of physical circuits in each section of the line. If an overlay, at least two orientation points taken from the map must be shown, and a reference must be made on the overlay to the map used. The line route map contains as few lines, symbols, and notations as is consistent with its purpose.

*Q.* What is a circuit diagram? *A.* A circuit diagram is a diagram which gives schematically the technical arrangement and connections of the circuits and terminal installations of the wire system. It is a means of giving to the wire personnel detailed instructions for the installation of the system and of assisting them in its maintenance. The circuit diagram contains technical information necessary for wire personnel to install wire lines, centrals, test stations, and telephones on long local circuits, and to simplex or phantom the required circuits.

*Q.* What does the circuit diagram indicate? *A.* The circuit diagram indicates the following:

(1) Telephone centrals at command posts and establishments served by the wire system, commercial telephone centrals, switching centrals, test stations, and long local telephone circuits (that is, circuits to local telephones not in the immediate vicinity of a tele-

phone central). These are shown by their special symbols and their telephone directory names. Their locations are indicated by names of map or terrain features and by coordinates.

(2) The number of circuits, including trunks and long locals, between each of the command posts or establishments shown.

(3) The number assigned to each circuit.

(4) The manner of connecting each circuit into or through telephone centrals and test stations This includes the connections for simplex and phantom circuits.

(5) The type of line construction used for each line, such as field wire, open wire, cable, commercial circuits, etc.

*Q.* What is meant by a "simplex" circuit? *A.* A simplex circuit is a ground return circuit superimposed on both lines of metallic circuit. It is constructed by placing a repeating coil at each end of the metallic circuit so that a pulse of current entering the midpoint of the line side of one of the repeating coils divides so that half flows in each of the two metallic circuit lines.

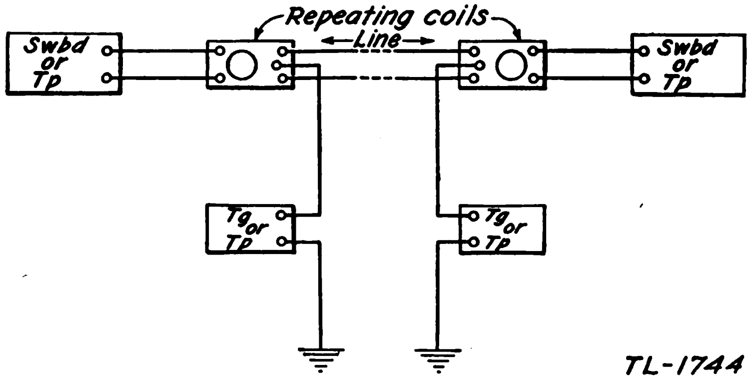



FIGURE 109.—Simplex circuit constructed with repeating coils.

*Q.* What prevents the current in the superimposed circuit from interfering with the original telephone circuits? *A.* The current from this circuit cannot interfere with the telephone currents because the superimposed current is divided equally at the midpoint of the line winding of the repeating coil. Any magnetic field set up by the additional current in one-half of the coil winding, is exactly neutralized by the magnetic field set up in the other part of the winding, resulting in no interference with the original telephone circuits.

*Q.* What is a phantom circuit? *A.* A phantom circuit is a circuit made up by combining two simplex circuits. Whereas the simplex circuit uses a ground return for one side of the circuit, the phantom circuit is made up by superimposing a circuit on two metallic circuits so that a metallic circuit is used on each side of the phantom circuit.

*Q.* What is a traffic diagram? *A.* A traffic diagram is a chart showing the number of telephone channels actually existing between the centrals in a telephone system. Circuits connecting to distant locals are also shown. A single line indicates direct telephone communication; a numeral placed on the line indicates the number of channels available including phantom circuits. The units to which each telephone central or distant local pertains are indicated by the telephone directory name and symbol of the unit.

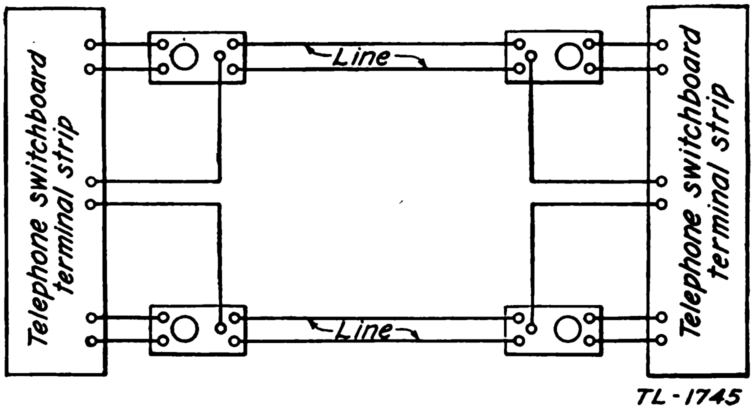



FIGURE 110.—Phantom circuit constructed with repeating coils.

*Q.* Who prepares the traffic diagram? *A.* The traffic diagram is prepared at each switchboard by the wire chief or chief operator, assisted by the operator on duty.

*Q.* How is the traffic diagram prepared? *A.* The traffic diagram is prepared from information received over the wire system and shows only such circuits as are available for traffic.

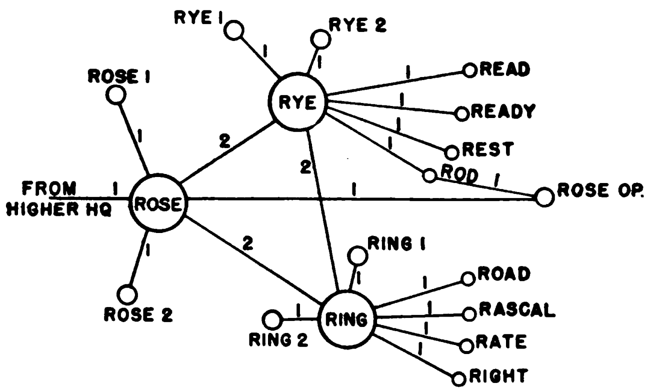



FIGURE 111.—Traffic diagram.

*Q.* What is the purpose of the traffic diagram? *A.* The purpose of the traffic diagram is to indicate to the operator the most direct routing for a call to any other central in the system, and to show alternate routings in case the direct routing is busy or out of order.

For this purpose it often includes connecting telephone systems of other higher, lower, and adjacent units. It must be corrected continuously as changes occur, and expanded as information is obtained.

*Q*. In the case of wire lines between higher and lower units, who is responsible for their installation and maintenance? *A*. The higher unit is responsible for the wire communications from its command post to the command post of the next lower unit.

*Q*. What would be a good telephone position? *A*. One free from enemy observation and protected from shell fire. It should not be necessary for the operator to lie down nor should he be in a position where he is continually annoyed by others.

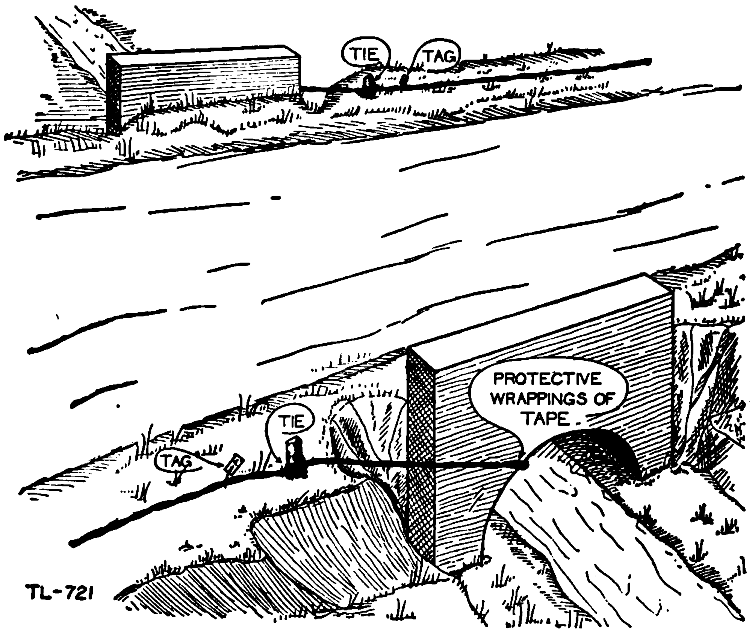



FIGURE 112.—Wire crossing road through a culvert.

*Q*. Where should the switchboard be placed? *A*. At some quiet spot, centrally located and well protected from shell fire.

*Q*. Give some points to be observed when selecting a route for a telephone line. *A*. It should—

(1) Be as short as possible.
(2) Avoid main lines of travel.
(3) Avoid road junctions.
(4) Follow some natural line of concealment.
(5) Be camouflaged if in view of the enemy.

*Q*. What tests should be made when laying the line? *A*. Before the reels are taken out for laying wire the wire should be tested for shorts and for open circuits. For this purpose the wire on each reel should be continuous and should have the ends exposed. Then as the lines are payed out they should be tested back to the starting point every ¼ mile and at every splice that is made.

*Q*. What natural features can be utilized when laying a line? *A*. Reverse slopes of hills, trenches, ditches, and woods.

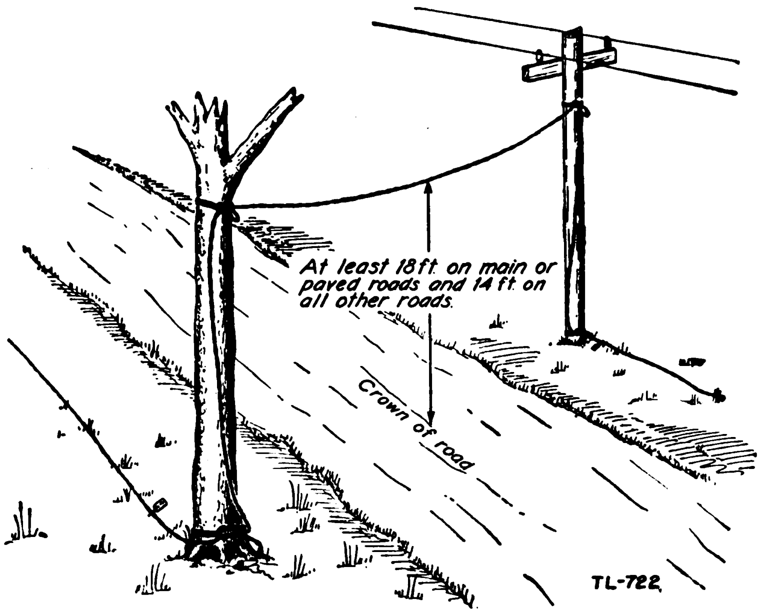



FIGURE 113.—Wire crossing road overhead.

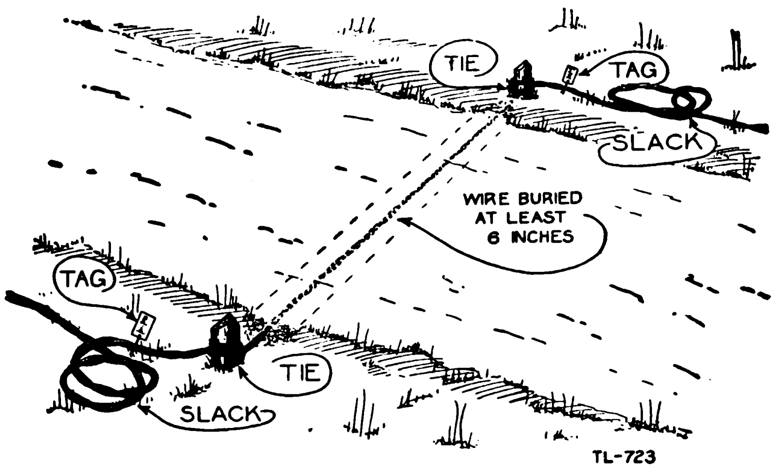



FIGURE 114.—Wire crossing under road in a trench.

*Q*. How should wire lines cross a road? *A*. Through a culvert, high enough overhead to clear all traffic, or buried to a depth of 6 inches.

*Q*. Should there be any slack when wire is laid? Why? *A*. Wire should be laid slack so breaks can be repaired and short pieces cut out if necessary.

*Q.* How are lines laid across water? *A.* Use a single section of weatherproof wire and weight it sufficiently to hold it against the movement of the current.

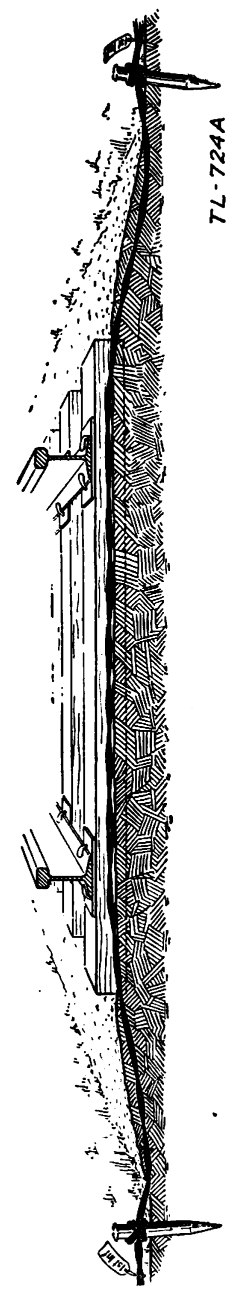



FIGURE 115.—Wire crossing under railroad track.

*Q.* What provision is made to maintain communication should a line be broken by shell fire or other causes? *A.* Duplicate lines are run to distant stations by different routes whenever possible. These lines are connected to the switchboard and are readily substituted for defective lines.

*Q*. How are telephones and operators at base end and spotting stations protected from enemy action? *A*. Such stations are normally carefully concealed by camouflage and are provided with some cover.

*Q*. What is "short stake construction"? *A*. Short stakes, about 4½ feet in length, are driven into the ground at intervals of about 15 to 20 feet. Small insulated knobs of wood or porcelain, etc., are fastened to these stakes and the wires are attached to these knobs.

*Q*. What is "wire trench construction"? *A*. Short stakes are driven into the bottom of a small wire trench at intervals of about 15 to 25 feet and the wire attached to the stakes as in the short stake construction.

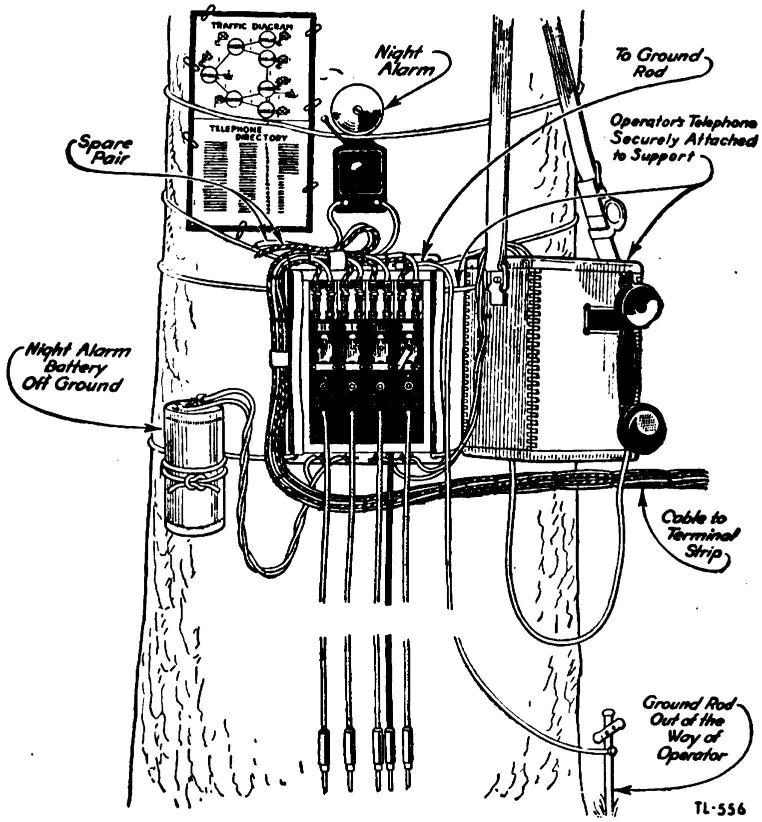



FIGURE 116.—Installation of monocord switchboard.

**72. Duties of switchboard operators.**—*Q*. What are the duties of the switchboard operator? *A*. He should understand the board thoroughly, be familiar with all the connections thereon, be able to make all desired connections promptly, and to make emergency repairs and maintain the board in operating condition.

*Q*. When using a switchboard built up of units of the type illustrated can more than two lines be connected for transmitting orders simultaneously to several stations? *A*. Yes. Plug No. 1 may be inserted in jack No. 2, plug No. 2 in jack No. 3, etc., and the lines so plugged are connected in parallel.

*Q*. How are the various stations indicated on the board? *A*. The line number plate (a white celluloid strip) is mounted on each unit. The number or other designation of each station is written in pencil on the corresponding plate. The designation is then easily erased if it becomes necessary to change it.

*Q*. Is it necessary to run all the lines of a telephone system through the switchboard? *A*. No. Many of the lines of a mobile artillery installation do not pass through the switchboard.

*Q*. Show how to operate a switchboard. *A*. (Practical demonstration.)

*Q*. What operating phrases are prescribed for use by switchboard operators? *A*. The following phrases are prescribed for use by switchboard operators in all cases where they apply, to the exclusion of other phrases of similar meaning:

(1) "Thompson." Used by the operator at the switchboard of the unit whose directory name is Thompson in answering a call.

(2) "Thank you." Used by an operator to indicate that he has correctly understood a number given to him by either a local party or by an operator of another central, and that he is proceeding to complete the call.

(3) "What number please?" Used by an operator to request repetition of a number which he has not understood.

(4) "The line is busy." Used by an operator to report that a local telephone for which he has received a call is already in use.

(5) "Maytime is busy." Used by an operator who has received a call to be completed to a certain central (Maytime) to report that all trunks to that central are in use.

(6) "Thompson one-one does not answer." Used by an operator in reporting that a called party (Thompson one-one) does not answer.

(7) "Here's your party." Used by an operator whenever it is necessary for him to start the conversation over a connection.

(8) "Waiting"? Used by an operator in supervising a connection, when no conversation is heard.

(9) "I will ring again." Used by an operator when, in supervising a connection, he is informed that the called party did not answer.

(10) "What number is calling, please"? Used by an operator if after supervising a connection he is given a new number to call by one of the parties.

(11) "Thompson three-zero has no telephone but I can give you Thompson one-one." Used by an operator when there is no telephone

at the number called, but another telephone is available to which the calling party might desire to be connected instead.

(12) "What number are you calling, please"? Used by an operator to determine the number desired by a party who reports he has been given a wrong number or has been cut off.

(13) "One moment please" or "I have a call for you." Used by an operator, if necessary, to hold either party on the line while a connection is being completed.

(14) "Hello Thompson" or "Hello Thompson one-one." Used by an operator when there is confusion or interruption in getting an operator or called party on the line.

(15) "I must interrupt—urgent call from Thompson six—please hang up." Used by an operator to inform the parties using a circuit that it is required for an urgent call by a certain calling party.

## SECTION III

## RADIO COMMUNICATION



**73. General.**—*Q*. What is radiotelegraphy? *A*. Radio communication by means of International Morse Code.

*Q*. What is radiotelephony? *A*. Radio communication by means of voice signals.

*Q*. Radio is used as a means of communication between what units? *A*. All combat units down to and including battalions; individual airplanes, and certain individual vehicles. Under certain situations the battery must also be included.

*Q*. What are some advantages of radio as a means of communication? *A*. It is independent of roads and traffic and quick to operate. There is no wire to lay or maintain.

*Q*. What are some disadvantages of radio? *A*.

(1) Messages can be intercepted by the enemy.

(2) The number, type, and location of sets in an area may give the enemy an estimate of our dispositions and strength.

(3) A particular frequency or band can be blocked, thereby interfering with communication.

(4) Weather conditions may adversely affect range and quality.

*Q*. What are important considerations when locating radio stations? *A*.

(1) Radio stations should be in quiet localities protected from weather and enemy fire.

(2) They should not be placed close to sources of possible radio interference such as power lines, telegraph and telephone lines, and other radio stations.

(3) The location should be such that the antenna is in the clear and elevated.

(4) The presence of buildings, hills, woods, and other objects may screen the waves.

*Q*. What are some of the uses of radio in the military service, other than transmission of ordinary messages? *A*.

(1) *Reception*.—(*a*) Location of enemy radio stations on land, sea, or air.

(*b*) Interception of enemy radio traffic.

(*c*) Interception of friendly radio traffic for supervisory purposes.

(*d*) Collection of upper air meteorological data.

(2) *Transmission*.—(*a*) Meteorological messages.

(*b*) Time signals.

(*c*) Press reports.

(*d*) Propaganda.

**74. Definitions.**—*Q*. What is meant by "Brake-in operation"? *A*. Operation wherein the receiving operator can interrupt the transmitting operator at any time.

*Q*. What is meant by "call sign"? *A*. A group of letters, or of letters and numerals, used for station identification.

*Q*. What is meant by "frequency assignment"? *A*. The frequency assignment of a station is the frequency or frequencies, usually expressed in kilocycles (kc) or megacycles (mc), at which the station is authorized to operate.

*Q*. What is meant by "heading"? *A*. The heading of a message is that part which appears before the text or body begins.

*Q*. What is meant by "intercept station"? *A*. A station that copies enemy radio traffic for the purpose of obtaining information or friendly traffic for the purpose of supervision.

*Q*. What is meant by "internet traffic"? *A*. Traffic between stations which are not assigned to the same net.

*Q*. What is meant by "linking station"? *A*. A station used for the relay of messages from one net to another.

*Q*. What is meant by "position finder station"? *A*. A station containing one or more radio receivers capable of finding the location from which incoming radio waves are arriving at the receiver.

*Q*. What is meant by "mobile station"? *A*. A station that normally operates from a stationary location but which can be rapidly transported to another location.

*Q*. What is meant by "vehicular station"? *A*. A station so installed in a vehicle that it is capable of operation with the vehicle in motion.

*Q*. What is meant by "net call sign"? *A*. A call sign used to call all stations in a net.

*Q*. What is meant by "service"? *A*. The service of a message consists of the notations made on a message by transmitting and receiving operators.

*Q*. What is meant by "station log"? *A*. A chronological record of traffic kept at a station.

*Q*. What is meant by "traffic"? *A*. Traffic consists of all transmitted and received messages.

*Q*. What is meant by "transmission"? *A*. A complete communication between stations including all queries, repeat-backs, and receipts.

*Q*. What is meant by "trick" or "watch"? *A*. A tour of duty as an operator.

**75. Radio nets and net control stations.**—*Q*. What is a radio net? *A*. In order that radio communication may follow the proper channels of tactical command, the radio station of a superior unit and the radio stations of the next subordinate units are grouped together for operation. The superior unit together with its subordinate units is called a radio net.

*Q*. What are tactical radio nets? *A*. Tactical nets are made up of mobile or vehicular low-powered radio stations of tactical units in the field. They are designated by a name indicative of the superior headquarters in the net.

*Q*. How is the transmission of messages usually controlled in a net? *A*. In each net one station is designated as net control station (NCS). The NCS is charged with clearing traffic within the net, working the internet traffic, and maintaining order within the net.

*Q*. What is a directed net? *A*. In a directed net no station except the NCS can communicate, except for the transmission of urgent messages, with any other station without first obtaining permission of the NCS. A free net on the other hand is not so restricted. Directed nets are used only when the NCS cannot maintain control otherwise.

*Q*. How is interference between various nets avoided? *A*. Each net is assigned a definite frequency on which it must operate.

**76. Operation.**—*Q.* Give some of the transmitting rules that must be observed by an operator. *A.*

(1) An operator will listen on the transmitting frequency assigned his station before making any call or other transmission. If there are other stations working on the frequency, he will not interrupt communication unless such interruption is warranted by the class of his traffic.

(2) All transmissions must be as short and concise as possible. An operator may test his transmitting set before the first transmission by sending a few "V's" followed by his own station call sign.

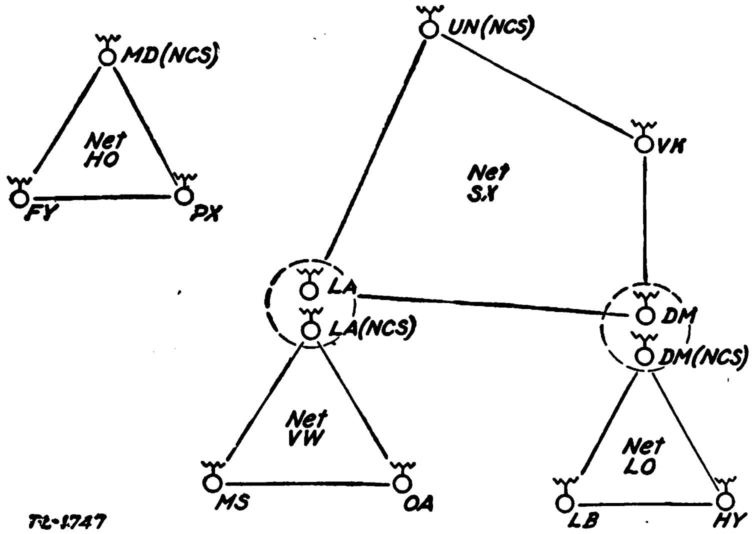



FIGURE 117.—Tactical radio nets.

(3) Messages and transmissions must be sent at a speed which will allow the receiving station to copy them on the first transmission. Thus no transmissions should be faster than the slowest operator in a net can receive them.

(4) Particular care is necessary that all call signs are made slowly and distinctly.

(5) The procedure sign for "wait" is used when an immediate answer cannot be given.

(6) An "end of message" sign will always be used.

*Q.* Can the call sign or frequency of another station or net be used? *A.* The use of any call sign or frequency not assigned by higher headquarters is prohibited.

*Q.* Where is information as to call signs and frequencies published? *A.* It is published in Signal Operation Instructions.

*Q.* What is "radio day"? *A.* It is the 24-hour period covered by a complete set of station records. It commences at midnight of the time zone in which the station is located and ends at the following midnight of the same zone. All station records of all stations in the net will be opened and closed in accordance with this rule.

*Q.* What is the operator's personal sign? *A.* Each operator is identified by a personal sign of one or two letters. No two operators in the same station will use the same sign. It is never transmitted but is used only in keeping of station records.

*Q.* What are procedure signals? *A.* Arbitrary nonsecret signals which have a specific meaning. The use of such signals cuts down materially on the time required by operators to handle traffic.

*Q.* Where are procedure signals prescribed? *A.* In the Joint Army and Navy Radiotelegraph and Radiotelephone Procedure, short title JANP.

*Q.* How may interference by hostile radio stations be minimized? *A.*

(1) By training radio operators in the strict observance of radio discipline and radio security.

(2) By the use of prearranged signals or groups of letters preceding each transmission to identify the station making the transmission.

(3) By frequent changes and limited use of call signs.

(4) By limiting the number of stations in a net.

*Q.* What messages are transmitted by the radio station? *A.* Only those authorized by competent authority.

*Q.* If a message is received in code, where is it decoded? *A.* The message center.

*Q.* What essential elements are recorded in the station log. *A.*

(1) Time entry for each notation.

(2) Operators on duty.

(3) Opening and closing of stations.

(4) Causes of delays in traffic.

(5) Frequency adjustments and changes.

(6) Unusual occurrences such as procedure violations and verifications.

*Q.* If the capture of station records by the enemy seems certain, what action should be taken? *A.* They should be destroyed.

*Q.* State the primary and secondary mission of radio station operators. *A.*

(1) *Primary.*—Closest cooperation with the message center to insure delivery of the message to the addressee without delay and exactly as written by the writer.

(2) *Secondary.*—The keeping of station records.

*Q.* What benefits are derived from station records? *A.* They are valuable in determining errors made by operating personnel, causes of delays in traffic, and in determining the proper actions necessary for increasing traffic efficiency. They are useful in the recovery of lost messages and as verification records.

*Q.* What is the range of the set furnished to your organization—

(1) Using radiotelephone?

(2) Using radiotelegraph?

*A.* See the operating instruction pamphlet issued with the set.

*Q.* Demonstate the procedure in setting up a radio set in the field. *A.* (Practical demonstration.)

*Q.* Demonstrate the operation of the field power unit. *A.* (Practical demonstration.)

*Q.* Demonstrate the operation of the radio set. *A.* (Practical demonstration.)

*Q.* Demonstrate ability to send and receive radiotelegraph messages. *A.* (Practical demonstration.)

## CHAPTER 12

# SEARCHLIGHTS



## SECTION I

## DRILL OF SEARCHLIGHT SECTION



**77. Mobile or portable seacoast searchlight.**—The examination in drill will be practical, the candidate performing the duties of such members of the searchlight squad as may be required. (See table V.)

*Q.* Of what personnel does the searchlight squad consist? *A.* The searchlight squad consists of a light commander (corporal) and four privates as follows: No. 1, controller operator; No. 2, light operator; No. 3, power plant operator; No. 4, chauffeur.

*Q.* How are mobile and portable seacoast searchlights designated? *A.* Sites selected for occupation by searchlights are designated consecutively from right to left, looking seaward, by numerals. Searchlights when occupying a given site are designated by the number of that site.

*Q.* How is the operation and control of searchlights coördinated? *A.* By certain definite commands having a prescribed meaning.

*Q.* What is the meaning of the command PREPARE FOR ACTION? *A.* The light will be put in its operating position, the power plant started, the light and the control means tested, and the personnel will take their posts.

*Q.* What is the meaning of the command REST? *A.* The designated light, if in action will be put out and the power plant shut down. Personnel except telephone operators will fall out but will remain in the immediate vicinity.

*Q.* What is the meaning of the command STAND BY? *A.* The designated light will be kept ready for action, and if the position of the target is known, the light will be kept trained on it.

*Q*. What is the meaning of the command IN ACTION? *A*. The designated searchlight will be put in operation immediately. Thus EIGHT, IN ACTION signifies that searchlight No. 8 is to be put in operation.

*Q*. What is the meaning of the command OUT? *A*. The designated searchlight is to be put out immediately and places the searchlight in the condition of STAND BY.

*Q*. What is the meaning of the command LOCAL CONTROL? *A*. The designated light will be operated by the hand control provision at the light. REMOTE CONTROL means that the light will be controlled by means of the electric controller located at some distance from the light.

*Q*. What is the meaning of the command AZIMUTH, FOUR ZERO? *A*. The designated searchlight will be set at the stated azimuth, thus TWO, AZIMUTH FOUR ZERO.

*Q*. What is the meaning of the command SEARCH? *A*. The designated searchlight will be used to search its entire area of responsibility. If the search of a certain subarea is desired, the command is TWO (or other light number) SEARCH LYNNHAVEN (or other subarea). The searchlight may be caused to search left or right by adding LEFT or RIGHT to the command SEARCH. It will continue to do so until ordered to halt.

*Q*. What is the meaning of the command FOLLOW? *A*. The beam of the searchlight will be kept on the target even if the latter passes out of the area which the light has been ordered to search, thus TWO FOLLOW.

*Q*. What is the meaning of the command COVER? *A*. The searchlight designated first will pick up the target being illuminated by another light, thus EIGHT, COVER TWO.

*Q*. What is the meaning of the commands FOCUS, SPREAD, CONTRACT, RIGHT, LEFT, RAISE, LOWER, HALT? *A*. These are commands used to accomplish the objects indicated by them. The first three have a direct application to a regulation of the beam condition.

*Q*. What is the meaning of the commands SLOW, SLOWER, FAST, FASTER? *A*. The rate of searching is regulated by these commands.

*Q*. What is the meaning of the command ELEVATE? *A*. At this command the beam is raised 30° above the horizontal and held there until further orders.

*Q*. What is the meaning of the commands TWO CONTROLLER, TWO LIGHT? *A*. These commands are used to distinguish between the telephone operator on the controller and the telephone operator at the light. The commands as above will always be given designating the proper light.

TABLE V.—*Drill of mobile and portable seacoast searchlight*

| Details | PREPARE FOR ACTION | EXAMINE EQUIPMENT | REST | STAND BY | IN ACTION | OUT OF ACTION | MARCH ORDER |
|---|---|---|---|---|---|---|---|
| Light commander. | Upon arrival at the designated site for the light, commands: PREPARE FOR ACTION. Supervises unloading and setting up of equipment. Proceeds to control station. | Commands: EXAMINE EQUIPMENT. Supervises the operations of members of the squad. Supervises orienting and synchronization of searchlight and controller. Has power turned on and tests functioning of distant electric control system. Assures himself that the signal buzzer to light operates. When reports have been received from all members of the squad, reports to searchlight officer "No.—in order." | After reporting in order and if no warning of a target has been received, commands: REST. Causes all personnel to remain in the immediate vicinity of their posts prepared to assume the "stand by" without delay. Arranges any reliefs that may be necessary. | Commands: STAND BY. When power is on and all lines and equipment are in "stand by" condition he reports "No. —standing by." If a target has been designated he causes the light to be traversed to that azimuth. If extended hand control is being used he causes No. 1 to proceed to the light to take over the extended hand control and control the light in accordance with verbal directions from the control station. | If electric control is being used, signals the light operator by means of the buzzer system. If extended hand control is used commands: IN ACTION, to light by telephone from control station. | Commands or signals by buzzer: OUT, to the light. Causes crew to assume "stand by" status. | Ascertains the conditions of movement of the unit. Commands: MARCH ORDER. Supervises the picking up and stowing of equipment. Checks to see that hold-down devices are fastened in the truck prior to taking the road. |

TABLE V.—*Drill of mobile and portable seacoast searchlight*—Continued

| Details | PREPARE FOR ACTION | EXAMINE EQUIPMENT | REST | STAND BY | IN ACTION | OUT OF ACTION | MARCH ORDER |
|---|---|---|---|---|---|---|---|
| No. 1, azimuth controller. | Assists in maneuvering power plant into position and unloading searchlight. When truck arrives at control station, unloads and sets up control station assisted by No. 4. Assisted by No. 2, moves power cable (yellow) reels to rear of truck. Pays out cables as truck moves from power plant to searchlight. Assisted by No. 2, moves light control cable (red) reel to rear of truck. Pays out cable as truck moves from light to control station. Remains at control station and connects red cable to controller. Removes telephone from truck and connects it to line to searchlight officer and checks communication. | Nos. 1 and 4 together examine and test control system by elevating and traversing the light. They assist the light commander in orienting and synchronizing the control station and searchlight. Reports "Control station in order." | Remains near the control station telephone. | Takes post at azimuth control at the control station awaiting orders. If extended hand control is used, proceeds to the extended hand control of light at the direction of the light commander and awaits orders from the control station. | Moves the light in azimuth in accordance with instructions received by telephone from the searchlight control officer, keeping the target in the side of the beam next to the using organization. If extended hand control is used moves the light in azimuth and elevation in accordance with instructions from the control station. | Stands by for further orders. | Assisted by No. 4 knocks down control stations and packs it on truck. Disconnects telephone and places it on truck. Places red cable reel on rear of truck and reels in cable. Assists in loading searchlight on truck. Verifies that controller is properly fastened by hold-down devices. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| No. 2, light operator. | Assists in maneuvering power plant into position and, assisted by Nos. 1, 3, and 4, unloads searchlight from truck. Sets up and levels searchlight. Removes extended hand control from truck. Connects yellow and red cables. Procures cleaning and greasing material. Prepares light for action. Removes telephone from truck and makes wire connection and checks communication. | Examines searchlight and verifies electrical connections. Sees that fresh carbons (positive with preformed crater) are in place in the light. Verifies that spare carbons are on hand. Assists in orienting and synchronizing searchlight and control station. Verifies that extended hand control is close to light and ready for use. *If allowable*, tests light mechanism by turning on arc.<br>*Note*.—In many situations it is unwise to test by turning on arc, giving away position. This may be overcome by covering front of light with tarpaulin, or piece of canvas.<br>Reports "Light in order." | Turns off arc, if on. Remains in vicinity of light. | Stands by at post alongside searchlight. Verifies that voltmeter reads the proper voltage. | Closes main arc switch on command or signal. Keeps watch on instruments to see that arc operates at 78 volts and 150 amperes. Recarbons arc at first break in operation after positive carbon is half burned (after about 45 minutes of operation). | Opens main arc switch upon signal or command. Stands by ready to close main switch on command or signal. | Disconnects cables at the light. Secures light in traveling position. Assisted by Nos. 1, 3, and 4, loads light on truck. Verifies that light has been properly fastened by hold-down devices. Assisted by No. 1, moves yellow reels to rear of truck and reels in cables. Disconnects telephone at the light and places it on truck. Places extended hand control on truck. |
| No. 3 | Assisted by Nos. 1, 2, and 4, maneuvers power plant into position. Assists in unloading searchlight. Connects power cables (yellow) to power plant. | Sees that gasoline, oil, and water supply is correct. Starts motor and builds up voltage to required value. *If allowable*, the searchlight is lighted to make the necessary adjustments. Reports "Power plant in order." | Opens switches. Shuts down power plant, if running. Checks condition of power plant. Remains in the immediate vicinity of power plant. | Starts motor, builds up voltage to proper no-load value, closes switches, and reports or signals "Power plant ready" to light commander. | Continues as at "Stand by," checking that voltage is at proper full-load value and amperage is correct. | Continues as at "Stand by," checking that voltage is at proper no-load value. | Disconnects power cables at the power plant. Secures the power plant for traveling. Enters in log hours run. |

TABLE V.—*Drill of mobile and portable seacoast searchlight*—Continued

| Details | PREPARE FOR ACTION | EXAMINE EQUIPMENT | REST | STAND BY | IN ACTION | OUT OF ACTION | MARCH ORDER |
|---|---|---|---|---|---|---|---|
| No. 4 | Assists in maneuvering power plant into position. Drives truck to searchlight position. Assists in unloading searchlight. Drives truck to control station. Assists No. 1 in unloading and setting up control station. Drives truck to indicated parking position and sees that it is properly concealed. Returns to control station and acts as elevation controller. | Assists No. 1 in examining and testing control station system and in synchronizing and orienting control station and searchlight. | Such duties as directed by light commander. | Takes his post at elevation control of the control station. If extended hand control is being used proceeds to the light with No. 1 to act as telephone operator for light control. | Moves the light in elevation by means of the controller in accordance with instructions received. If extended hand control is used, receives instructions at the light by telephone from the control station and relays them to No. 1. | Stands by for further orders. | Drives truck to control station. Assists No. 1 in knocking down and stowing control station equipment. Drives truck to searchlight and assists in loading the light. Drives truck to power plant and picks up power plant. Receives instructions from the light commander relative to the movement of the unit. |

## SECTION II

## NOMENCLATURE OF VARIOUS PARTS OF SEARCHLIGHT



**78. General.**—*Q*. In learning the names of the various parts what should you bear in mind? *A*. In addition to learning the names of the various parts, you should also find out for what purpose each part is used.

*Q*. What is the maximum range of a searchlight? *A*. This depends on atmospheric conditions—an average value of 10,000 yards as an approximate maximum range under good conditions.

*Q*. What shape or type is the mirror of the searchlight? *A*. It is a metal parabolic mirror. When light is emitted from a source (the carbon arc) at the focal point of the mirror, the light is reflected from the mirror in parallel rays of light.

*Q*. What is the beam candlepower of the searchlight? *A*. It is rated at 800 million candlepower.

*Q*. What causes such a great amount of light in the beam? *A*. This is caused by the burning of gases in the positive carbon crater.

*Q*. In general, how long do the positive and negative carbons burn? *A*. All carbons burn for approximately 1½ hours.

*Q*. In how many ways may the carbons be fed? *A*. Three: automatically, semiautomatically, or by hand.

*Q*. How can you tell the positive carbon from the negative carbon? *A*. The positive carbon is longer and thicker than the negative carbon. When issued the positive carbon is 22 inches long and 0.633 inch in diameter; the negative carbon is 12 inches long and 0.434 inch in diameter.

*Q*. Which carbon burns out first? *A*. The positive carbon. For this reason the arc must be watched carefully so that the positive nose cap is not melted.

*Q*. Do all antiaircraft searchlights have an extended hand controller for pointing the light manually in azimuth and elevation? *A*. Yes.

**79. Sperry searchlights.**—*Q*. Point out the various parts of the Sperry searchlight with which your unit is equipped. While pointing out each part describe its use. *A*. See figures 118, 119, 120, and 121.

NOTE.—All Sperry searchlights are similar except as noted under columns headed "Part" and "Purpose or use".

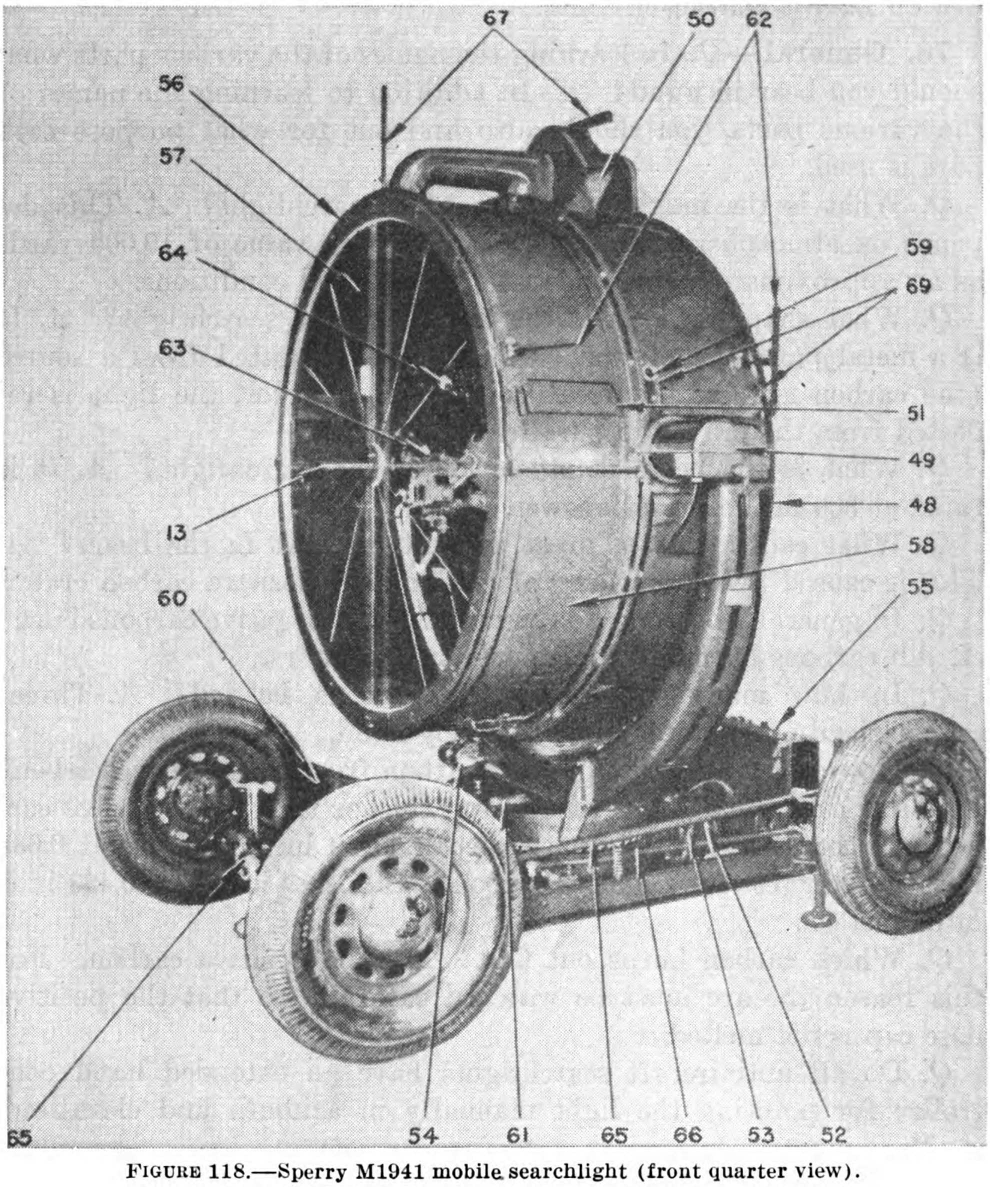



FIGURE 118.—Sperry M1941 mobile searchlight (front quarter view).

| Part | Purpose or use |
|---|---|
| 13. Positive carbon | When burning, light comes from incandescent gas which forms in the positive crater. |
| 48. Rear drum | Made of aluminum alloy, it houses and supports the metal mirror and the arc lamp column on which is mounted the lamp unit. |
| 49. Elevation data receiver housing. (Not part of M1934 and M-VI lights. M-VI light has a transmitter instead of a receiver at this location.) | It houses the elevation data receiver which is connected electrically by cable to the sound locator elevation data transmitter. The receiver causes the elevation zero readers (one at the searchlight and one at the control station) to indicate elevation data. (For the M-VI light only: The transmitter sends data to the comparator giving the position of the light.) |
| 50. Ventilating motor and exhaust vent. | This motor causes fresh air to be drawn into the drum, and it exhausts burnt gases from the arc through the exhaust vent. |
| 51. Ventilating fan intake vents. | Fresh air enters the drum at five intake vents. |
| 52. Azimuth control motor | This motor causes the searchlight to rotate in azimuth and is controlled by the azimuth distant electric control handwheels at the control station. (For the M-VI light only: A control switch for this motor is mounted under main power receptacles.) |
| 53. Azimuth motor clutch lever. | When clutch lever is in the "out" position, the shaft of the azimuth control motor is disconnected. When the clutch lever is "in," the azimuth control motor shaft is connected to the searchlight ring gear and can turn the light in azimuth. |
| 54. Azimuth scale lamp | To furnish illumination so azimuth scale may be set to correct azimuth when orienting. |
| 55. Junction box | All cables are connected to the junction box, and wiring goes out of the junction box to connect the proper circuit. |
| 56. Front drum | Made of sheet duralumin, it is bolted to the rear drum and supports the front door. |
| 57. Glass door | This glass protects the arc from wind and rain. The twelve-segment construction makes it shockproof. |
| 58. Sliding panel | There are two sliding panels, one on each side of the front drum, to permit access to the interior of the drum for maintenance and recarboning. |
| 59. Arc view peep sight | To observe the condition and position of the arc. |
| 60. Ballast resistor | Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.* |
| 61. Handhold plate | Permits access into the base to inspect brushes and slip rings which form a part of various circuits, including the main arc circuit. |
| 62. Elevation daylight sights | These are provided so that the error in pointing the searchlight in elevation may be determined. The sights are graduated in mils. |
| 63. Lamp unit | Mechanism for supporting and feeding the carbons. |
| 64. Recarboning lamp | To give illumination inside the drum when recarboning the lamp at night. |
| 65. Steering tongue and lug | For steering the searchlight. |
| 66. Transportation bar | To lock the searchlight drum in its traveling position. |
| 67. Azimuth daylight sights | These are provided so that the error in pointing the searchlight at the target in azimuth may be determined. |
| 69. Orienting sights | For use in orienting the searchlight with sound locator. (On earlier models than the M1941, the orienting sights are mounted on the right side of the drum.) |

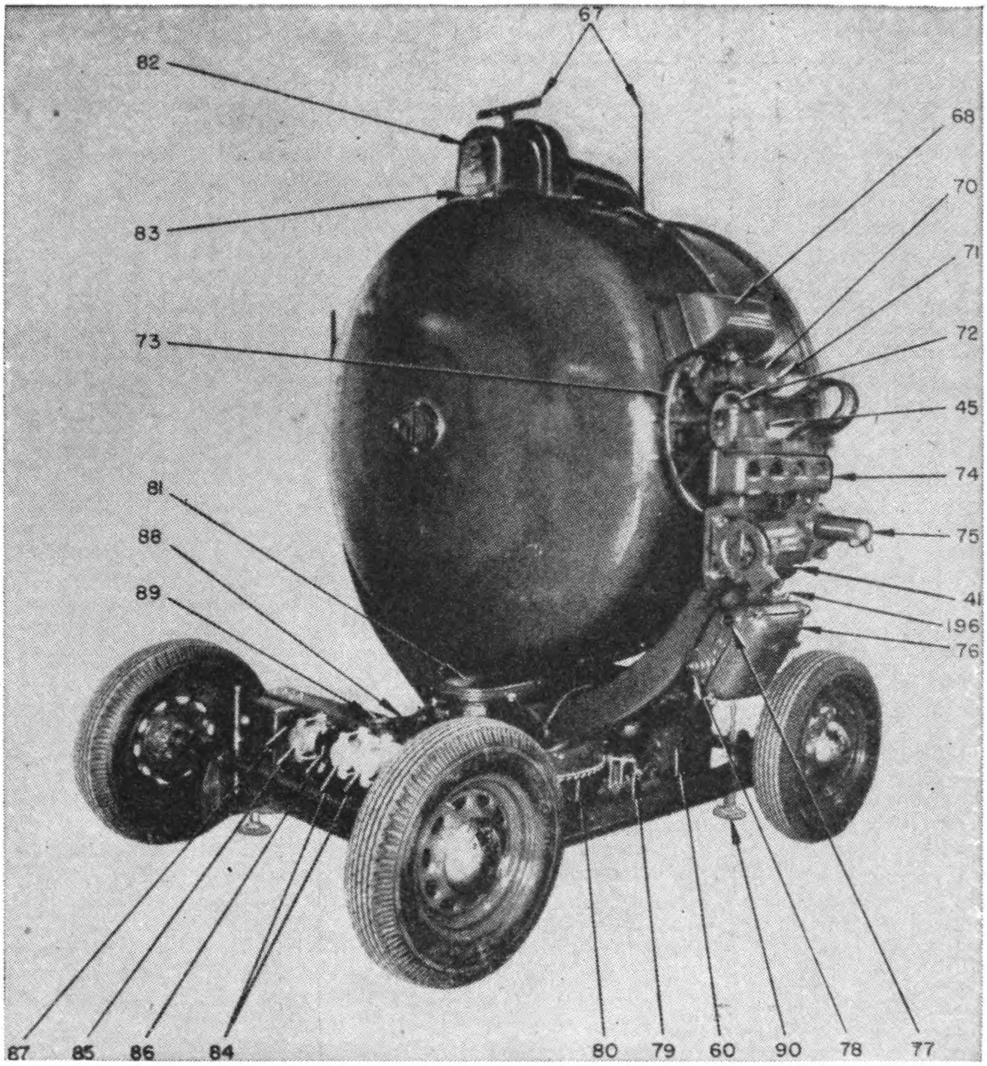



FIGURE 119.—Sperry M1941 mobile searchlight (rear quarter view).

| Part | Purpose or use |
|---|---|
| 41. Elevation control motor | This motor causes the searchlight to elevate or depress and is controlled by the elevation distant electric control handwheels at the control station. (For the M–VI light only: A control switch for this motor is mounted on the right trunnion arm.) |
| 45. Arc view peep sight | To observe the condition and position of the arc. |
| 60. Ballast resistor | Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.* |
| 67. Azimuth daylight sights | These are provided so that the error in pointing the searchlight in azimuth may be determined. |
| 68. Lamp control mechanism box. | This box houses the mechanism which automatically feeds the carbons so that the arc operates at a voltage of 78 volts and a current of 150 amperes. |
| 70. Recarboning lamp switch | Turns on the recarboning lamp. The scale and meter light switch must be "on" also, except on the M–VI light. |
| 71. Elevation scale lamp | To illuminate the elevation scale when orienting. |

| Part | Purpose or use |
|---|---|
| 72. Elevation scale | It is used for orienting and pointing the light in elevation. |
| 73. Elevation gear sector | The elevation control motor and the elevation extended hand control are geared to this gear sector so that the light may be elevated or depressed. |
| 74. Meter box | It contains an azimuth zero reader, an elevation zero reader, an ammeter to check the arc current at 150 amperes, and a voltmeter to check the arc voltage at 78 volts. (For the M1937 light only: The elevation zero reader is mounted near the left trunnion on its receiver, the azimuth zero reader on the base of the light near its receiver.) (For the M-VI and M1934 lights only: There are no zero readers on these lights.) |
| 75. Hand controller socket | The extended hand controller fits into this socket. |
| 76. Arc switch box | This box houses the arc switch. |
| 77. Extension lamp receptacle | A trouble lamp extension cord is connected to this receptacle. |
| 78. Scale and meter light switch. | Lights lamps so that the meter box instruments can be seen, and also turns on the azimuth and elevation scale lamps. |
| 79. Azimuth lock | Locks searchlight in azimuth traveling position. |
| 80. Azimuth scale | For orienting the searchlight in azimuth. |
| 81. Azimuth data receiver housing. (Not part of M1934 and M-VI lights. M-VI lights has a transmitter instead of a receiver at this location.) | It houses the azimuth data receiver which is connected electrically by cable to the sound locator azimuth data transmitter. The receiver causes the azimuth zero readers (one at the searchlight and one at the control station) to indicate azimuth data. (For the M-VI light only: The transmitter sends data to the comparator giving the light position.) |
| 82. Ventilating motor housing | Houses ventilating motor and fan. |
| 83. Transportation lock bar lug | The transportation bar is locked to this lug so that the drum can be locked in its traveling position. |
| 84. Power cable receptacles | Painted yellow. The yellow positive and negative power cables are connected here. |
| 85. Control station cable receptacle. | Painted red. The red cable from the control station is connected here. |
| 86. Sound locator cable receptacle. (Not part of the M-VI and M1934 lights since this cable goes to comparator directly on these models. The M-VI light has a white receptacle and a green receptacle at this location.) | Painted blue. The blue cable from the sound locator connects to this receptacle. (For the M-VI light only: The white cable for sending searchlight position data to the comparator connects to the white receptacle. The green cable for delivering 110-volts alternating-current for the a-c data transmission system connects the green receptacle to the power unit.) |
| 87. Signal buzzer. (Not part of the M-VI or M1934 lights.) | The buzzer switch button at the control station is closed when the searchlight is to be put "in action." |
| 88. Dynamotor (behind wheel). (For the M-VI light it is located at the power plant. For the M1934 unit it is located at the control station.) | This is a motor generator. The motor operates at line voltage, driving the generator which generates 110-volts alternating current to operate the data transmission system. |
| 89. Dynamotor pilot light | A red light indicates that there is a-c power for the data transmission system. |
| 90. Leveling jacks | For leveling the searchlight. Two levels are provided on the base of the searchlight for this purpose. |
| 196. Recarboning safety switch. (Found only on the M1941 light.) | *Switch must be thrown to "recarboning" position before entering drum, otherwise a person may be killed.* |

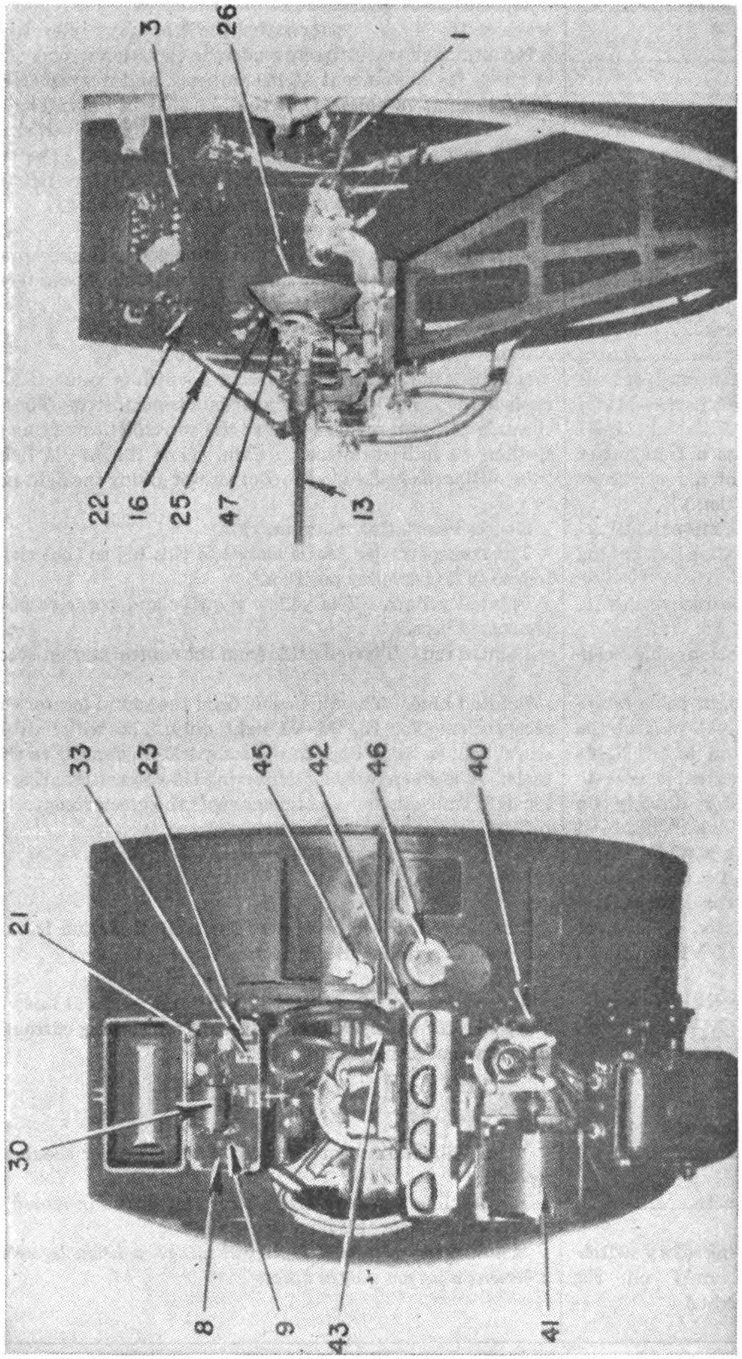



FIGURE 120.—Lamp and lamp-control mechanism, Sperry M1941 searchlight.

| Part | Purpose or use |
|---|---|
| 1. Negative carbon | Direct current passing through this carbon and the positive carbon forms the arc of the searchlight. |
| 3. Negative control rod | This rod rotates so as to feed the negative carbon forward or backward. |
| 8. Negative hand feed knob | Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed. |
| 9. Negative feed centralizer lever. | When this lever is moved to its "auto" position, the negative carbon feeds automatically. When moved to "hand" position, the negative carbon must be fed by hand. (See part 8 above.) |
| 13. Positive carbon | When the arc is operating, the positive carbon burns, causing incandescent gas to form a "positive crater." From this crater comes the brilliant light for the beam. |
| 16. Positive control rod | This rod rotates counterclockwise so that the positive carbon may be fed forward and then rotated to cause the positive crater to burn evenly. |
| 21. Positive hand feed handwheel. | Rotating this handwheel counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon. |
| 23. Positive feed rate adjustment screw. | Adjust this screw so that the "normal rate of feed" (one "click") is *slightly less* than the rate of burning of the positive carbon. This normal rate of feed allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror. |
| 25. Thermostat | When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This causes rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror. |
| 26. Thermostat lens | This lens focuses rays of light so as to cause the thermostat to operate. |
| 30. Feed motor | This motor activates the feed mechanism so that the positive and negative carbons may be fed automatically. |
| 33. Arc length adjustment screw. | In automatic operation, this screw is adjusted so that the arc voltage is 78 volts as read on the voltmeter. |
| 40. Elevation control clutch lever. | With this clutch in the D. E. C. position, the searchlight is elevated or depressed by distant electric control. With the clutch in the "hand" position, the extended hand controller is used to elevate or depress the searchlight. |
| 41. Elevation control motor | See figure 119, part 41. |
| 42. Focusing knob (behind meter box). | Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror. |
| 43. Thermostat adjusting screw | This screw adjusts the distance between the contacts of the thermostat bimetallic switch. |
| 45. Peep sight | To observe the condition and position of the arc. |
| 46. Ground glass finder | This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black or focal line. *Never allow the positive carbon to burn back beyond the red danger line.* |
| 47. Focusing rod | This rod rotates when the focusing knob is turned, and moves the lamp unit. |

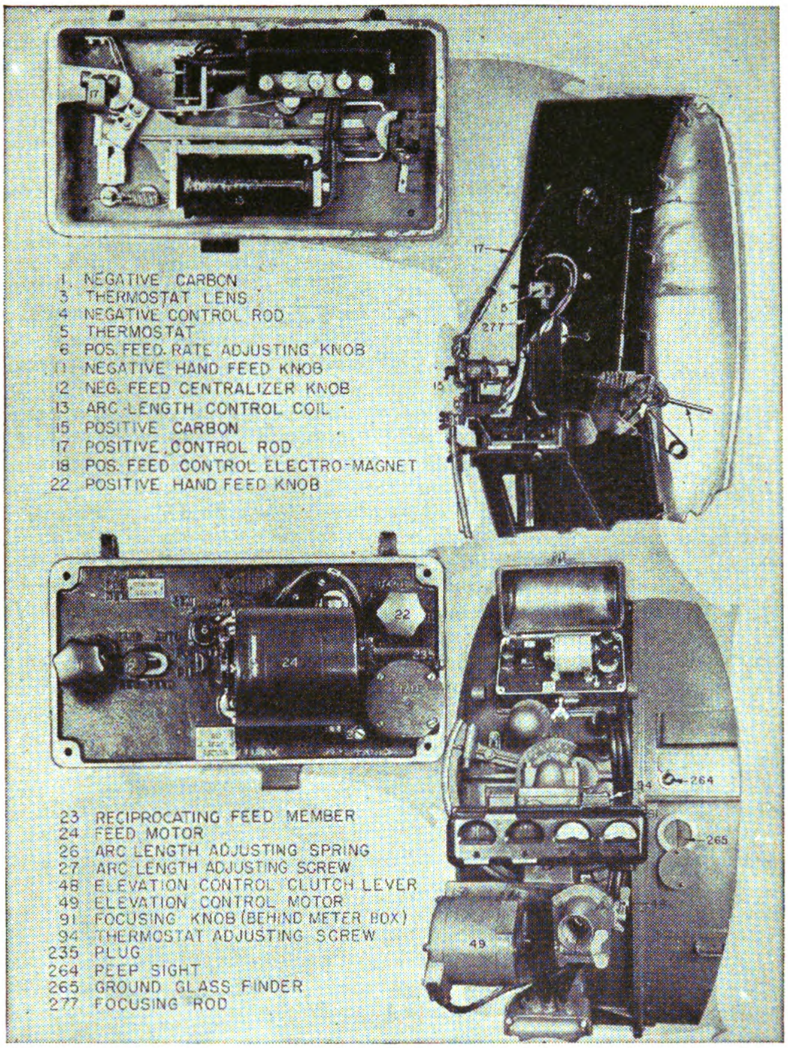



FIGURE 121.—Lamp and lamp control mechanism, Sperry M1934 searchlight.

NOTE.—The nomenclature of the M-VI, M1937, M1939, and M1940 Sperry lights is the same as that of the M1934 light.

| Part | Purpose or use |
|---|---|
| 1. Negative carbon | Direct current passing through this carbon and the positive carbon forms the arc of the searchlight. |
| 3. Thermostat lens | This lens focuses rays of light on the thermostat bimetallic strip. |
| 4. Negative control rod | This rod rotates so as to feed the negative carbon forward or backward. |
| 5. Thermostat | When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This causes rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror. |
| 6. Positive feed rate adjusting knob. | Adjust this knob so that the normal rate of feed (one click) is *slightly less* than the rate of burning of the positive carbon. This normal rate of feed allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror. |
| 11. Negative hand feed knob | Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed. |
| 12. Negative feed centralizer knob. | When this knob is moved to its "auto" position, the negative carbon feeds automatically. When moved to "hand" position, the negative carbon must be fed by hand. |
| 13. Arc length control coil | This coil acts as a magnet and positions an armature which causes the negative carbon to feed so as to keep the arc length constant. |
| 15. Positive carbon | When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam. |
| 17. Positive control rod | This rod rotates counterclockwise so that the positive carbon may be fed forward and then rotated to cause the positive crater to burn evenly. |
| 18. Positive feed control electromagnet. | This magnet is energized when the thermostat operates. It pulls up a guard so that the positive carbon may be fed forward faster. |
| 22. Positive hand feed knob | Rotating this knob counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon. |
| 23. Reciprocating feed member | The part is moved back and forth by the feed motor and causes the positive and negative carbons to be fed. |
| 24. Feed motor | This motor is the source of power for operating the feed mechanism. |
| 26. Arc length adjusting spring | This holds the armature in its correct position against the pull of the arc length control coil. |
| 27. Arc length adjusting screw | It adjusts the arc length adjusting spring so as to keep the arc voltage at 78 volts as read on voltmeter. |
| 48. Elevation control clutch lever. | With this clutch in the D. E. C. position, the searchlight is elevated or depressed by distant electric control. With the clutch in the "hand" position, the extended hand controller is used to elevate or depress the searchlight. |
| 49. Elevation control motor | Causes light to be elevated or depressed. It is controlled by the elevation operator at the control station. |
| 91. Focusing knob (behind meter box). | Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror. |
| 94. Thermostat adjusting screw | This screw adjusts the distance between the contacts of the thermostat bimetallic switch. |
| 235. Plug | Removal of this plug provides access to the feed motor shaft. |

**80. General Electric searchlight.**—*Q*. Point out the various parts of the M1940 General Electric searchlight. *A*. See figures 122 and 123.

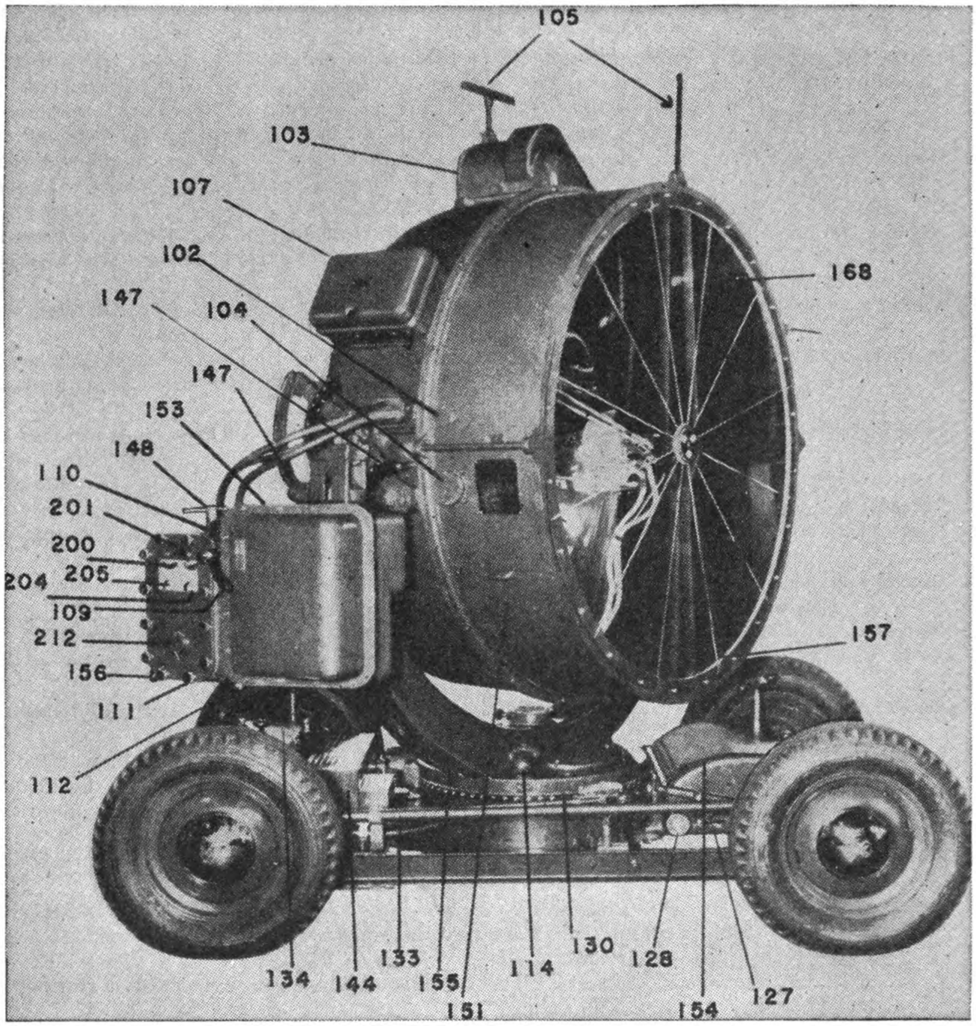



FIGURE 122.—General Electric M1940 searchlight (front quarter view).

| Part | Purpose or use |
|---|---|
| 102. Arc viewing window | To observe the position and condition of the arc. |
| 103. Ventilating fan motor housing. | This houses the ventilating fan which exhausts the burned gases from the drum interior. |
| 104. Arc image screen | This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.* |
| 105. Azimuth daylight sights | For use in training. Platoon commander may check in azimuth while a target is being tracked, thus observing any error. |
| 107. Lamp control mechanism box. | Within this box are located the various mechanisms for feeding the positive and negative carbons. |
| 109. Elevation brake handle | For locking the searchlight at any desired elevation. |
| 110. Extended hand control bar socket. | The extended hand control bar fits in this socket so light may be moved by hand in elevation and azimuth. |
| 111. Recarboning lamp switch | Light is turned on inside the drum during recarboning. |
| 112. Scale lamp switch | This switch turns on meter, elevation scale, and azimuth scale lamps. |
| 114. Azimuth scale lamp | To illuminate azimuth scale. |
| 127. Azimuth clutch handle | This disconnects the azimuth D. E. C. training motor when traversing by hand. |
| 128. Dynamotor switch | This turns on the dynamotor which converts direct current into alternating current for use in the data transmission system and for the D. E. C. system. |
| 130. Elevation stowing rod | The searchlight drum is elevated and locked in this position by means of the stowing rod when the light is put in traveling position. |
| 133. Towing bar | For steering the light and for towing by hand for short distances. |
| 134. Junction box | All cables are connected to the junction box, from which place connections are made to the proper circuits. |
| 144. Ballast resistor | This resistor is in the arc circuit. *Never change this connection except under the direct supervision of an electrical sergeant or an officer.* |
| 147. Focusing knob | By turning this knob the lamp may be moved so that positive crater is at the focal point of mirror. |
| 148. Extended hand control bar clamp. | This clamps the extended hand control bar in the socket. |
| 149. Elevation scale lamp | For illuminating the elevation scale. |
| 151. Drum access door | For entering drum for recarboning or other purpose. |
| 153. Elevation control box | Within this box is the D. E. C. elevation training motor and its auxiliary equipment. |
| 154. Azimuth control box | Within this box is the D. E. C. azimuth training motor and its auxiliary equipment. |
| 155. Azimuth scale | This scale is used when orienting the searchlight. It may be slipped around for proper setting. |
| 156. Arc switch handle | This switch when "closed" allows the arc to form and a current to flow through it. |
| 157. Counterweight | This helps to balance the searchlight on its trunnions. |
| 168. Glass door | This glass protects the arc from wind and rain. The twelve-segment construction makes it shockproof. |
| 200. Azimuth zero reader | This is a voltmeter which has a pointer at the center of its scale. When new sound locator azimuth data is received this pointer moves away from its center (or zero) position. |
| 201. Elevation zero reader | This is a voltmeter with a pointer at the center (or zero) of its scale. When new sound locator elevation data is received the pointer moves away from its center (or zero) position. |
| 204. Arc ammeter | This ammeter indicates the amount of current flowing through the arc. It should read 150 amperes when the arc is operating properly. |
| 205. Arc voltmeter | The voltmeter indicates the voltage drop across the arc. It should read 78 volts when the arc is functioning properly. |
| 212. Dynamotor a-c indicating lamp. | A red lamp glows when the dynamotor is operating. |

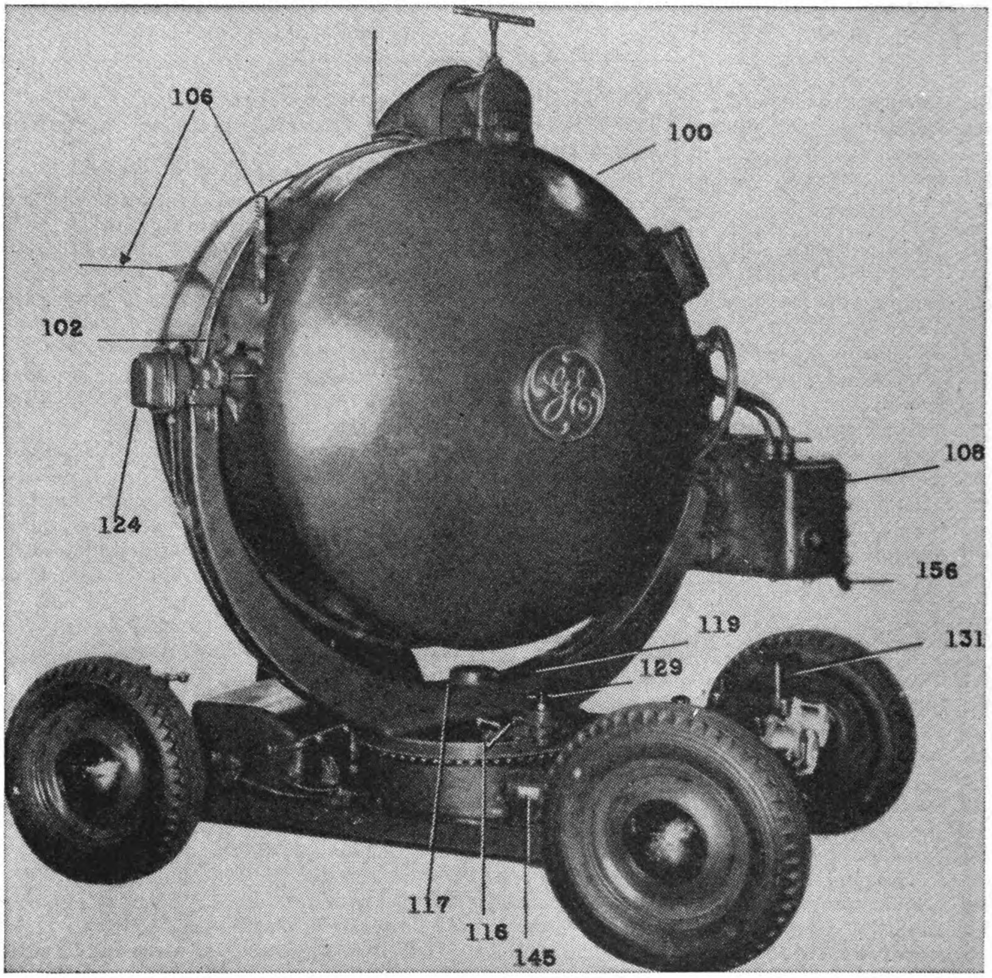



FIGURE 123.—General Electric M1940 searchlight (rear quarter view).

| Part | Purpose or use |
|---|---|
| 100. Drum | The drum contains the metal mirror and supports the lamp, lamp feed mechanism, and the ventilating system. |
| 102. Arc viewing window | To observe the position and condition of the arc. |
| 106. Elevation daylight sights | For use in training. Platoon commander can check in elevation while a target is being tracked, thus observing any error. |
| 108. Elevation clutch handle | When this handle is in the hand control position the searchlight may be elevated by hand. |
| 116. Levels | To level the searchlight. |
| 117. Spindle cover | For access to the spindle and azimuth data receiver. |
| 119. Azimuth correction knob | For use when synchronizing the azimuth zero reader system. |
| 124. Elevation data receiver cover. | This cover must be taken off to synchronize the elevation zero reader system. |
| 129. Azimuth stowing lock | When putting the searchlight in traveling position this locks the searchlight in azimuth. |
| 131. Leveling jacks | For leveling the searchlight. |
| 145. Dynamotor | Converts direct current to alternating current which is used by the data transmission system and the D. E. C. system. |
| 156. Arc switch handle | Closing this switch permits the arc to start. |

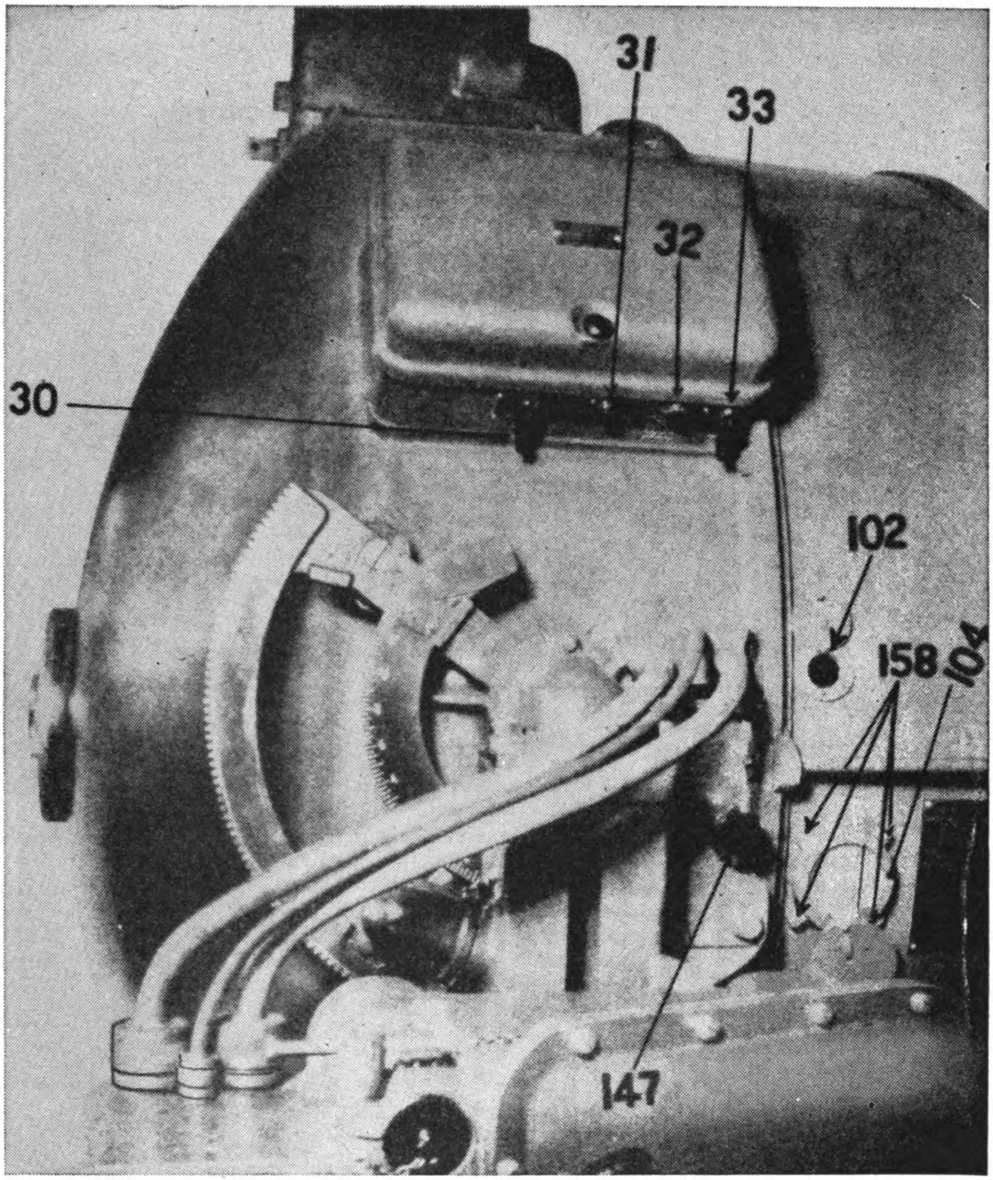



FIGURE 124.—General Electric M1940 searchlight (right upper view).

| Part | Purpose or use |
|---|---|
| 30. Negative carbon manual drive crank. | By pushing this crank "in," the negative carbon may be fed by hand instead of automatically. |
| 31. Positive carbon feed button. | Push button "in" to feed positive carbon faster. In hand operation it is worked in conjunction with part 33. |
| 32. Positive carbon feed rate adjustment knob. | Turning this knob clockwise causes the positive carbon to feed faster. |
| 33. Positive carbon manual drive crank. | Push in crank and turn in clockwise direction to rotate positive carbon. In hand feed it is worked in conjunction with part 31. |
| 102. Arc viewing window | To observe the condition and position of the arc. |
| 104. Arc image screen | This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.* |
| 147. Focusing knob | By turning this knob the lamp assembly is moved so that the positive crater is placed at the focal point of the mirror. |
| 158. Arc image adjusting screws. | These are for making a correct adjustment of the positive carbon on the image screen *by the searchlight commander.* |

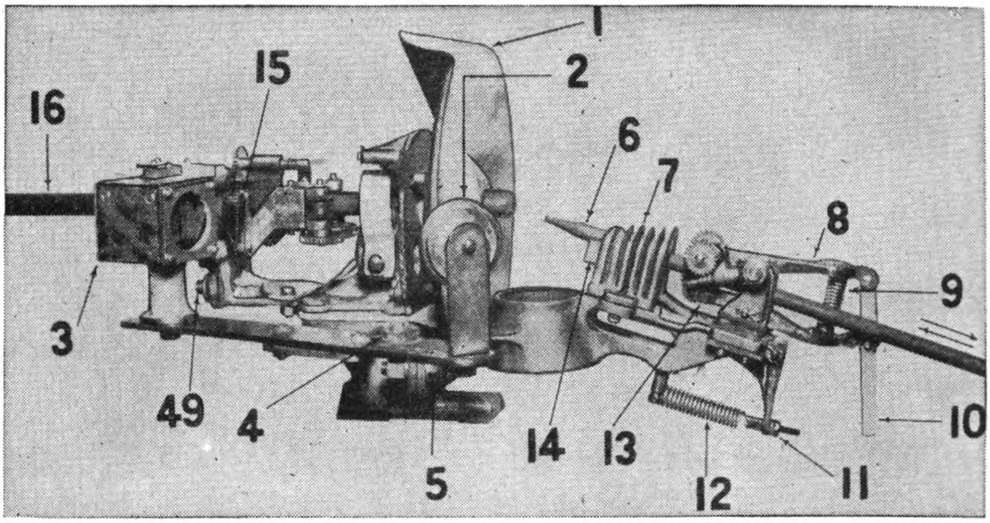



FIGURE 125.—General Electric M1940 lamp.

| Part | Purpose or use |
|---|---|
| 1. Obturator | This is a bronze casting to protect the positive head from excessive heat. It also prevents stray light. |
| 2. Thermostat mirror | This mirror reflects rays of light from the positive crater onto the thermostat. |
| 3. Thermostat | When the positive carbon burns back too far, rays of light heat up the thermostat bimetallic strip which closes a circuit. This causes the positive carbon to feed forward to its proper position. |
| 4. Positive carbon protrusion adjusting nut. | This adjustment positions the thermostat mirror which, through the thermostat, keeps the positive carbon at its proper position, ¾ inch from positive nose. |
| 5. Negative head mounting bolts. | Holds negative head to lamp base. |
| 6. Negative carbon | This carbon, plus the positive carbon, allows the arc to function by having *direct current* pass through it. |
| 7. Negative nose | Bronze casting for holding negative carbon. |
| 8. Movable drive roller bracket | On this bracket are mounted the upper negative feed rollers. |
| 9. Negative carbon drive pressure spring. | This spring causes the negative feed rollers to make good contact with the negative carbon. |
| 10. Negative carbon drive roller clamp. | Pushing this clamp to the left lifts the movable drive roller bracket so that a new negative carbon may be inserted. |
| 11. Negative carbon brush pressure adjusting nut. | Screwing the adjusting nut further up causes more pressure to be applied by negative brush 14 on negative carbon 6. |
| 12. Negative carbon brush pressure spring. | This spring exerts the force which causes a pressure of the negative brush on the negative carbon. |
| 13. Adjustable drive roller bracket. | On this adjustable bracket are mounted the lower negative feed rollers. |
| 14. Negative brush | This brush makes a good contact with the negative carbon so current may flow through it more easily. |
| 15. Positive carbon feed roller clamp. | This clamp is used when renewing the positive carbon. It separates the postive feed rollers. |
| 16. Positive carbon | When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam. |
| 49. Positive head mounting bolt. | This holds the positive head to the lamp base. |

SECTION III

# NOMENCLATURE OF VARIOUS PARTS OF CONTROL SYSTEM



**81. General.**—*Q*. Why is a control station necessary? *A*. To obtain the best "contrast" the operator must be at least 50 feet away from the searchlight beam. At this distanee an electrical remote control system must be used to point the searchlight in azimuth and elevation. The control station is a part of this remote control system, and from this station the searchlight may be pointed in azimuth and elevation.

*Q*. What is meant by "contrast"? *A*. "Contrast" means the difference between the amount of light reflected from the target and the amount of light reflected from the illuminated sky background. The greater the contrast the better the target can be seen in the beam.

*Q*. In addition to being able to control the searchlight from a remote point, what other function must the control station perform? *A*. It must give an indication of sound locator data so that the searchlight may be pointed correctly. Also, M1934 and later control stations have a means for searching 5° around sound locator data.

**82. Sperry control stations.**—*Q*. How is "searching" accomplished on the Sperry control stations? *A*.

(1) *M1939, M1940 and M1941 control stations only.*—Each zero reader has three graduations on its face, a center index, and a graduation on either side of the index. Using the zero reader handwheel to move the pointer *slowly* between the outer graduations will cause the searchlight to search 5° around sound locator data.

(2) *M1937 control station only.*—Pushing in the search control knob (located to the right of the azimuth zero reader) causes an electric motor to drive an oscillating mechanism, which causes an automatic oscillation in elevation of 5° around sound locator data. Rotating the search control knob slowly offsets the azimuth zero reader pointer which, when brought back to its center position, causes a 5° search in azimuth around sound locator data.

(3) *M1934 control station only.*—An automatic spiral searching device, which causes a search in both azimuth and elevation of 5° around sound locator data, is controlled by a handwheel placed di-

rectly under the binocular mount. When the handwheel is rotated *slowly* the searchlight searches 5° around sound locator data.

*Q.* Name and give the functions of the various parts of the control station with which your organization is equipped. *A.* See figures 126 to 129, inclusive.

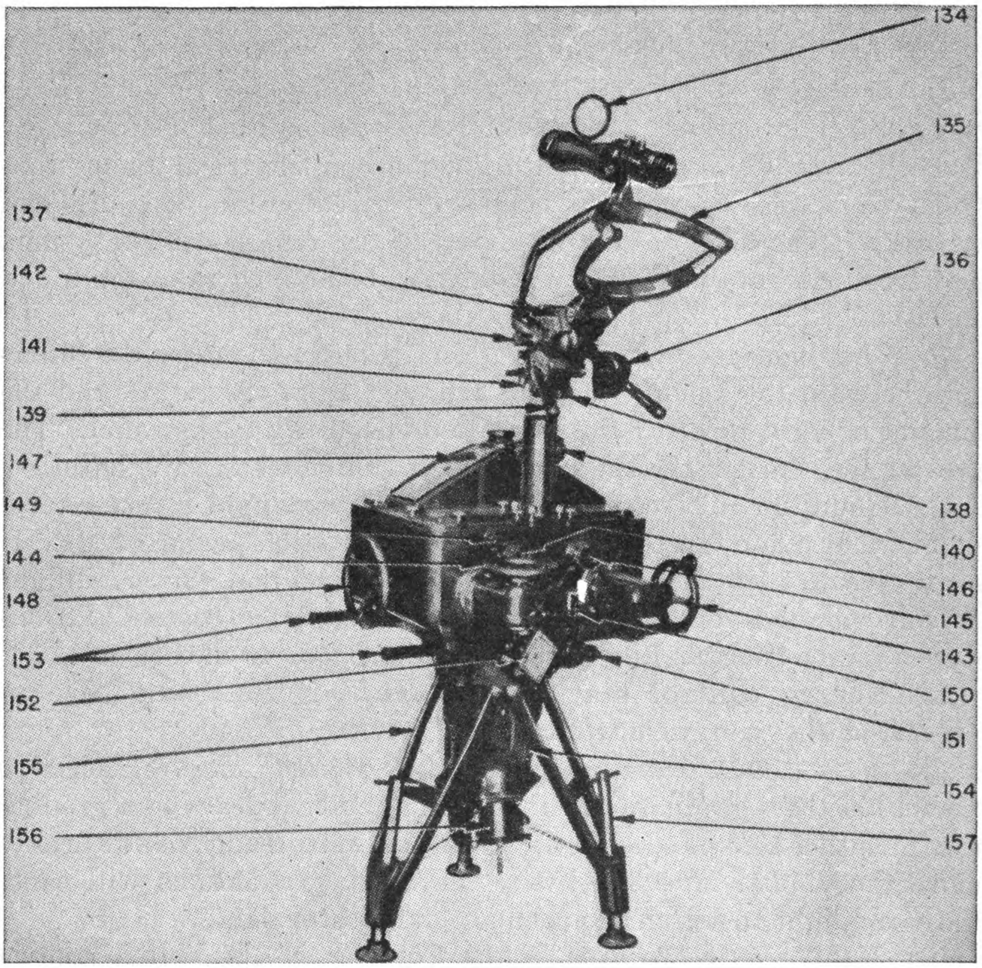



FIGURE 126.—Sperry M1941 control station (binocular mount in position).

NOTE.—The nomenclature of the M1937, M1939, and M1940 Sperry control stations is the same as the M1941 control station.

| Part | Purpose or use |
|---|---|
| 134. Open sight | For getting approximately on a target and for orienting the control station. |
| 135. Binocular mount | Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the control unit moves. |
| 136. Binocular mount counter weights. | To balance the binoculars. |
| 137. Binocular elevation zero marker. | To establish zero elevation when orienting the control station. |
| 138. Binocular azimuth zero marker. | To establish the correct azimuth when orienting the control station. |
| 139. Binocular mount adjustment handles. | By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars. |
| 140. Binocular height adjusting knob. | This knob allows adjustment of the binocular mount for individual height. |
| 141. Binocular mount azimuth adjustment. | Tightening up on this adjusting nut tightens a spring friction disk so that binocular mount does not move too easily in azimuth. |
| 142. Binocular mount clutch adjustment. | This adjusting screw must be adjusted so that binocular mount does not move too easily in elevation. |
| 143. Observer's elevation handwheel. | The observer uses this handwheel to track in elevation after the target is flicked. |
| 144. Observer's azimuth handwheel. | The observer uses this handwheel to track in azimuth after the target is flicked. |
| 145. Elevation drive slip clutch | This clutch protects the elevation drive mechanism. |
| 146. Azimuth drive slip clutch | This clutch protects the azimuth drive mechanism. |
| 147. Azimuth zero reader. | This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator azimuth data are received. |
| 148. Azimuth zero reader handwheel. | This handwheel rotates the control station and operates the azimuth D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data. |
| 149. Signal buzzer push button | This is used to signal the searchlight to go "in action" or "out of action." |
| 150. Zero reader light switch | The switch when turned "on," lights the zero reader dials. |
| 151. D-c switch | The switch must be turned "on" before the D. E. C. can be used. |
| 152. Alinement lug | This lug fits in a notch machined in the control unit. The lug and notch must be lined up when putting control unit on tripod. |
| 153. Carrying handles | Self-explanatory. |
| 154. Handhole cover plate | Access may be had to the slip rings which electrically connect red cable to interior of control station. |
| 155. Tripod | Supports control unit. |
| 156. Fifteen-point receptacle | Red cable plug from searchlight fits into this receptable. |
| 157. Leveling jack | Adjustment of these jacks permits leveling of the control station by means of spirit levels. |

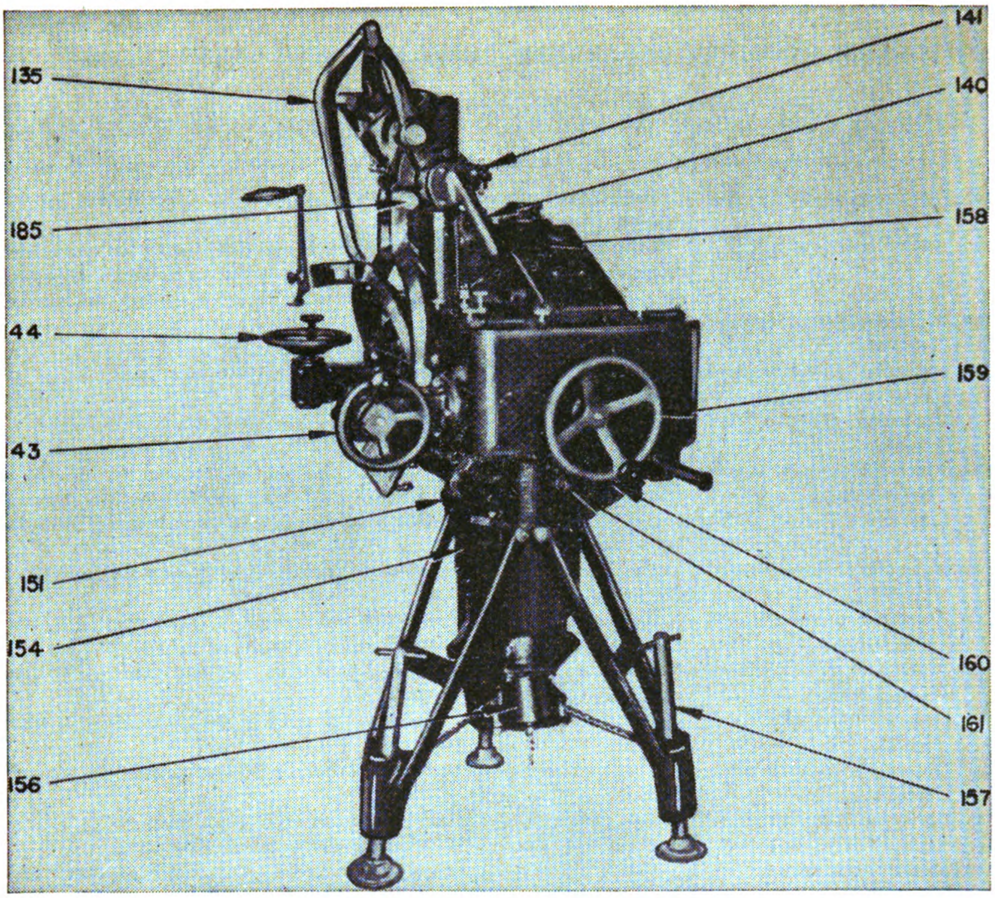



FIGURE 127.—Sperry M1941 control station (binocular mount folded down).

NOTE.—The nomenclature of the M1937, M1939, and M1940 control stations is the same as the M1941 control station.

| Part | Purpose or use |
|---|---|
| 135. Binocular mount | See figure 126. |
| 140. Binocular height adjusting knob. | See figure 126. |
| 141. Binocular mount azimuth slip clutch. | See figure 126. |
| 143. Observer's elevation handwheel. | See figure 126. |
| 144. Observer's azimuth handwheel. | See figure 126. |
| 151. D-c switch | See figure 126. |
| 154. Handhole cover plate | See figure 126. |
| 156. Fifteen-point cable receptacle. | See figure 126. |
| 157. Leveling jacks | See figure 126. |
| 158. Elevation zero reader | This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data are received. |
| 159. Elevation zero reader handwheel. | This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data. |
| 160. Spirit levels | These spirit levels are used to level the control station. |
| 161. Clamp knob | Two knobs on opposite sides of the control unit lock the control unit to the tripod. |
| 185. Binocular mount locking pin. | This locks the binocular mount in its operating position so mount will move in elevation. |

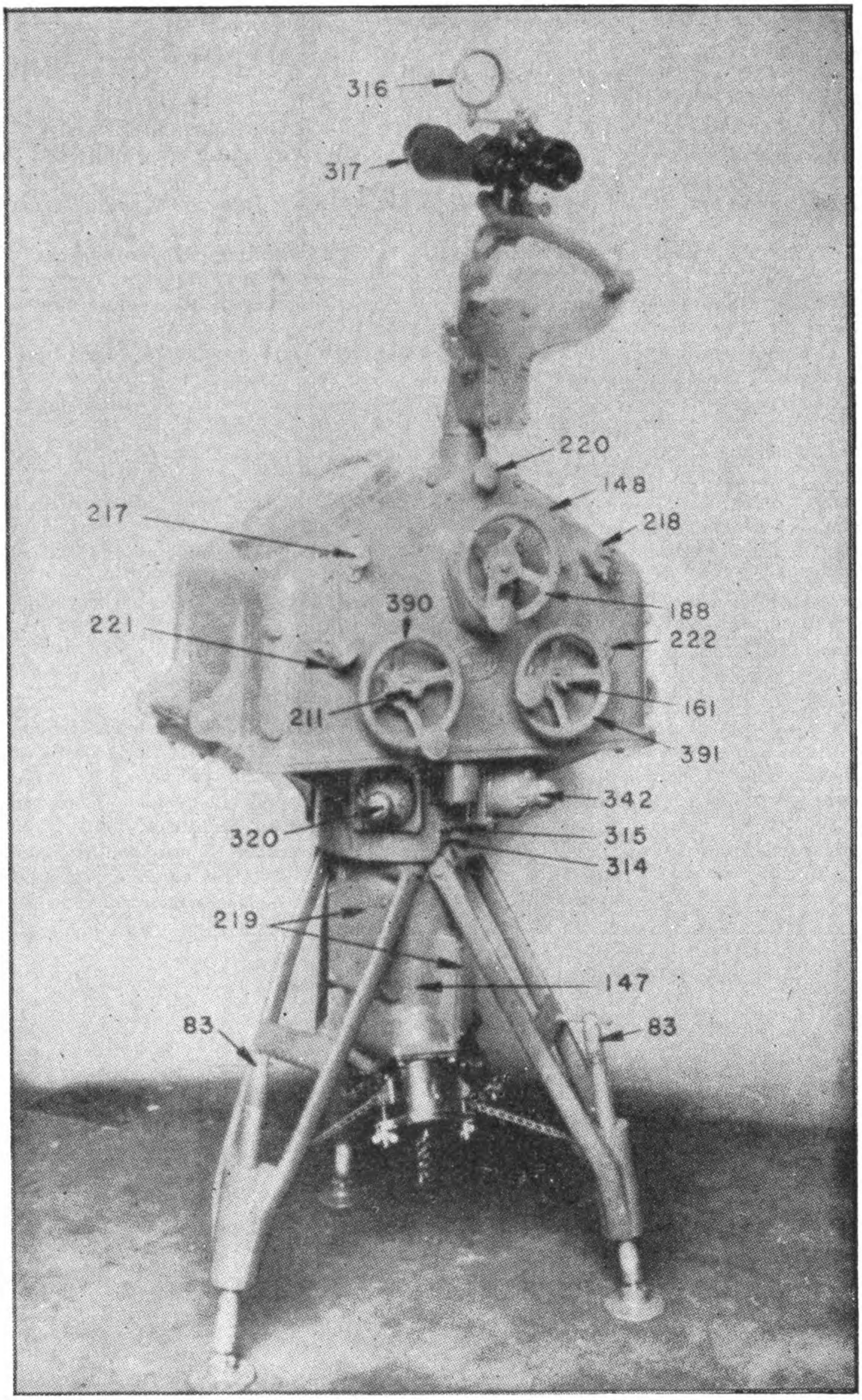



FIGURE 128.—Sperry M1934 control station.

NOTE.—For explanation of numbers see following page.

| Part | Purpose or use |
|---|---|
| 83. Leveling jacks | Adjustment of these jacks permits leveling of the control station by means of spirit levels. |
| 147. Tripod | Supports control unit. |
| 148. Control unit | This unit houses the D. E. C. and comparator mechanism. |
| 161. Elevation handwheel clutch knob. | With clutch "in," the control station may be oriented and synchronized. |
| 188. Searching handwheel | Rotation of this handwheel allows a search of 5° around sound locator data. |
| 211. Azimuth handwheel clutch knob. | This knob is pushed "in" when orienting and synchronizing. |
| 217. Sound locator azimuth dial synchronizing knob. | This knob is used to synchronize the azimuth receiver with the sound locator azimuth transmitter. |
| 218. Sound locator elevation dial synchronizing knob. | This knob is used to synchronize the elevation receiver with the sound locator elevation transmitter. |
| 219. Handhole cover plates | Removal of these three plates provides access to the slip rings and brushes. |
| 220. Binocular height adjusting knob. | To adjust the binocular to any desired height. |
| 221. Azimuth drive friction clutch adjustment screw. | Adjust this screw until a position is obtained at which the aximuth handwheel will slip if jerked. |
| 222. Elevation drive friction clutch. | Adjust this screw until a position is obtained at which the elevation handwheel will slip if jerked. |
| 314. Alinement slot | This slot must engage a lug on the tripod when setting up the control station. |
| 315. Alinement lug | See remark above. |
| 316. Open sight | For approximately orienting the control station. |
| 317. Binocular | For searching the searchlight beam. |
| 320. A-c switch | This switch supplies a-c power for the data transmission system. |
| 342. D-c switch | This switch supplies d-c power for the distant electric control (D.E.C.). |
| 390. Observer's azimuth handwheel. | The observer can control the searchlight in azimuth by means of this handwheel. To the shaft of this handwheel on the opposite side of the control unit, is the azimuth follow-the-pointer handwheel. |
| 391. Observer's elevation handwheel. | The observer can control the searchlight in elevation by means of this handwheel. To the shaft of this handwheel, on the opposite side of the control unit, is attached the elevation follow-the-pointer handwheel. |

| Part | Purpose or use |
|---|---|
| 1. Azimuth handwheel | This handwheel controls the searchlight in azimuth. |
| 2. Searchlight controller | This houses the D. E. C. mechanism which causes the searchlight to be remotely controlled in azimuth and elevation from the control station. |
| 3. Elevation handwheel | This handwheel controls the searchlight in elevation. |
| 4. Cable from tripod to controller. | The wire conductors for the electric circuits of the D. E. C. are contained in this cable. |
| 5. Azimuth training gear | Movement of the azimuth handwheel causes the comparator and controller to rotate in azimuth about the tripod by means of this gear. |
| 6. Tripod | The tripod supports the controller and comparator. |

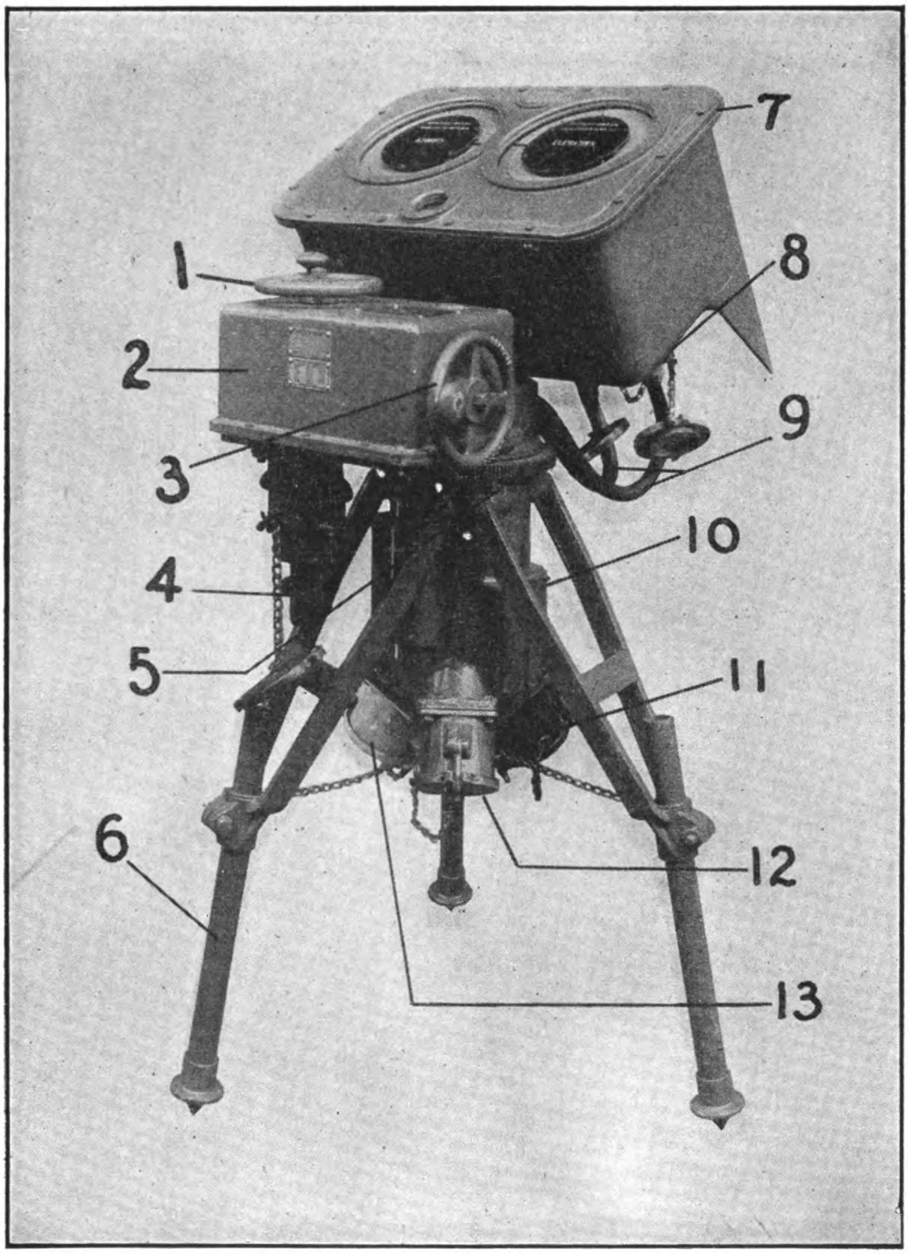



FIGURE 129.—Sperry M–VI control station.

| Part | Purpose or use |
|---|---|
| 7. A-c comparator | This houses four a-c synchronous receivers. Two are connected through the blue cable to the sound locator, one for azimuth, the other for elevation. The other two are connected by the white cable to the searchlight, one for azimuth, the other for elevation. The azimuth operator causes the two azimuth pointers to be matched, while the elevation operator matches the two elevation pointers. |
| 8. Synchronizing knob | For synchronizing the receivers with their respective transmitters. |
| 9. Cables from tripod to comparator. | Connects the four receivers to the white and blue cables. |
| 10. Slip ring cover | Removing this cover provides access to the slip rings and brushes. |
| 11. Receptacle for controller cable. | Painted red. This cable connects the controller to the searchlight training motors. |
| 12. Receptacle for sound locator cable. | Painted blue. This cable connects the comparator sound locator data receivers to their respective transmitters at the sound locator. |
| 13. Receptacle for searchlight cable. | Painted white. This cable connects the comparator searchlight receivers to their respective transmitters at the searchlight. |

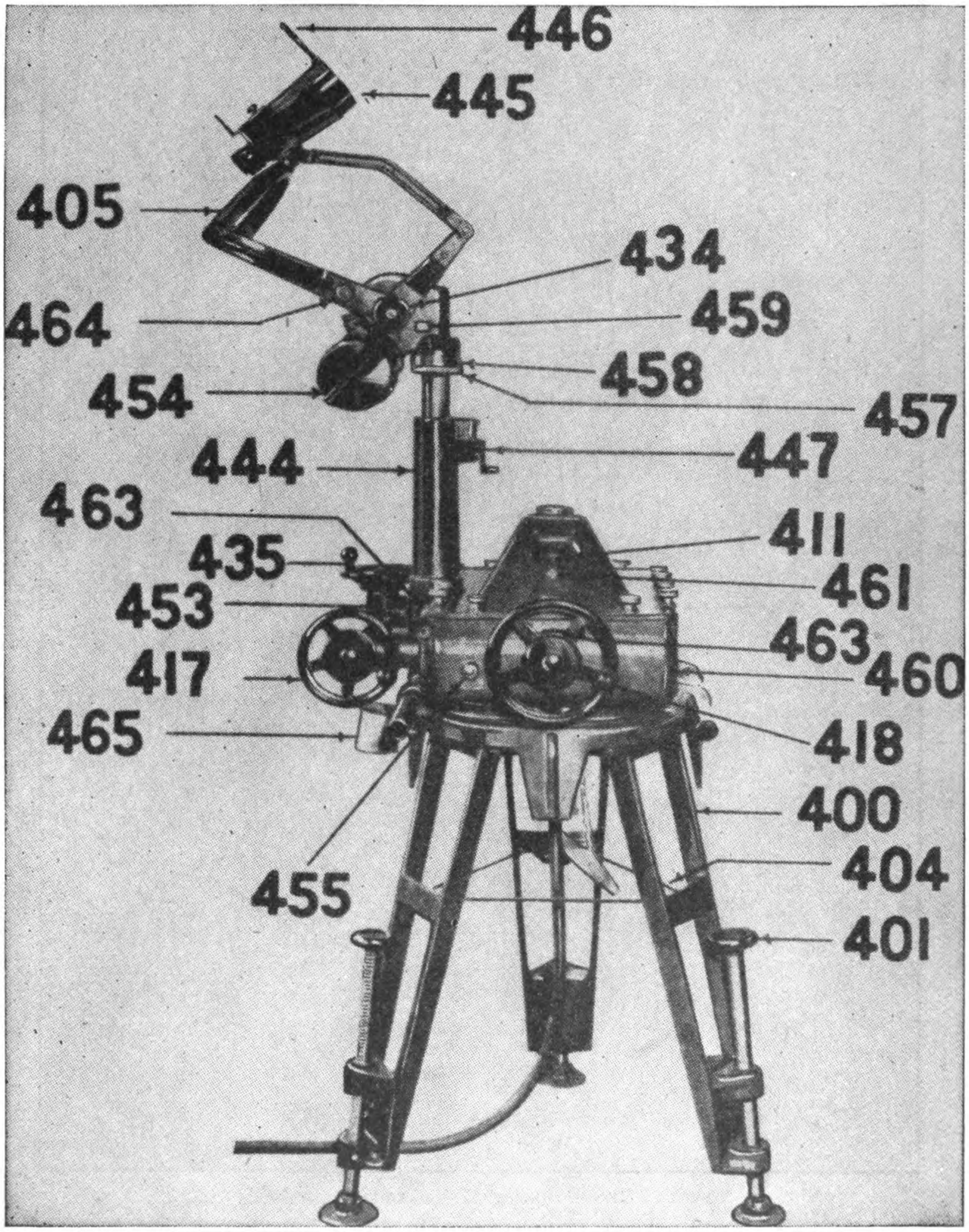



FIGURE 130.—General Electric M1940 control station (right side view).

**83. General Electric control station.**—*Q*. Name and give the functions of the various parts of the M1940 General Electric control station. *A*. Refer to figures 130 and 131.

| Part | Purpose or use |
|---|---|
| 400. Tripod | Controller is supported by this tripod. |
| 401. Leveling jack | By adjusting the three jacks the control station may be leveled. |
| 404. Tripod leg braces | To give rigidity to the tripod. |
| 405. Binocular mount | Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the controller moves. |
| 411. Elevation zero indicator | This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data are received. |
| 417. Observer's elevation handwheel. | The observer uses this handwheel to track in elevation after the target is flicked. |
| 418. Elevation zero reader handwheel. | This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data. |
| 434. Binocular linkage clamp | This clamp must be adjusted so that the elevation clutch does not allow the binocular mount to move too easily in elevation. |
| 435. Observer's azimuth handwheel. | The observer uses this handwheel to track in azimuth after the target is flicked. |
| 444. Binocular mount column | This column is a support for the binocular mount. |
| 445. Binoculars | Self-explanatory. |
| 446. Open sight | This is used when orienting the control station and for quickly getting on an illuminated target. |
| 447. Binocular height adjusting crank. | This allows adjustment of the height of the binocular for each individual. |
| 453. Binocular column lock clamp. | When binocular mount is lowered in column, it is locked by pushing in this lock clamp and turning clockwise. |
| 454. Binocular positioning handles. | By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars. |
| 455. Signal switch | To signal searchlight to go "in action" or "out of action." |
| 457. Binocular column azimuth friction adjusting nut. | This nut is adjusted so that the binocular mount does not move too easily in azimuth. |
| 458. Azimuth reference mark | For use in orienting the control station in azimuth. |
| 459. Horizontal reference mark | For use in orienting the control station in elevation. |
| 460. Controller box | The controller box houses all the mechanisms and supports the binocular mount. |
| 461. Elevation zero reader adjustment plug. | Loosen the plug and with a small screw driver turn voltmeter pointer adjusting screw until pointer is zeroed. |
| 463. Level | To be used when leveling the control station. |
| 464. Linkage pin | This pin must be in place so that the binocular mount operates properly. |
| 465. Column socket cover | When binocular mount is disassembled this cover is screwed over the opening in the controller box. |

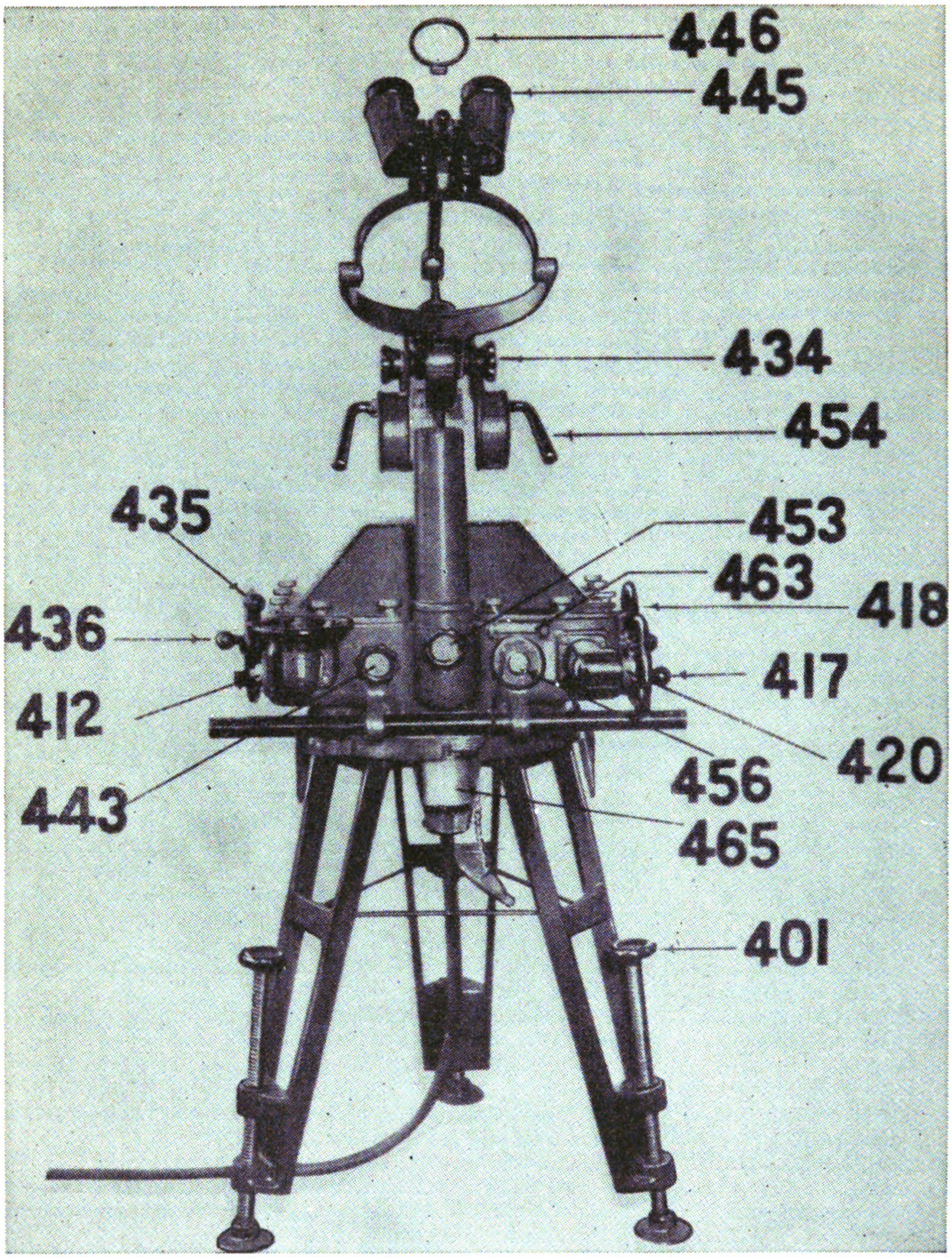



FIGURE 131.—General Electric M1940 control station (rear view).

| Part | Purpose or use |
|---|---|
| 401. Leveling jack | See figure 130. |
| 412. Scale lamp switch | To provide illumination for the zero readers. |
| 417. Observer's elevation handwheel | See figure 130. |
| 418. Elevation zero reader's handwheel | See figure 130. |
| 420. Handwheel friction clutch | To prevent damage to the elevation mechanism. |
| 434. Binocular linkage clamp | See figure 130. |
| 435. Observer's azimuth handwheel | See figure 130. |

| Part | Purpose or use |
|---|---|
| 436. Azimuth zero reader's handwheel. | This handwheel rotates the controller in azimuth and operates the D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data. |
| 443. Azimuth drive clutch knob | With this knob in its released position the controller may be moved in azimuth when orienting, without moving the azimuth zero reader's handwheel. |
| 445. Binoculars | Self-explanatory. |
| 446. Open sight | See figure 130. |
| 453. Binocular column lock clamp | See figure 130. |
| 454. Binocular positioning handles | See figure 130. |
| 456. D. E. C. switch | This switch must be turned on before the D. E. C. will function. |
| 463. Level | See figure 130. |

## Section IV

## CARE AND OPERATION OF POWER PLANT



**84. General.**—*a. Operation.*—Beginning with the M1934 portable power plant, all models are fundamentally the same. This is especially true of the Sperry power plants M1937, M1939, M1940, and M1941, and the General Electric power plant M1940. The M-VI and M1934 mobile power plant generators are driven by the vehicle engines through suitable transmissions.

*Q.* What is the principal purpose of a power plant? *A.* To furnish direct current power to operate the arc.

*Q.* Name the two principal parts of a power plant. *A.* A gasoline engine which furnishes motive power to drive a d-c generator.

*Q.* What is the purpose of a governor on the power plant? *A.* A governor is a device on an engine which controls the fuel supply to the engine in such a way that the engine-generator speed will remain constant from no load to full load.

*Q.* What is supplied to control the power output to the generator? *A.* All necessary control apparatus, meters, and engine indicators, mounted on a control panel.

*Q.* How does the engine adjust itself between "arc load" and "listening load" conditions? *A.* Automatically. The governor control system having once been adjusted for arc load condition will regulate the engine speed and maintain it at the proper speed during listening load.

*Q.* Should the hood doors on the power plant be open while the plant is operating? *A.* On the Sperry power plants M1934 portable, M1937, M1939, M1940, and M1941, and the General Electric M1940, the hood doors next to the radiator should be kept closed at all times while the power plant is operating. The switchboard (control panel) hood door should be open. On the M–VI power plant the side hoods of the vehicle engine should be raised or taken off while the power plant is operating to drive the generator.

*Q.* On the Sperry M1934 portable, M1937, M1939, M1940, and M1941, and the General Electric M1940 power plants, why is it necessary to have the hood doors next to the radiator closed while the power plant is operating? *A.* The cooling fan is located at the rear of the engine and blows the air across the engine and through the radiator. If the hood doors are left open no cooling air will pass through the radiator but will pass out through the hood door openings and will cause the engine to overheat.

*Q.* What three main items should the operator check before starting the power plant? *A.*

(1) The cooling liquid in the radiator.

(2) The oil in the crankcase.

(3) The gasoline supply.

*Q.* How would you start the power plant? *A.*

(1) *Sperry M1937, M1939, M1940, M1941 and General Electric M1940.*—(*a*) Throw main switch or circuit breaker to "off" position.

(*b*) Pull out choke and throttle about half way.

(*c*) Start engine by turning on ignition switch and pressing starter button. After engine starts, adjust the choke for smooth operation and pull the throttle all the way out. After the engine has warmed up and has been operating smoothly for a few minutes, push the choke back in.

(2) *Portable power plant M1934.*—(*a*) Throw main switch to "off" position.

(*b*) Turn on ignition switch.

(*c*) Start the engine by pressing starter button and choking as required.

(*d*) When the engine warms up, decrease choking until no further choking is required.

(3) *Mobile power plant M1934.*—The engine in this case is the engine which drives the truck, so its starting is similar to that of any vehicle motor.

(*a*) Open generator ventilating covers.

(*b*) Start engine and permit it to operate at idling speed.

(*c*) Close auxiliary circuit breaker.

(*d*) Disengage the truck clutch.

(*e*) Remove chain from the generator clutch lever and move lever toward the rear of the truck to the generator position.

(*f*) Put truck transmission gear shift lever in fourth gear.

(*g*) Reengage the foot clutch slowly.

(*h*) Push foot throttle down slowly to full open position and pull out the hand throttle to the full open position.

(4) *Mobile power plant M–VI.*—The engine in this case is the engine which drives the vehicle so its starting is similar to that of any vehicle motor.

(*a*) Open ventilator covers on the generator.

(*b*) Raise both sides of engine hood.

(*c*) Open switch and circuit breaker on power panel.

(*d*) Start engine and permit it to operate at idling speed.

(*e*) Close the cut-out to the second muffler by raising the cut-out button.

(*f*) Shift the generator clutch lever to its rear (generator) position.

(*g*) Depress the engine clutch, place gear shift in "high," and let out engine clutch slowly.

(*h*) Press in governor cut-out button on dash.

(*i*) Accelerate the engine by gradually advancing the hand throttle to its wide open position. The spark lever should be fully advanced. The governor should control the speedometer speed to 23 to 27 mph.

(*j*) Regulate the voltage with the field rheostat to 100 volts.

(*k*) When the engine has been warmed up, close circuit breaker on power panel.

(*l*) Close switch to start rotary converter.

*Q*. How would you adjust the voltage and current? *A*.

(1) *Sperry M1940, M1941, and General Electric M1940.*—With the engine speed set to 1,000 rpm for Sperry M1940, 1,100 rpm for Sperry M1941, or 1,200 rpm for General Electric M1940 under arc load condition, the following procedure should be observed:

(*a*) With the searchlight arc burning, adjust the voltage regulating rheostat so that the ammeter at the *searchlight* indicates the proper arc current, approximately 150 amperes. The voltmeter at the power plant should then indicate approximately 100 volts and the ammeter at the power plant should indicate approximately 162 amperes (160 amperes on the General Electric M1940).

(*b*) Voltage and current adjustment should be made with the arc load "on."

(2) *Sperry M1937 and M1939.*—The governor and generator voltage control equipment has two operating positions, listening load and arc load. Therefore two separate rheostats are provided.

(*a*) At listening load speed (875 to 900 rpm) the listening load rheostat should be adjusted so that the generator delivers 10 to 15 amperes at 100 to 110 volts.

(*b*) At arc load speed (1,200 rpm) the arc load rheostat should be adjusted so that the generator delivers 165 amperes at 100 volts.

(3) *M1934 portable.*—(*a*) Set the "voltage manual" rheostat on the painted marks. This rheostat controls the voltage directly when the voltage regulator and electrical governor are disconnected. Under automatic operation, the proper setting of this rheostat is necessary so that the engine will run at the proper speed while generating the proper voltage.

(*b*) Set the "voltage automatic" rheostat on the painted marks. This rheostat provides a fine adjustment of the voltage by changing the setting of the voltage regulator.

(*c*) With the rheostats set on the painted marks as indicated, the generator should develop approximately 100 volts at approximately 850 rpm with a hot engine. If this operating condition is obtained, it will indicate that the electrical governor is functioning. It may be necessary to shift the rheostat settings very slightly to obtain the above desired values. After these settings are made, no further adjustments of the rheostats will normally be required while operating the searchlight.

(4) *M1934 mobile.*—The M1934 mobile power plant has incorporated in it an automatic voltage regulator which maintains approximately constant voltage regardless of current fluctuations. The desired voltage is set by the voltage adjustment rheostat, located on the upper right hand side of the control panel. The knob of the rheostat is turned clockwise to increase the voltage and counterclockwise to decrease the voltage. The normal operating voltages are 98 volts with 150 amperes arc load and 101 volts with a listening load speed of 900 rpm.

(5) *M–VI.*—With the searchlight in operation, and the power plant running at a speedometer speed of 25 mph, adjust the generator field rheostat so that the voltage of the generator is 100 volts. The ammeter should then indicate approximately 150 amperes.

*Q.* In case of an emergency, how would you manually control the engine speed and voltage? *A.*

(1) *Sperry M1941, M1940, and General Electric M1940.*—(*a*) The first precaution is to make certain that the governor arm is blocked (tied) in the forward position to prevent interference from the governor itself.

(*b*) With throttle adjusted to a setting of approximately normal arc-load speed, start engine, allow it to warm up, and then strike the arc. Adjust the throttle until the tachometer indicates normal arc-load speed with the arc burning.

(*c*) If required, adjust the voltage regulating rheostat until the ammeter indicates the proper current.

(*d*) When the arc is cut off, the throttle at the power plant must be immediately readjusted to prevent overspeeding and excessively high voltages.

NOTE.—Do not readjust the voltage regulating rheostat after it has once been adjusted for arc load.

(2) *Sperry M1939 and M1937.*—(*a*) Block the governor arm in the forward position (tie it) to prevent interference from the governor.

(*b*) Set the throttle at listening speed. When the arc is struck adjust the throttle to obtain the normal arc-load speed.

(*c*) When changing from arc load to listening load, quickly push in the throttle simultaneously with the removal of arc load to decrease engine speed. This must be done to avoid overspeeding and excessively high voltage.

(*d*) If engine speed adjustments are carefully made it will be unnecessary to change settings of listening-load rheostat or arc-load rheostat, when changing from one speed to the other.

(3) *M1934 portable.*—The voltage and speed may be manually controlled should the electrical governor or regulator fail.

(*a*) Normally on failures or opening of the electrical governor circuit, the electrical throttle will return to and remain at the wide open position. If this does not happen disconnect one lead of the voltage automatic rheostat.

(*b*) Release the mechanical governor thumb nuts to permit the rod to go to the limit of its travel into the panel.

(*c*) Turn the voltage manual rheostat to the extreme clockwise position.

(*d*) Pull out the mechanical governor rod and lock it at the no-load speed of 1,150 rpm.

(*e*) Adjust the voltage manual rheostat until the no-load voltage is 110 volts.

(*f*) When the arc is struck, adjust the voltage manual rheostat to 98 volts when searchlight arc is drawing 150 amperes.

(*g*) When changing from arc load to listening load quickly readjust the voltage manual rheostat to 110 volts.

(*h*) If the voltage regulator fails, remove the front of the panel and block regulator in the closed position. The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle. When the arc load is removed, immediately push in the throttle to decrease engine speed in order to prevent overspeeding and excessively high voltages.

(4) *M-VI.*—(*a*) Block the governor arm (tie it) so that the butterfly valve on the carburetor is in the open position.

(*b*) The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle.

(*c*) When the arc load is removed, immediately push in the throttle to decrease the engine speed in order to prevent overspeeding and excessively high voltages.

*Q*. What should you do if the governor rod or governor arm should break? *A*. Wire the valve lever that goes to the carburetor so as to hold the butterfly control valve in the *open* position. The power plant may then be manually controlled.

*Q*. How would you stop the power plant? *A*.

(1) *Sperry M1941, M1940, M1939, M1937, and General Electric M1940.*—(*a*) Throw main switch (21) to the "off" position.

(*b*) Push the throttle all the way in to allow the engine to slow down to idling speed.

(*c*) Turn ignition switch (35) to "off" position. If the ignition switch is turned off before engine has slowed down to idling speed, it will backfire and probably damage the exhaust stack or muffler, or both.

(2) *Sperry M1934 portable.*—(*a*) Open the main circuit breaker.

(*b*) Turn off ignition switch.

(3) *M1934 mobile.*—(*a*) Open main circuit breaker.

(*b*) Close the throttle.

(*c*) Disengage the clutch.

(*d*) Put the truck transmission gear shift lever in neutral.

(*e*) Move generator clutch lever to truck position and fasten it with safety chain.

(*f*) Remove foot from clutch.

(*g*) Open auxiliary circuit breaker.

(*h*) Close the generator ventilating covers.

(4) *M-VI.*—(*a*) Open the circuit breaker.

(*b*) Decelerate the engine by gradually closing the hand throttle.

(*c*) Pull out the governor cut-out button on the dash.

(*d*) Depress the engine clutch and place the gear shift in neutral.

(*e*) If the power plant is not to be operated again immediately, the operator should then shift the generator clutch lever to its forward position, open the contact to the second muffler, stop the engine, lower and clamp the covers on the engine hood, and lower and clamp the generator port covers.

*b. Care of power generator.*—*Q.* Should mechanisms and bearings be overlubricated? *A.* No. Never overlubricate as it may cause much trouble, especially around electrical apparatus.

*Q.* Is more grease required in the tropics than in cold climate? *A.* Yes. However, be careful not to overlubricate.

*Q.* Should the commutator be lubricated? *A.* No. The brushes contain sufficient graphite to maintain proper lubrication.

*Q.* How are the generator bearings lubricated? *A.*

(1) *Sperry M1941, M1940, M1939, and M1937.*—The armature is supported at the commutator end by a sealed or cartridge type of ball bearing. The grease is provided in the bearing at the factory and will give adequate lubrication for 3 years of normal service. It is recommended that when the engine is reconditioned the grease in this bearing be examined, if the grease is discolored or has a bad odor, the bearing should be cleaned and repacked with new ball-bearing grease of the type furnished for this purpose. Be very careful not to overlubricate.

(2) *General Electric M1940 and Sperry M1934 portable.*—The bearing at the commutator end is provided with a grease cup. A soft grade of grease should be used. Be careful not to overlubricate, because the bearing will overheat and the grease may leak past the seal into the generator. The amount of grease added must be determined by experience.

(3) *Sperry M1934 mobile and M–VI.*—There are three distinct rotating members included in the generator: armature, propellor shaft, and tail shaft. Each of these units is supported on two antifriction bearings. The bearings for the armature and propellor shaft at the commutator end should be lubricated with a soft grease by means of the fittings provided. Be careful not to overlubricate. The remaining bearings are lubricated with oil (SAE No. 70) from the clutch housing.

*c. Care of engine.*—*Q.* How can the amount of oil in the crank case be determined? *A.* By means of an oil gage rod or dip stick.

*Q.* What oil should be used? *A.* In summer, SAE No. 30 is recommended for normal operation. For heavy-duty operation in summer, SAE No. 40 may be used. In winter, use SAE No. 10W. (All Navy specifications.)

*Q.* Why should the filler cap be on the filler pipe at all times, except when refilling the engine with oil? *A.* With the filler pipe open, the breathing action of the engine will draw dust and dirt into the engine, causing rapid wearing of the cylinder walls and bearing surfaces.

*Q.* How often should valves be ground and carbon cleaned from the engine? *A.* If instructions as given are followed carefully, the valves will seldom require grinding and little carbon will be formed. *Watch the oil and gasoline for impurities.*

*Q.* How often should the oil pan be removed? *A.* Every 6 months so that the oil screen may be cleaned.

*Q.* Should the carburetor be adjusted frequently? *A.* No. Very often carburetor trouble is caused by dirty gasoline or by water in the gasoline.

*Q.* How often should the gasoline filter be cleaned? *A.* Whenever there is any sediment present, or when there is a noticeable amount of water in the glass bowl of the filter.

*Q.* Should the distributor points be checked? *A.* Yes. Check frequently to see that they are clean and making good contact without unnecessary sparking. If pitted, clean with No. 00 sandpaper.

*Q.* How often should the radiator be cleaned? *A.* At least twice a year, usually in the spring and in the fall. Use ½ pound sal soda and ½ pint kerosene per gallon of water. Fill the radiator with this solution and run the engine for 3 or 4 hours, then flush out thoroughly with clear water, using at least two changes of clear water before filling the radiator for normal operation.

*Q.* Where can you find instructions for adjusting the various parts, replacements and trouble shooting? *A.* Refer to the Operators' Manual furnished with your power plant. *Follow instructions exactly.*

TABLE VI.—*Main parts of searchlight power plants*

LUBRICATION SCHEDULE

| | Sperry M1941, M1940, M1939 | General Electric M1940 | Sperry M1937 | Portable M1934 | Mobile M1934 and M–VI |
|---|---|---|---|---|---|
| *Engine* | | | | | |
| Engine oil change | Every 3 months, or every 30,000 "hundreds" revolutions of the engine. | | | | 1,000 miles. |
| Chassis | 3 months | 3 months | 3 months | 3 months | Do. |
| Fan bearings | 6 months | 6 months | 6 months | 6 months | Do. |
| Water pump | Weekly | Weekly | Weekly | Weekly | Do. |
| Governor and throttle linkages | do | do | do | do | Do. |
| Side-door hinges | do | do | do | do | |
| Carburetor | do | do | do | do | Do. |
| Charging generator | Monthly | Monthly | Monthly | Monthly | Do. |
| Starting motor | do | do | do | do | Do. |
| Distributor | do | do | do | do | Do. |
| Magneto | | | Yearly | Yearly | |
| Electrical governor | | | | 2 months | |
| Trailer | | | | 1,000 miles | |

| | Sperry M1941, M1940, M1939 | General Electric M1940 | Sperry M1937 | Portable M1934 | Mobile M1934 and M-VI |
|---|---|---|---|---|---|
| *Generator* | | | | | |
| Main bearing | 3 years | Monthly | Monthly | Monthly | 5,000 miles. |
| Tachometer drive | 3 months | 3 months | 3 months | 3 months | |

MAINTENANCE SCHEDULE

| | | | | | |
|---|---|---|---|---|---|
| *Engine* | | | | | |
| Air cleaner | Weekly | Weekly | Weekly | Weekly | 1,000 miles. |
| Oil filter, renewed | When black streaks begin to appear in the oil | | | | Clean every 1,000 miles. |
| Oil screen, cleaned | 6 months | 6 months | 6 months | 6 months | |
| Radiator, cleaned | 6 months | 6 months | 6 months | 6 months | 5,000 to 10,000 miles. |
| Fan motor cleaned | 3 months | | 3 months | 3 months | |
| Battery | Weekly | Weekly | Weekly | Weekly | Weekly. |
| Distributor points | Monthly | Monthly | Monthly | Monthly | Monthly. |
| Magneto | | | do | do | |
| *Generator* | | | | | |
| Cleaned | 3 months | 3 months | 3 months | 3 months | 3 months. |
| Brushes, checked | do | do | do | do | Do. |

NOTE.—Above schedule is based on normal or average conditions; in some cases more frequent maintenance and lubrication may be necessary, as will be determined by experience. For detailed maintenance and lubrication consult the Operator's Manual furnished with each power plant.

**85. Sperry power plants.**—*Q.* What difference is there between the M1941 Sperry power plant and previous Sperry power plants? *A.* There is very little difference between the Sperry M1941 power plant and the previous models. The rated speed of the engine varies, but in general, all models back to and including the portable M1934 power plant are very similar.

*Q.* What is the rated engine horsepower of the M1941 Sperry power plant? *A.* It is rated at 42 hp at 1,100 rpm.

*Q.* What is the generator rating of the M1941 Sperry power plant? *A.* The generator is rated as follows:

| *Volts* | *Amperes* | *Rpm* | *Kilowatts* |
|---|---|---|---|
| 100 | 162 | 1,100 | 16.2 |

*Q.* Is the power plant engine similar to an ordinary automobile engine? *A.* Yes. It has a self-starter, battery, battery charging generator, water-cooling system, ignition, choke, and other features of an ordinary automobile engine.

*Q*. Point out the various parts, by name, of the power plant with which your organization is equipped. *A*. Refer to figures 132 and 133 for the M1941 Sperry power plant.

NOTE.—For the mobile M-VI, mobile M1934, portable M1934, M1937, M1939, and M1940 power units, refer to the Operator's Manual furnished with these units, using examination questions and nomenclature corresponding to those used in this manual.

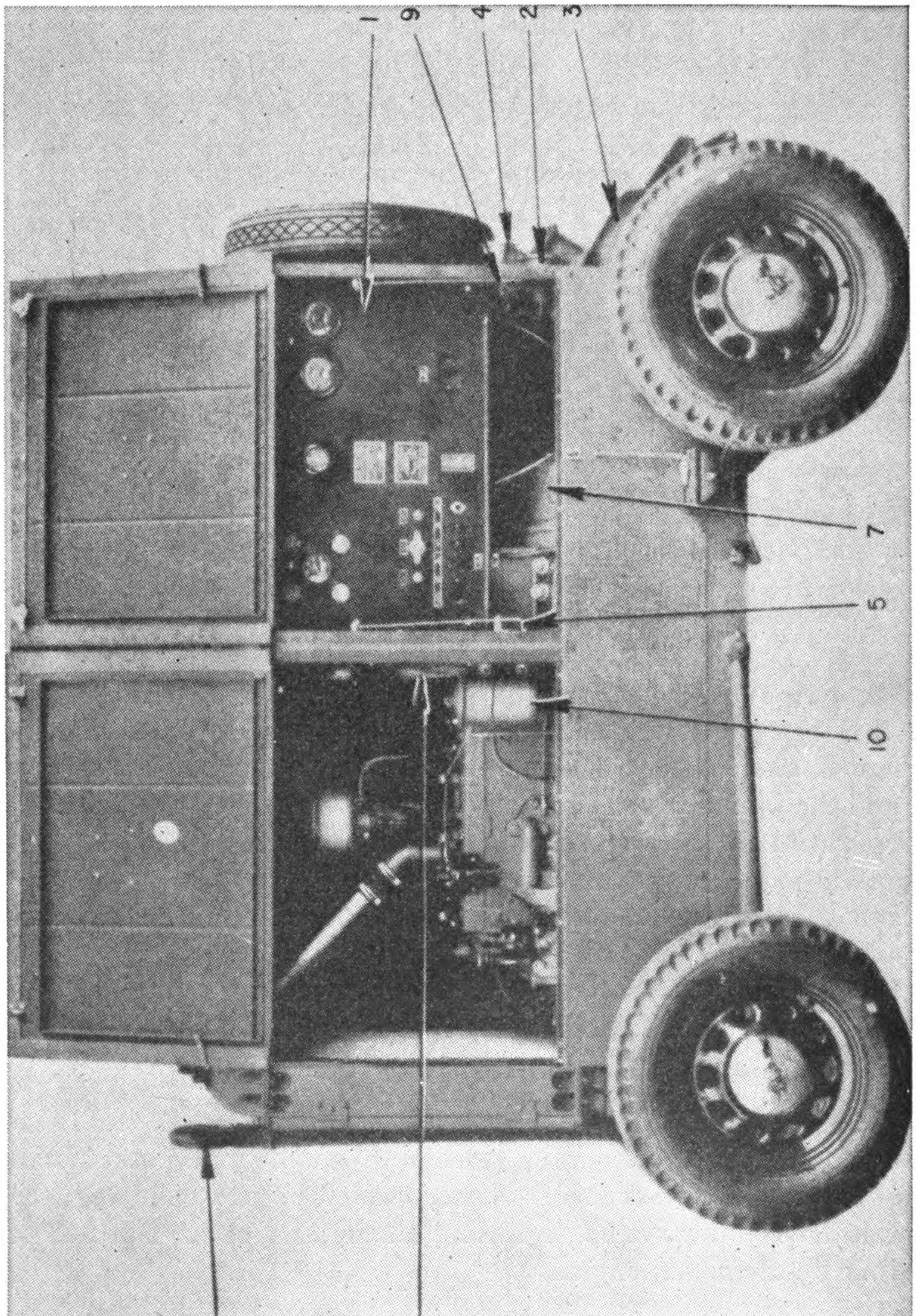



FIGURE 132.—Sperry M1941 power plant (left side).

| Part | Purpose or use |
|---|---|
| 1. Control panel | Contains all the necessary indicating instruments and equipment for controlling and operating the unit. |
| 2. Power receptacles | Provides a convenient means of attaching and removing the two power cables that transmit the electrical power from the power plant to the searchlight. One receptacle is for the positive cable, the other receptacle for the negative cable. |
| 3. Fuel tank | Gasoline supply for the engine. Capacity is 27½ gallons. |
| 4. Tail lamp | Same purpose as tail lamp on automobile. |
| 5. Control panel door bracket | Holds the control panel door in a horizontal position. |
| 6. Tow bar | Used for towing and steering. |
| 7. Power generator | A d-c compound wound generator which furnishes electrical power to operate the equipment of the searchlight section. |
| 8. Fan | Used for cooling the power plant. It is driven by a direct current ¾ hp motor. |
| 9. Tail lamp switch | Turns tail lamp "on" or "off." |
| 10. Oil filter | Filters the oil in the engine. |

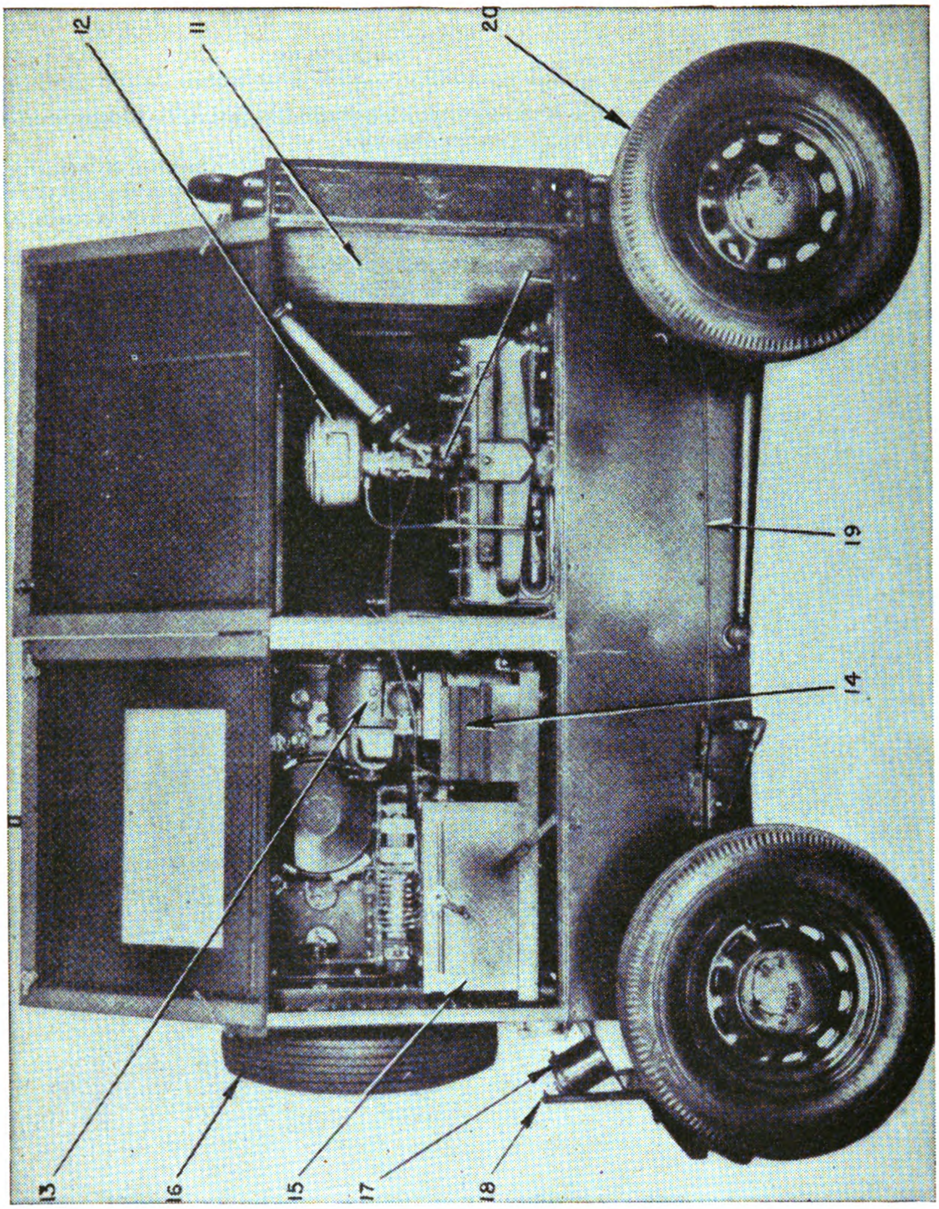
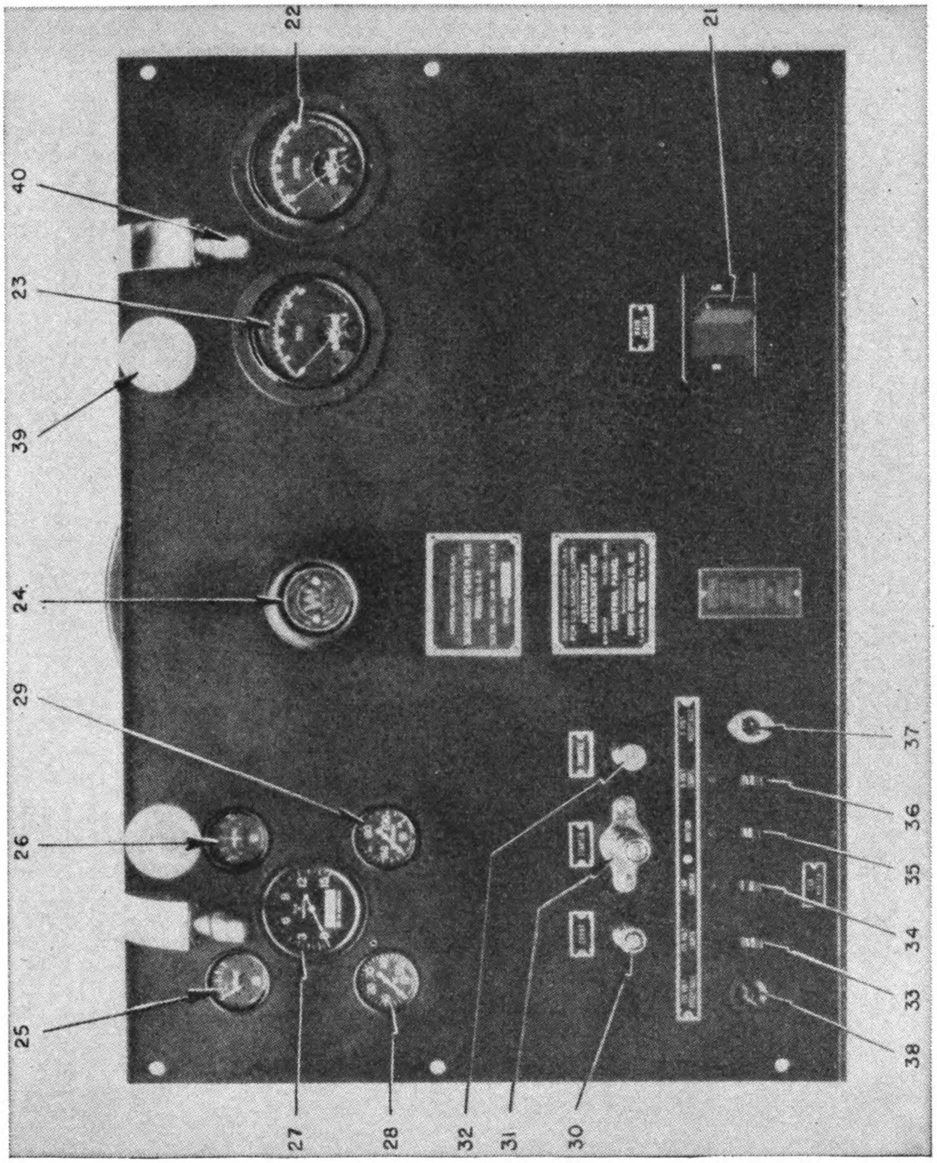



FIGURE 133.—Sperry M1941 power plant (right side).

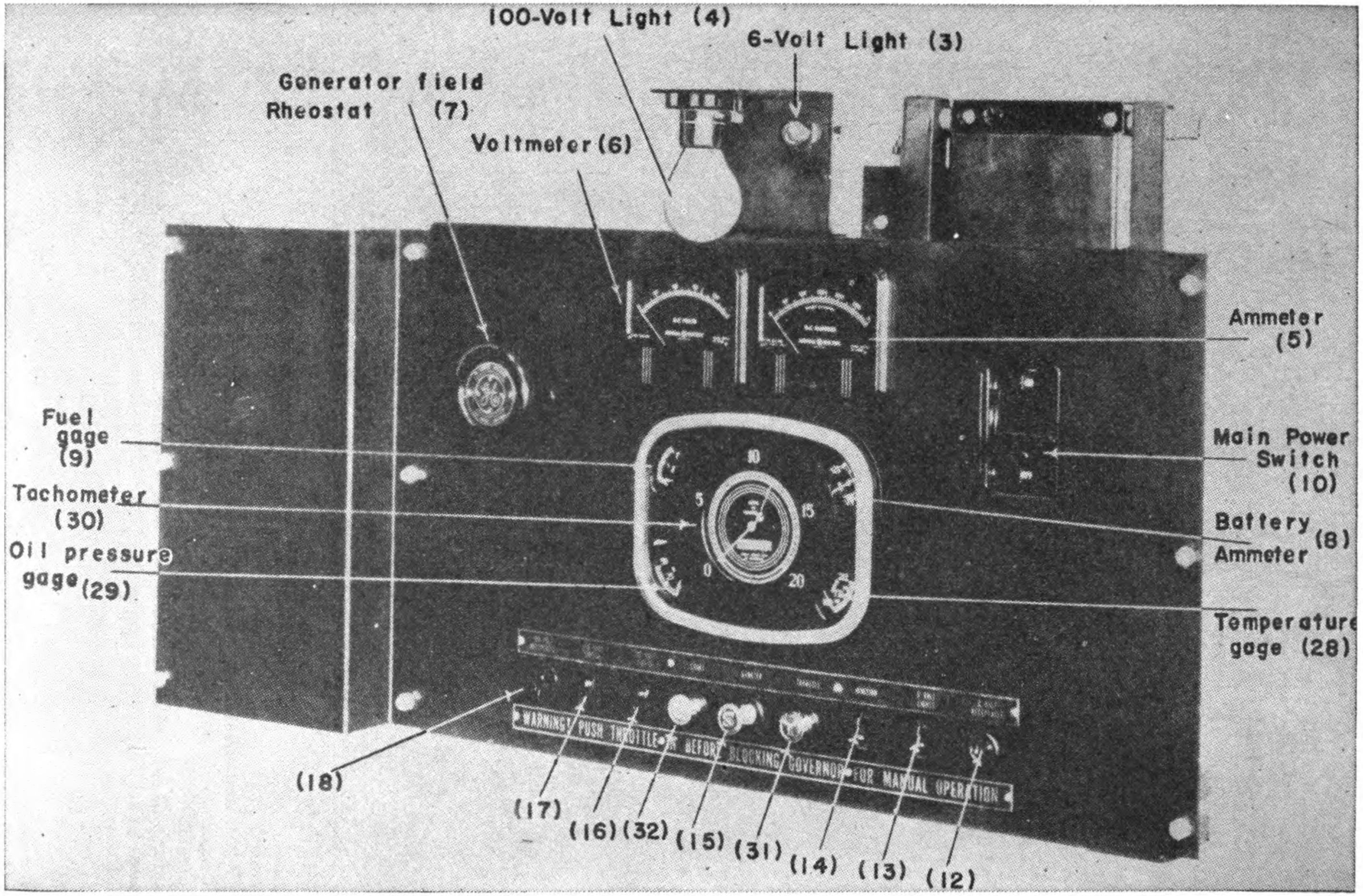
| Part | Purpose or use |
|---|---|
| 11. Radiator | Cools the liquid in the engine cooling system. |
| 12. Air filter | Filters the air going into the carburetor. |
| 13. Fan motor | A ¾ hp, d-c motor, having two speeds: winter, 500 vpm; summer, 675 vpm. |
| 14. Battery | Furnishes 6 volts for the engine ignition system and 6-volt lights on the control panel and the tail light. |
| 15. Tool box | Storage place for tools. |
| 16. Spare wheel and tire | Self-explanatory. |
| 17. Fuel tank filler pipe | Self-explanatory. |
| 18. Brake lever | Self-explanatory. |
| 19. Safety chain brake cable | Operates, in case the safety chain breaks, to apply the brakes on the power plant. |
| 20. Exhaust | Self-explanatory. |




21. Main switch.
22. Power ammeter.
23. Power voltmeter.
24. Voltage regulating rheostat.
25. Gasoline gage.
26. Charging meter.
27. Tachometer and revolution counter.
28. Oil pressure gage.
29. Temperature gage.
30. Choke control.
31. Starter button.
32. Throttle control.
33. 115-volt light switch.
34. Fan season switch.
35. Ignition switch.
36. 6-volt light switch.
37. 6-volt receptacle.
38. 115-volt receptacle.
39. 115-volt panel lights.
40. 6-volt panel lights.

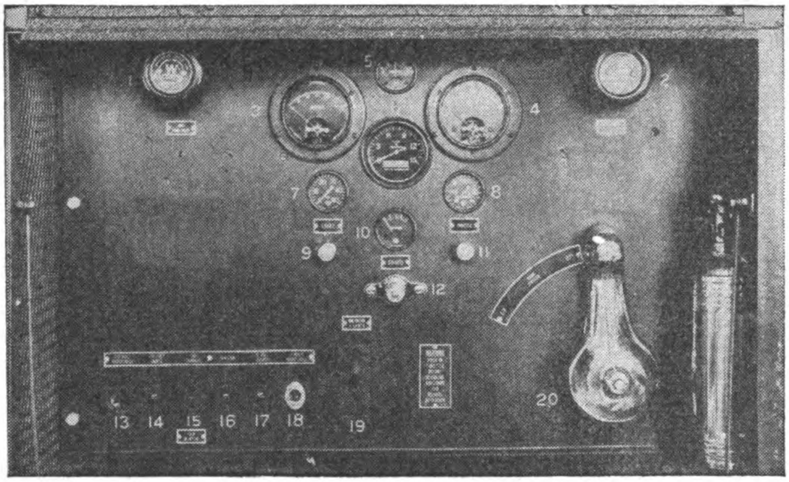
FIGURE 134.—Control panel, Sperry M1941.

NOTE.—Control panel for Sperry M1940 same as for Sperry M1941 except that circuit breaker is substituted for main switch.




12. 6-volt receptacle.
13. 6-volt light switch.
14. Ignition switch.
15. Starter.
16. 100-volt light switch.
17. 100-volt switch.
18. 100-volt receptacle.
31. Throttle.
32. Choke.

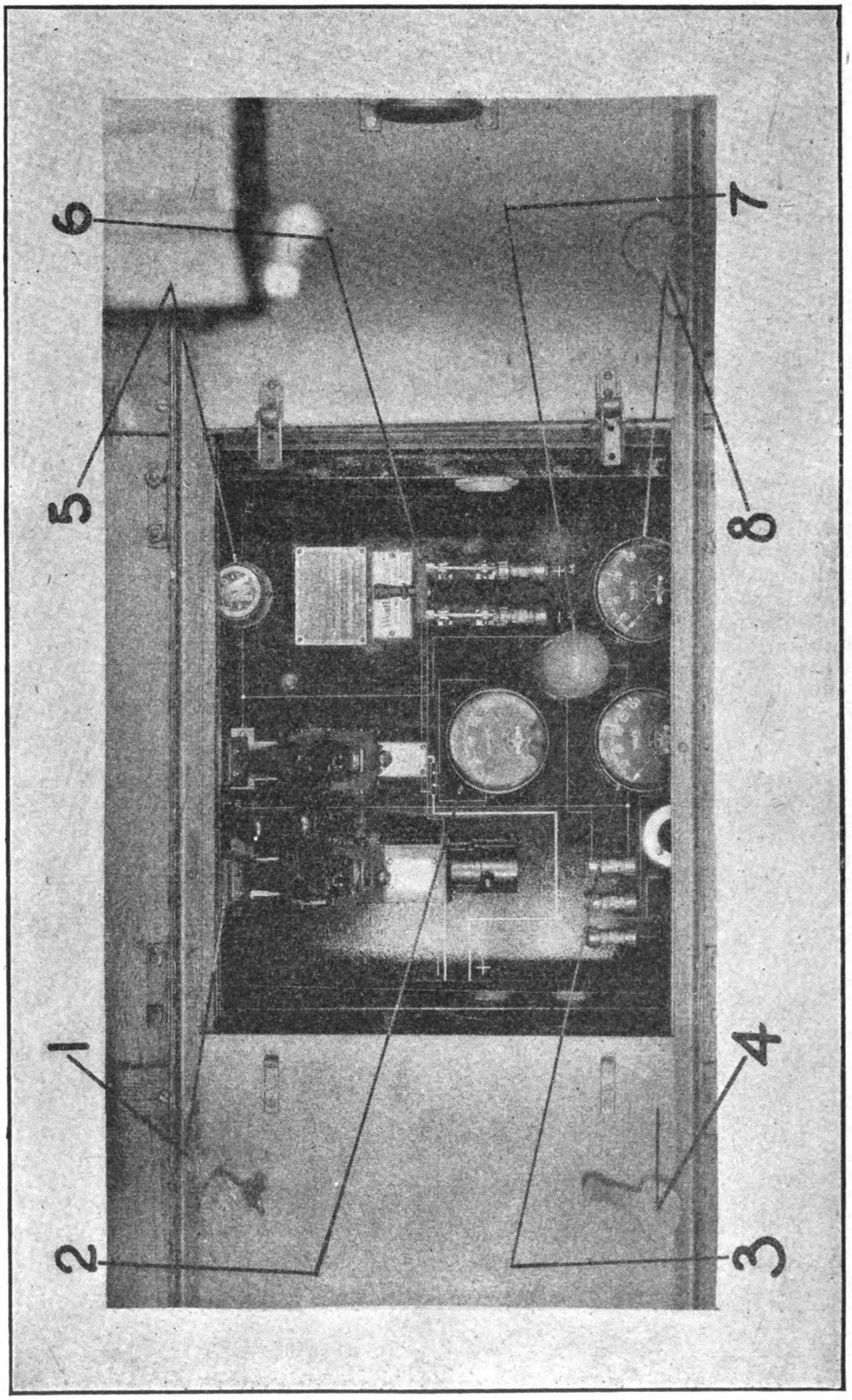
FIGURE 135.—Control panel, General Electric M1940.




1. Arc load voltage rheostat.
2. Listening load voltage rheostat.
3. Power ammeter.
4. Power voltmeter.
5. Charging ammeter.
6. Tachometer and revolution counter.
7. Oil pressure gage.
8. Temperature gage.
9. Choke.
10. Gasoline gage.
11. Throttle.
12. Starter button.
13. 115-volt lamp receptacle.
14. 115-volt light switch.
15. Fan season switch.
16. Ignition switch.
17. 6-volt light switch.
18. 6-volt receptacle.
19. Power voltmeter and lamp circuit breaker.
20. Main switch.

FIGURE 136.—Control panel, Sperry M1939.

NOTE.—Control panel for Sperry M1937 same as for Sperry M1939 except that circuit breaker is substituted for main switch.




1. Circuit breaker.
2. D-c ammeter.
3. D-c voltmeter.
4. Sliding door.
5. Generator field rheostat.
6. A-c switch for rotary converter.
7. Lamp.
8. A-c voltmeter.

FIGURE 137.—Power panel (control panel) M–VI (duplex truck).

**86. General Electric power plant.**—*Q*. What difference is there between the Sperry M1941 and the General Electric M1940 power plants? *A*. Very little. The engines are the same except the Sperry runs at 1,100 rpm and the General Electric at 1,200 rpm. The generators are made by different manufacturers, but both deliver 150 amperes at 78 volts to the searchlight.

*Q*. What is the rating of the generator of the M1940 General Electric power plant? *A*. It is rated as follows:

| *Volts* | *Amperes* | *Rpm* | *Kilowatts* |
|---|---|---|---|
| 100 | 160 | 1, 200 | 16. 0 |

*Q*. Is the nomenclature of the Sperry and the General Electric power plants similar? *A*. Yes. Parts (compare fig. 138 with figs. 132 and 133) correspond except as follows:

(1) The General Electric tank holds 26 gallons.

(2) The General Electric tail lamp switch is located on the tail lamp.

(3) The General Electric fan is driven by a pulley from the main crankshaft.

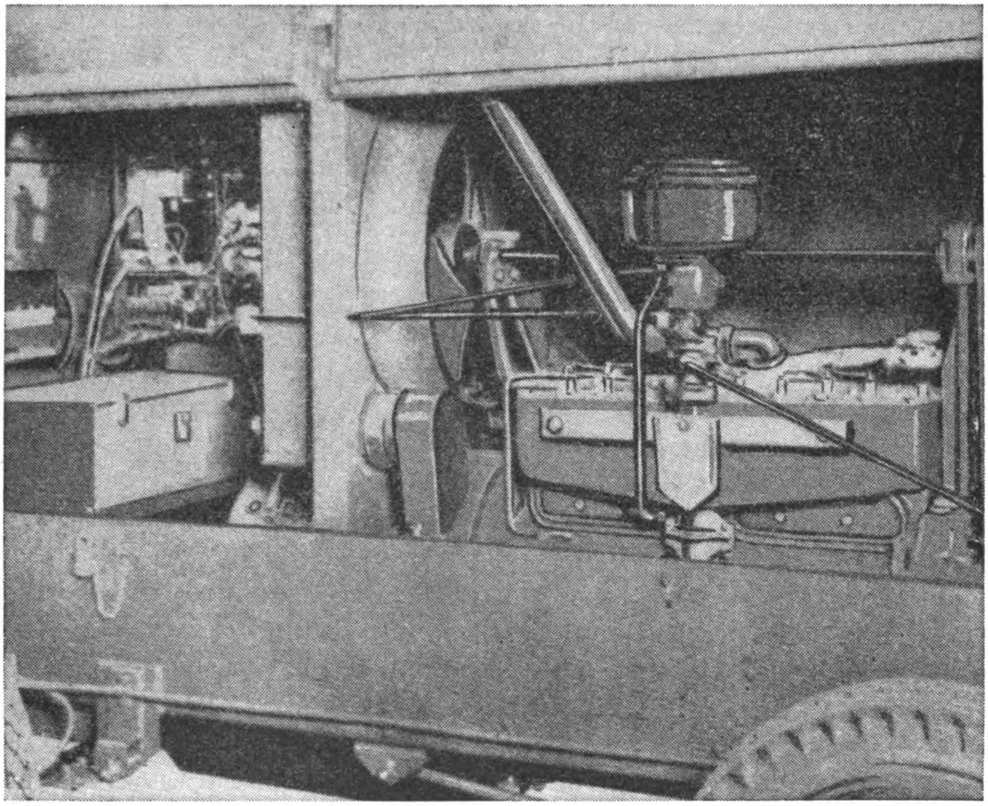


FIGURE 138.—General Electric M1940 power plant.

## Section V

## CARE AND OPERATION OF SEARCHLIGHT



**87. General.**—*Q*. How is the power transmitted from the power plant to the searchlight? *A*. Through two single-conductor cables.

*Q*. How are these cables identified? *A*. The plugs and receptacles are painted yellow.

*Q*. What is the normal operating current and voltage for the arc of the searchlight? *A*. The arc should operate with a current of 150 amperes and a voltage of 78 volts.

*Q*. What is the relation between the arc length, arc voltage, and arc current? *A*.

(1) The arc voltage varies directly as the arc length; that is, the arc voltage decreases as the arc length becomes shorter.

(2) The arc current varies inversely as the arc length; that is, the arc current increases as the arc length becomes shorter.

*Q*. What are the dimensions and burning time of the carbons? *A*.

| *Carbon* | *Size* | *Burning time (approximate)* |
|---|---|---|
| Positive | 22 inches by 0.633 inch outside diameter | 1½ hours |
| Negative | 12 inches by 0.434 inch outside diameter | 1½ hours |

*Q*. When recarboning should new carbons be used? *A*. Yes, always use a pair of full-length carbons.

*Q*. Before entering the drum what should be done? *A*. Make sure that the arc switch is open. In the Sperry M1941 light be especially sure that the recarboning safety switch has been thrown to the "recarboning" position.

*Q*. How should carbons be protected? *A*. Keep the carbons dry and protect then against jarring that might crack the carbons or their cores.

*Q*. How is the mirror cleaned? *A*. The mirror surface is of precious metal, and great care should be taken in cleaning it. The mirror should be cleaned with the solution supplied for that purpose. Use only dry cotton pads for applying and for wiping off the solution. Before using the solution, remove any dust with a soft camel's-hair brush. Never clean the mirror with a rotary motion; always pass the pad over the mirror surface from the center toward the edge. Since the cleaning solution contains ammonia, the drum should be well-ventilated while the solution is being used.

**88. Sperry searchlights.**—*a. Operation and care.*—*Q.* In what two ways can the arc be struck? *A.* Automatically or manually.

*Q.* Describe each briefly. *A.*

(1) *Automatically.*—With the lamp control mechanism set for automatic operation, close the arc switch. The negative carbon will automatically strike the arc and maintain the proper arc length.

(2) *Manually.*—First, centralize the negative feed pawls by moving the negative feed centralizer lever (or knob) to the hand position. This will allow feeding of the negative carbon by hand. Second, move the negative carbon forward by means of the negative hand feed knob. Third, after striking the arc, retract the negative carbon until the voltmeter reads approximately 78 volts.

*Q.* In the M1941 Sperry light what automatic provision is made to strike the arc quickly? *A.* The arc switch incorporates an additional switch known as a thermal operated circuit breaker. The circuit breaker is designed to close 5 to 7 seconds after the main arc switch is opened. The closing of the circuit breaker causes the negative carbon to feed forward rapidly, attempting to strike a new arc. When the carbons touch, a "short circuit" condition is caused which opens the circuit breaker and prevents the restriking of the arc. Thus the negative carbon is left in contact with the positive carbon and is in position for a quick strike of the arc.

*Q.* How would you insert a new positive carbon? *A.* Spread the feed roller brackets apart by means of the recarboning key. Insert the new carbon until it projects $1\frac{3}{16}$ of an inch beyond the positive nose cap. Turn the recarboning key slowly until it permits the positive rollers to grip the carbons.

*Q.* Explain the recarboning of the negative head. *A.* Push the lower end of the negative carbon release lever toward the positive head so that the negative carbon may be readily inserted through the rear of the head. Move carbon in until it projects approximately 1 inch beyond the negative nose cap. Return the release lever slowly to its normal position. Never allow the lever to snap back as this may break the negative carbon.

*Q.* What is the purpose of the thermostat? *A.* The positive carbon burns back twice as fast as the normal rate of feed, therefore the thermostat functions to give the positive carbon an additional forward feeding to keep the luminous ball of vapor at the focal point of the mirror.

*Q*. How does the thermostat function? *A*. It is a thin strip of two different metals welded into a single strip. When heated this strip will bend because the two metals have different rates of expansion. When rays of light from the positive crater are focused by the thermostat lens (26) on the bimetallic strip, the strip bends and closes an electrical contact which in turn energizes the positive feed electromagnet.

*Q*. How could the searchlight be operated if the thermostat or the positive control electromagnet failed? *A*.

(1) *Sperry M1941*.—Turn the positive feed rate adjustment screw approximately 1¼ turns counterclockwise toward "semi." The position of the positive carbon should be carefully watched to keep it at the focal center. The positive carbon can be fed forward by depressing the positive hand feed lever whenever the positive carbon is behind the focal point.

(2) *Sperry M1940*, *M1939*, *M1937*, *M1934*, *M–VI*.—Turn the positive feed rate adjusting knob (23) counterclockwise toward "semi." The positive carbon will feed forward at a rate so as to approximately position the positive crater at the focal point. Because of the absence of automatic control, the position of the carbon should be watched carefully through the ground glass view finder, to prevent over- and under-feeding.

*Q*. What is the function of the arc length control coil (28)? *A*. It acts as a magnet on armature (35), which in turn positions negative feed pawl guard (6), allowing ratchet (5) to retract the negative carbon when the arc voltage is less than 78 volts. Ratchet (7) is engaged when the voltage is greater than 78 volts. Thus it keeps the negative carbon positioned so as to maintain a constant arc length. It functions on the electrical principle that the arc voltage varies directly with the arc length.

*Q*. How could the searchlight be operated if the arc length control coil should fail? *A*. Set the negative feed centralizer lever or knob to "hand" position and turn the negative hand feed knob so as to maintain the required searchlight voltage of 78 volts.

*Q*. How is the interior of the lamp drum kept cool during operation? *A*. There is a small motor-driven fan on top of the searchlight drum which draws air from openings at the bottom and side of the searchlight and exhausts the hot gases out through the top.

*Q*. Should coarse sandpaper ever be used on the searchlight? *A*. No. Unless otherwise specified use No. 00 sandpaper whenever an abrasive is required for cleaning this equipment.

*Q.* How often should the negative head contact surfaces be cleaned? *A.* After every *third* change of carbons. Wrap a piece of No. 00 sandpaper around a negative carbon stub and work it back and forth in the negative head. Clean all abrasive materials from the surfaces.

*Q.* How often should the positive carbon contact surfaces be cleaned? *A.* After every *tenth* change of carbons. The brushes must be removed. Then with No. 00 sandpaper around a positive carbon stub move it back and forth between the two brushes. Wipe off all dust.

*Q.* Should the carbon contact surfaces ever be reamed out? *A.* Only in extreme circumstances.

*Q.* What lubrication is necessary after every 10 hours of operation? *A.* If the lamp has been lubricated with a graphite and oil mixture, place a few drops of a mixture of machine oil and kerosene on the bearings and gears of the lamp mechanism. If the lubricant Aquadag has been used this is not necessary.

*Q.* What cleaning and lubrication of the lamp mechanism are necessary after every 50 hours of operation? *A.* If Aquadag has been used, no cleaning is necessary. In any case, at periods of 2 months the entire lamp mechanism must be washed thoroughly with gasoline with the exception of the positive drive pinion bearing, the main positive feed bearing, and the roller bearing in the semifixed gear (all ball and roller bearings). Aquadag may be used as a lubricant. When Aquadag is used, apply with a spray gun when the lamp head is *hot*.

*Q.* What else should be lubricated every 50 hours of operation (or every 2 months)? *A.*

(1) The ventilating motor bearings (accessible after removing the ventilating motor fan housing) should have a small amount of medium motor oil at the time the motor is inspected (once every 3 months).

(2) Feed motor bearings should be oiled and the feed motor worm gear should be greased with a high temperature grease every 3 months.

(3) The feed mechanism ball bearings must be oiled with light machine oil from inside the drum.

(4) All alemite fittings must be greased at least once a month.

(5) Azimuth and elevation control (training) motors must be oiled once a month with medium oil.

*Q.* How is the thermostat cleaned? *A.*

(1) Remove the thermostat from the searchlight drum and place it on a suitable flat surface, preferably a workbench.

(2) Remove the four cover screws and cover.

(3) Unscrew the contact assembly holding screws and remove the contact assembly.

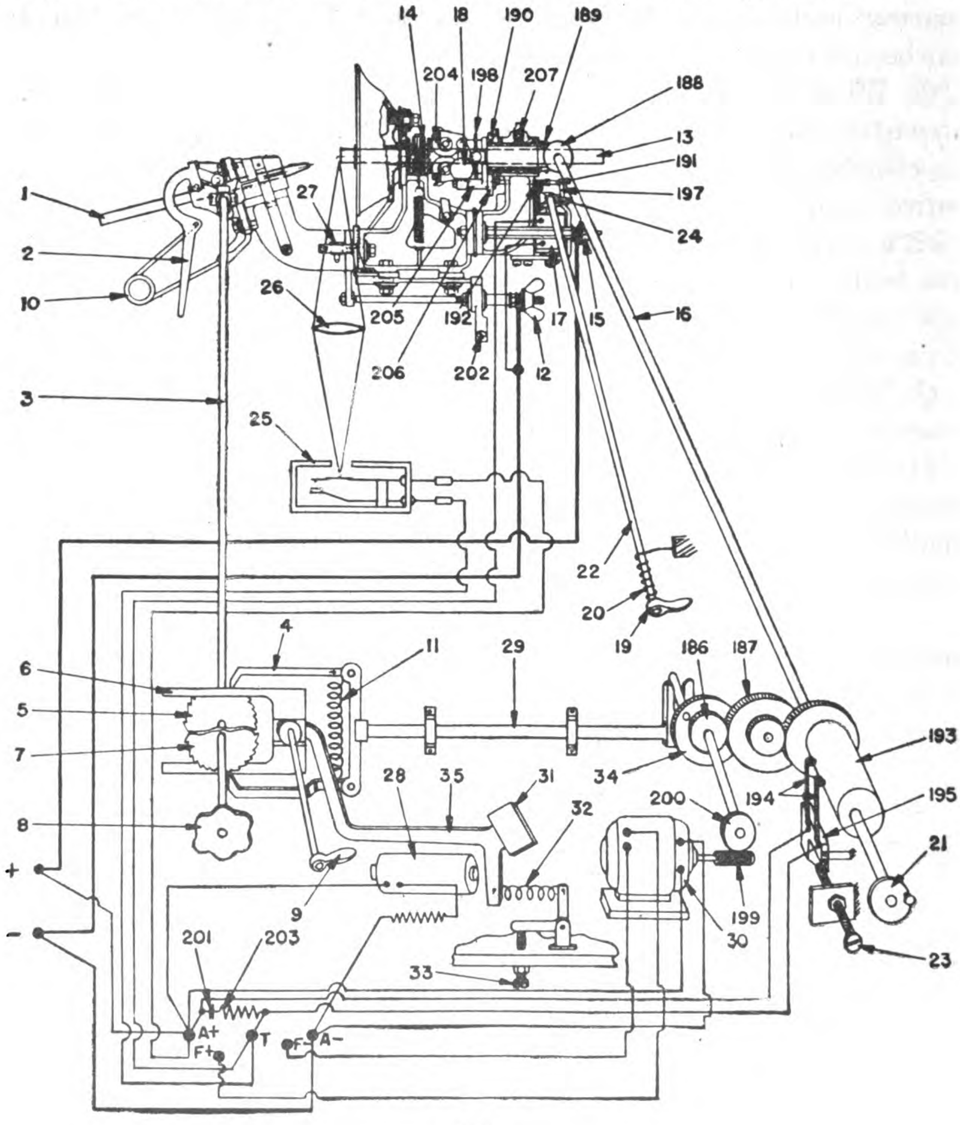
(4) Clean the points with crocus paper, being careful not to bend the contact arms and to avoid excessive rubbing with the abrasive.

(5) When finished cleaning, draw a piece of white paper between the contacts to wipe off any abrasive that may be left on the points.

(6) Reassemble the thermostat and replace it in its position in the drum.

*Q.* How are the supply and control slip rings cleaned? *A.* Access to these rings may be had through the handhole plate in top of the base of the searchlight. The rings should be cleaned with alcohol, whenever necessary, at least every 3 months. Use No. 00 sandpaper if necessary to clean any burned spots.

*Q.* How are the motor brushes cleaned? *A.* After every 50 hours of operation remove the brushes and wash them in gasoline. Wash



1. Negative carbon.
2. Negative release lever.
3. Negative control rod.
4. Negative feed pawls.
5. Negative feed-back ratchet.
6. Pawl guards controlling negative feed.
7. Negative feed forward ratchet.
8. Negative hand feed knob.
9. Negative feed centralizer lever.
10. Negative carbon release spring.
11. Negative feed pawl spring.
12. Negative terminal.
13. Positive carbon.
14. Positive contact.
15. Positive terminal.
16. Positive control rod.
17. Positive feed control electromagnet.
18. Positive feed gear.
19. Positive hand feed lever.
20. Positive hand feed lever spring.
21. Positive hand feed handwheel.
22. Positive feed shaft.
23. Positive feed rate adjustment screw.
24. Positive feed shaft pin and spring.
25. Thermostat.
26. Thermostat lens.
27. Lens positioning screw.
28. Arc length control coil.
29. Reciprocating feed member.
30. Feed motor.
31. Counterbalance.
32. Adjustment spring.
33. Arc length adjustment screw.
34. Eccentric disk.
35. Balanced armature.
186. Eccentric shaft gear.
187. Gear train.
188. Driving miter gear.
189. Driven miter gear.
190. Ratchet and positive feed gear assembly.
191. Spring loaded feed plunger.
192. Plunger spring.
193. Eccentric cam.
194. Roller arm contacts.
195. Switch.
197. Plunger operating armature.
198. Recarboning key.
199. Worm.
200. Worm wheel.
201. Condenser.
202. Focusing bracket set screw.
203. Resistor.
204. Positive carbon feed rollers.
205. Yoke.
206. Planetary gear.
207. Main positive feed bearing.

FIGURE 139.—Schematic diagram of the Sperry M1941 lamp and lamp control mechanism.

each brush and replace in its original position. Make sure that the brushes slide freely in their holders.

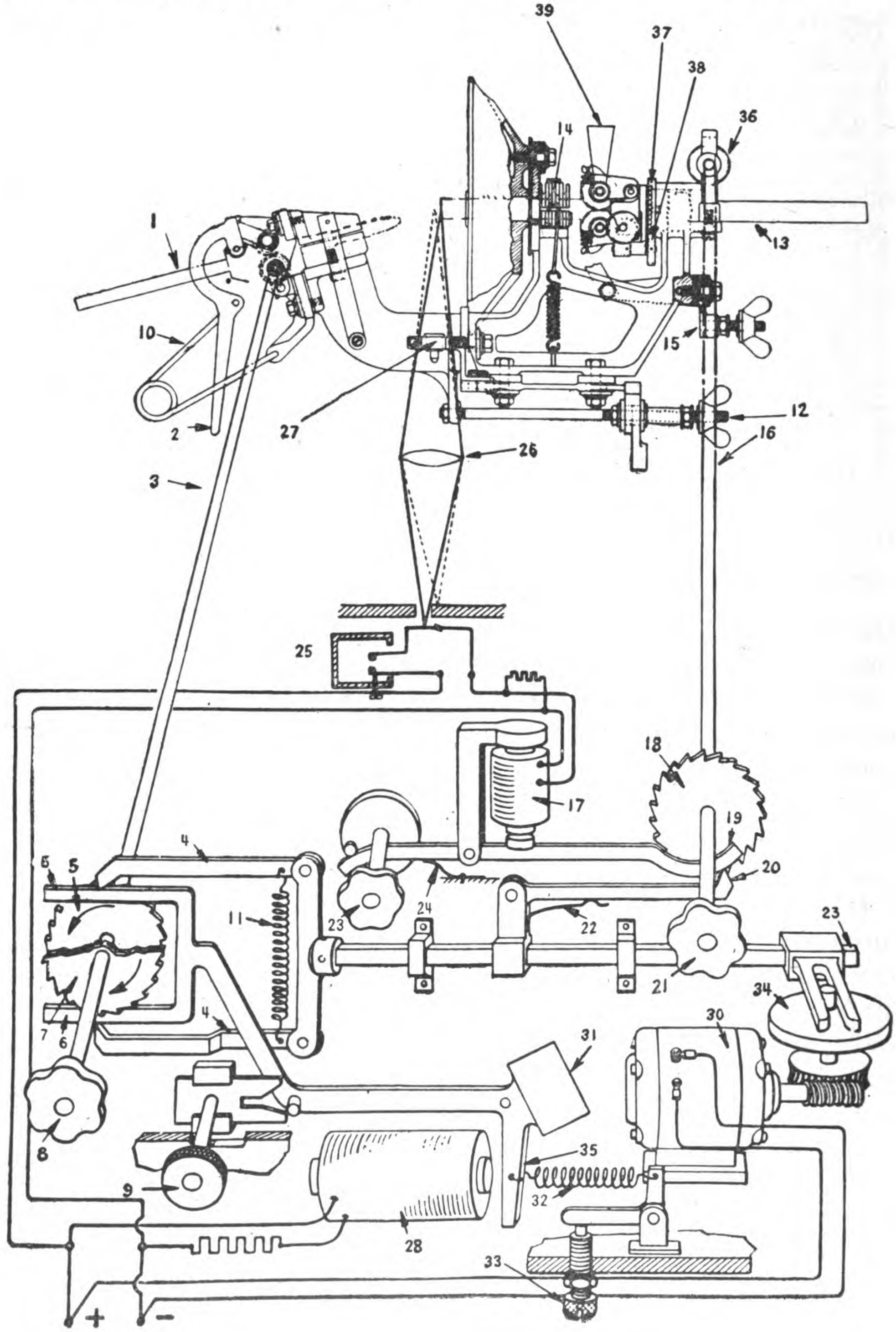
*Q*. How, and when, should the time delay mechanism of the M1941 searchlight be lubricated? *A*. It should be lubricated with light machine oil at intervals as determined by inspection.

*b. Sperry searchlight M1941*.—*Q*. Describe briefly the operation of the lamp control mechanism. *A*. The lamp control mechanism and lamp are shown in schematic form in figure 139.

(1) *Positive carbon feed system*.—The feed motor (30) drives, through a set of gears, the positive rod (16) which drives miter gear (188) and a driven miter gear. Miter gear (189) drives a yoke carrying with it a set of gears. This set of gears include a ratchet and gear assembly (190) which, when prevented from rotating by a feed plunger (191), causes a planetary gear (206) to rotate, which in turn causes the feed rollers to rotate, thus feeding the positive carbon forward.

(2) *Negative carbon feed system*.—The negative carbon feed system operates as follows: The feed motor (30) drives through eccentric gear (186), which in turn causes the reciprocating feed member (29) and the feed pawls (4) to oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed

control guard (6)) drives the negative control rod (3) so as to feed the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon.



1. Negative carbon.
2. Negative release lever.
3. Negative control rod.
4. Negative feed pawls.
5. Negative feed back ratchet.
6. Pawl guards controlling negative feed.
7. Negative feed forward ratchet.
8. Negative hand feed knob.
9. Negative feed centralizer knob for hand feed.
10. Negative carbon release spring.
11. Negative feed pawl spring.
12. Negative terminal.
13. Positive carbon.
14. Positive contact.
15. Positive terminal.
16. Positive control rod.
17. Positive feed control electromagnet.
18. Positive feed ratchet.
19. Positive feed control guard.
20. Positive feed pawl.
21. Positive hand feed knob.
22. Positive feed pawl spring.
23. Positive feed rate adjustment knob.
24. Positive feed electromagnet spring.
25. Thermostat.
26. Thermostat lens.
27. Lens positioning screw.
28. Arc length control coil.
29. Reciprocating feed member.
30. Feed motor.
31. Counterbalance.
32. Adjustment spring.
33. Arc length adjustment screw.
34. Eccentric disk.
35. Balanced armature.
36. Gear.
37. Fixed gear.
38. Planetary gear.
39. Recarboning wrench (shown in position for recarboning only).

FIGURE 140.—Schematic diagram of Sperry M1940 lamp and lamp control mechanism.

The negative control rod (3) is connected to the feed rollers which position the negative carbon.

*Q*. What operates the positive feed plunger (191), figure 139?
*A*. An electromagnet which may be energized from two sources: a cam operated switch (195) or thermostat (25).

*c*. *Sperry searchlight M1940.*—(M1939, M1937, M1934, and M–VI are similar.)

*Q*. Describe briefly the operation of the lamp control mechanism.
*A*. The control mechanism and lamp are shown in schematic form in figure 140.

(1) *Positive carbon feed system.*—The feed motor (30) drives an eccentric disk (34) causing the reciprocating feed member (29) and positive feed pawl (20) to move back and forth. Positive feed pawl (20) engages the teeth on positive feed rachet (18) rotating it and the positive control rod (16) in a counterclockwise direction. Control rod (16) drives gear (36) causing a yoke carrying planetary gear (38) to rotate. Planetary gear (38), through a worm drive, causes the carbon feed rollers to rotate and feed the positive carbon forward.

(2) *Negative carbon feed system.*—The reciprocating feed member (29) and the feed pawls (4) oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed control guard (6)) drives the negative control rod (3) so as to feed the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon. The negative control rod (3) is connected to the feed rollers which position the negative carbon.

*Q*. What is the function of the positive feed control guard (19)? *A*. Raising the positive feed control guard permits more teeth on the positive feed ratchet (18) to be engaged by positive feed pawl (20), thereby increasing the rate of feeding of the positive carbon. The opposite condition occurs when the guard (19) is lowered. The normal position of the positive feed control guard (19) is such as to allow the positive feed pawl (20) to engage only one tooth on the positive feed ratchet (18) for each stroke of the feed pawl.

*Q*. What actuates the positive feed control guard (19)? *A*. The positive feed control guard can be positioned, automatically or manually as follows:

(1) *Manually*.—By turning the positive feed rate adjustment knob (23) the position of the positive feed control guard (19) can be controlled, and therefore the rate of feeding of the positive carbon.

(2) *Automatically*.—The positive feed control electromagnet when energized will raise the positive feed control guard (19), thereby increasing the feeding of the positive carbon.

*Q*. What energizes the positive feed control electromagnet (17)? *A*. The closing of the contacts of the bimetallic strip in the thermostat (25).

**89. General Electric searchlight.**—*a. Operation*.—*Q*. Describe briefly the operation of the General Electric lamp mechanism. *A*.

(1) *Positive feed*.—See figure 141. The lamp motor, through a set of gearing and shafts, drives a helical gear on the positive head, which transmits a constant rotary motion to the yoke and positive carbon. When the detent is not engaged with the detent gear, the entire assembly including the spur gear rotates with the yoke. When the detent is engaged with the detent gear, the spur gear attached to the detent wheel is kept from rotating, causing the outside gear to rotate around the attached spur gear, thereby causing the feed rollers, through a worm drive, to feed the positive carbon forward.

(2) *Negative feed*.—The lamp motor, through a set of bevel gears, rotates the negative drive shaft. Mounted on and keyed to this shaft is a sliding armature friction driver which rotates with, but is free to slide along, the shaft. On each end of the sliding armature friction driver is a friction collar, either of which by proper positioning of the sliding armature can drive a friction driven disk. This friction driven disk is connected by shafting and gearing to the negative feed pawls. Positioning of the sliding armature friction driver is controlled by two stationary electromagnets, each of which is built around one of the friction collars. One of these electro-

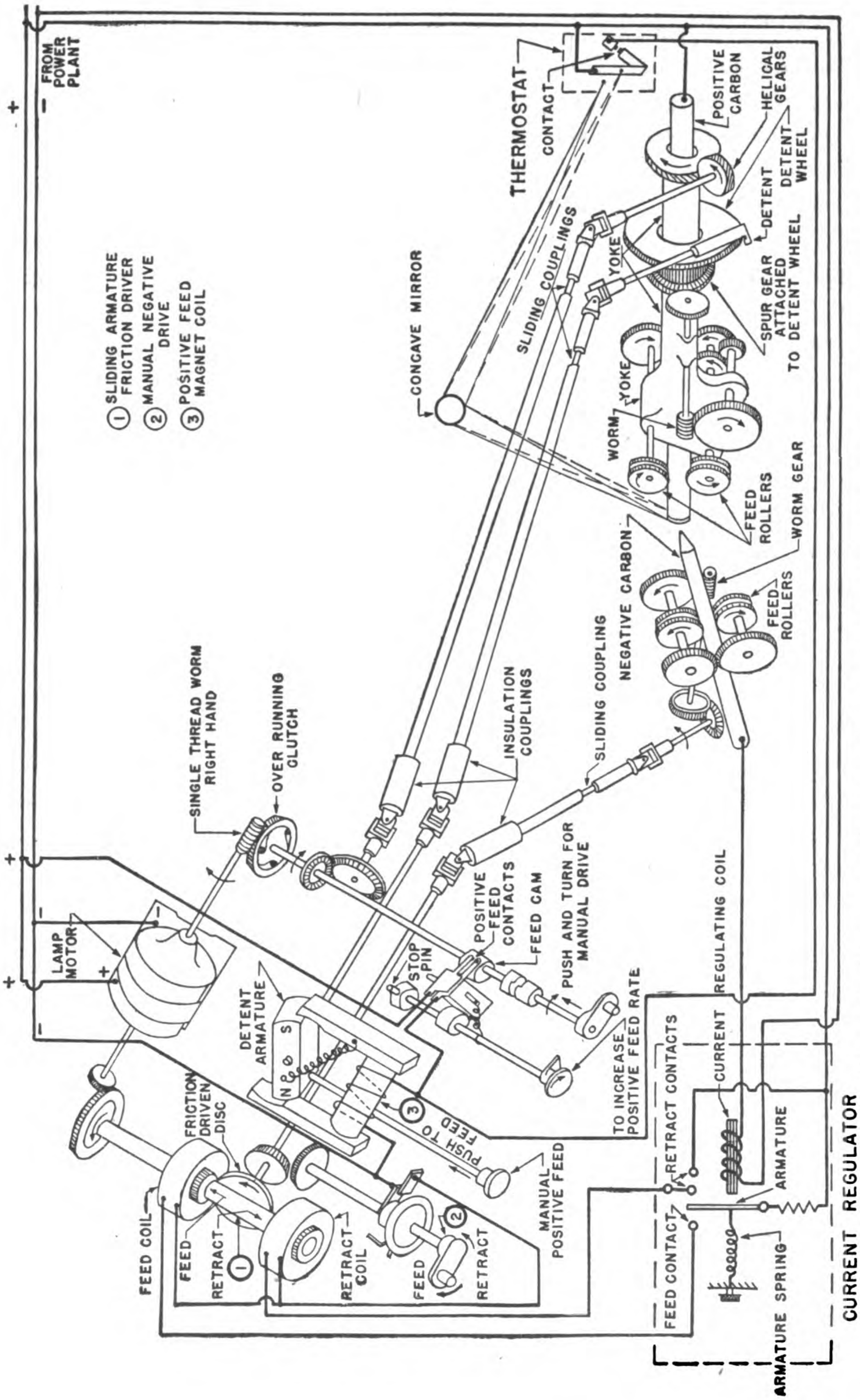



FIGURE 141.—Schematic diagram of General Electric lamp control mechanism and lamp mechanism.

magnets is termed the "feed coil" and the other is termed the "retract coil." When the feed coil is energized, the sliding armature friction driver is positioned so that the friction driven disk is rotated in the proper direction to cause the feed rollers to feed the negative carbon forward. When the retract coil is energized, the direction of rotation of the friction driven disk is reversed and the negative carbon is retracted.

*Q.* What actuates the detent? *A.* The positive feed magnet when energized causes an armature to turn; this turns a shaft which causes the detent to engage the detent gear. This armature may also be actuated manually by pushing the "manual positive feed."

*Q.* How is the positive feed magnet energized? *A.* It may be energized from two sources:

(1) By the thermostat, whenever the positive carbon burns back from the focal point of the mirror.

(2) By the closing of the positive feed contacts which are actuated by rotation of a cam. This provides an intermittent feed to the positive carbon which is somewhat less than the rate of burning of the positive carbon.

*Q.* Can the positive feed rate be adjusted? *A.* Yes, by turning the manual positive feed adjustment knob. This knob provides for a rate of feed from a minimum of 6.5 inches per hour to a maximum of 12 inches per hour.

*Q.* Can the positive carbon be fed forward manually? *A.* Yes, by pushing in and turning the manual drive crank clockwise, at the same time pushing in the manual positive feed button.

*Q.* What should be done if the thermostat fails? *A.* By observing the positive arc crater on the arc image screen, the crater can be moved to the focal point by simply pushing in the manual positive feed button and holding it until the positive crater returns to the focal point.

*Q.* How is the negative carbon kept at its proper position? *A.* By means of the current regulator, which is electrically connected to the feed coil and retract coil.

*Q.* How does the current regulator operate? *A.* The current regulator operates on a current principle. When the arc length is normal the current through the regulator is 150 amperes. This condition will cause the movable contact to be centered and neither the feed coil nor retract coil will be energized. When the current increases or decreases from the normal value of 150 amperes, as a result of a change in the arc length, the movable contact on the regulator will move to close either the feed coil circuit or the retract coil circuit. This in turn will cause the carbon to resume its normal position.

*Q.* Can the negative carbon be fed or retracted manually?—*A.* Yes, by pushing in the manual negative drive and turning the crank in the desired direction.

*Q.* How is the lamp kept cool? *A.* There is a small motor-driven fan located on top of the searchlight which draws air from openings in the drum and through the lamp support column.

*Q.* How can the arc be struck? *A.* Either automatically or manually.

(1) *Automatically.*—Close the main switch. The current regulator will cause the negative carbon to feed forward rapidly until the negative carbon touches the positive carbon. The rush of current will cause the retract coil to operate and retract the carbon quickly to its normal position where it will draw 150 amperes.

(2) *Manually.*—Push in the manual negative drive and turn the crank clockwise to feed the negative carbon forward until it strikes the positive carbon. Then quickly turn the crank counterclockwise and retract the carbon until the normal current of 150 amperes is indicated on the ammeter. When the manual negative drive crank is pushed in, an electric interlock opens the circuits of the magnetic clutch coils, thus preventing the automatic negative drive mechanism from functioning.

*Q.* When using the distant electric control, what actually positions or trains the searchlight? *A.* Two small d-c motors, one for training in azimuth and the other for training in elevation.

*Q.* How is the lamp recarboned? *A.*

(1) *Positive carbon.*—(*a*) Release the feed rollers by means of the feed roller clamp lever.

(*b*) Insert the new carbon through the hole in the positive head.

(*c*) Set the tip of the carbon so that it extends 3/4 to 7/8 of an inch beyond the obturator nose.

(*d*) Secure the feed roller clamp lever so that the positive rollers grip the carbon.

(2) *Negative carbon.*—(*a*) Push the release lever (negative carbon drive roller handle) in the direction of the positive head.

(*b*) Insert the negative carbon and push it forward until the point is about 1/4 inch from the positive carbon tip.

(*c*) Secure the feed roller levers.

*Q.* With respect to the positive carbon, when the arc is burning what should the operator especially observe? *A.* He should be particularly careful that the tip of the positive carbon does not burn beyond the line marked "danger," otherwise serious damage may result from burning of the obturator on the positive head. Furthermore, the operator must observe the beam in order to judge the satisfactory operation of the arc.

*b. Care.*—*Q.* Name the parts which should be cleaned daily. *A.*

(1) *Positive and negative contacts.*—Use the cleaning stone on the alinement gage.

(2) *Thermostat mirror.*—Use a clean, dry cloth or chamois skin.

(3) *Obturator.*—Remove all dust, and ream if necessary with the reamer included in the tool kit.

*Q.* How is the thermostat cleaned? *A.* Remove the thermostat and inspect the contacts for pitting or burning. If necessary, clean the surface of the contacts by passing a fine clean file between the contacts. Replace the thermostat.

*Q.* How should the collector rings be serviced? *A.* The collector rings are accessible through a handhole in the searchlight turntable. The collector rings should be cleaned with a clean cloth soaked in alcohol. If the rings are discolored they may be polished by using a clean chamois skin. If the rings are pitted or burned, use a clean, thin file for smoothing the surface. Great care must be taken not to remove the thin silver coating on these rings.

*Q.* In lubricating what should be watched? *A.* Be careful not to overlubricate. All excess lubricant should be carefully wiped off. Make sure sure that oil or grease does not get on the motor brushes, brush holders, commutators, coils, or slip rings.

*Q.* How should the lamp bearings and lamp head gears be lubricated? *A.* All lamp bearings and lamp head gears subject to high temperatures should be lubricated with Aquadag, a material consisting of graphite in suspension in water. If Aquadag is not available, then use flake graphite diluted in kerosene. When Aquadag is used it should be sprayed on; if a spray is not available then apply sparingly with a brush.

*Q.* What other parts require lubrication? *A.*

(1) The worm and gear of the lamp motor positive drive should be lubricated frequently but not excessively.

(2) The bearings of the lamp control mechanism should be lubricated with a few drops of light machine oil.

(3) The bearings of the dynamotor are filled with grease at the factory; they should be lubricated from time to time through tapped holes in the bearings.

*Q.* Where is the information on adjustments and trouble shooting found? *A.* In the Operator's Manual furnished with each searchlight.

## SECTION VI

## CARE AND OPERATION OF CONTROL SYSTEM



**90. General.**—*Q*. How can the searchlight be controlled or trained? *A*.

Two means are provided:

(1) The extended hand controller.

(2) The distant electric control.

*Q*. What does the control station accomplish? *A*.

(1) Provides remote control of the searchlight.

(2) Synchronizes the searchlight with sound locator data.

(3) Positions the binocular and open sight assembly.

NOTE.—The Sperry M-VI does not have a binocular mount.

**91. Sperry control stations.**—*a. General.*—*Q*. Should the azimuth gear and pinion be lubricated? *A*. No. They should be cleaned monthly with dry-cleaning solvent. Never lubricate, as lubricating will cause dust and dirt to gather on the gear teeth.

*Q*. How should the electrical contact rings and brushes be cleaned? *A*.

(1) Clean with alcohol when needed. Use No. 00 sandpaper if necessary to clean burned spots.

(2) The slip rings and brush assemblies in the tripod should be cleaned every 6 months.

(3) The D. E. C. transmitter rings and segments should be cleaned every 3 months.

(4) All electrical contacts should be clean and bright. Wipe off all contacts after using an abrasive. Do not permit oil or grease on the insulation.

*Q*. How should the control station be lubricated? *A*. Due to the fact that most of the control unit mechanism bearings are grease-sealed at the factory, little attention to lubrication is required. However, when the control unit cover is removed for cleaning, the gear teeth and bearings should be inspected and a few drops of machine oil applied if necessary.

*b. Sperry M1941, M1940, M1939, and M1937.*—*Q*. Of what does the control station consist? *A*. It consists of a tripod, control unit, and binocular mount.

*Q.* How is the searchlight synchronized with the sound locator data? *A.* Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator to self-synchronous receivers which are mounted and geared to the searchlight. The electrical output of the receivers goes to a phase detecting circuit, thence to d-c, double throw, zero reading voltmeters. When the indicator on the zero reading voltmeter is at the zero position the searchlight is pointed or synchronized with the sound locator data. There are a total of four zero reading voltmeters, two for azimuth and two for elevation. One set (one azimuth and one elevation) of zero readers is mounted on the searchlight drum, and the other set is mounted on the control station.

*Q.* How many men are required to operate the control station? *A.* Three: an azimuth zero reader operator, an elevation zero reader operator, and an observer.

*Q.* What are the duties of each man? *A.*

(1) The zero reader operators turn their respective handwheels to keep the zero pointers on the center, or zero, position of the azimuth and elevation zero reader indicators. If the target is not flicked when the searchlight goes into action, the zero reader operators cause the searchlight (except in the M1937 control station) to search in the vicinity of the sound locator data by operating their handwheels so as to cause the pointers of the zero reader meters to move slowly alternately to the right and left of the zero position. In the M1937 control station an automatic means is provided for searching; pushing down the search control knob operates an automatic search in elevation; turning the search control knob offsets the potentiometer which controls the pointer of the azimuth zero reader; thus the observer controls an automatic search in elevation, and a search in azimuth by offsetting the pointer of the azimuth zero reader.

(2) When the target is flicked the zero reader operators relinquish control of their respective handwheels, and the observer then takes over the control and follows the target by means of the observer's handwheels.

*Q.* What is actuated when the azimuth zero reader's handwheel, or observer's azimuth handwheel, is turned? *A.* The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

*Q.* What is actuated when the elevation zero reader's handwheel, or observer's elevation handwheel, is turned? *A.* The binocular mount is moved in elevation and the elevation distant electric control transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

*Q.* Is there a means of signaling at the control station? *A.* Yes. There is a push button on the control station that operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

*Q.* What is the color of the control cable plugs and receptacles? *A.* Red.

*Q.* What is the minimum distance that the control station should be placed from the searchlight? *A.* 50 feet.

*Q.* What type of distant electric control is used on Sperry searchlights, with the exeception of the M–VI. *A.* A d-c step-by-step system, which operates on the same voltage as does the arc.

*c. Sperry M1934.*—*Q.* Of what does the control station consist? *A.* It consists of a tripod and control unit, including binoculars.

*Q.* How is the searchlight made to follow the sound locator data? *A.* Self-synchronous transmitters on the sound locator transmit electrically the angular movements of the sound locator to self-synchronous receivers, which are mounted in the control station and position an inner dial of a set of concentric dials. The outer dials are geared to the control unit and indicate the azimuth and elevation of the control unit and searchlight, when correctly oriented and synchronized.

*Q.* How is searching accomplished? *A.* The searching is accomplished by a searching handwheel which superimposes an additional motion to the elevation and azimuth transmitters.

*Q.* How many men are required to operate the control station? *A.* Three: observer, azimuth follow-the-pointer operator, and elevation follow-the-pointer operator.

*Q.* What are the duties of each man? *A.* The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked the observer should start searching by turning the searching handwheel continuously in a clockwise or counterclockwise direction. When the target is flicked, the follow-the-pointer men should relinquish control of their respective handwheels to the observer, who from then on follows the target by means of the observer's handwheels.

*Q.* What type of distant electric control is used on the M1934 Sperry searchlight? *A.* A d-c step-by-step system, which operates on the same voltage as does the arc.

*d. Sperry, M-VI.*—*Q*. Of what does the control station consist? *A*. It consists of a tripod, controller, and comparator.

*Q*. How is the searchlight made to follow the sound locator data? *A*. Self-synchronous transmitters on the sound locator transmit electrically the angular movements of the sound locator to self-synchronous receivers, which are mounted in the comparator and positions an outer dial of a set of concentric dials. The inner dial is positioned by a self-synchronous receiver which is electrically connected to a self-synchronous transmitter on the searchlight. Operating the controller handwheels causes the searchlight to be trained in elevation and azimuth, and when the pointers on these two concentric dials at the comparator are matched the searchlight is pointing in the proper direction, if the searchlight unit has been correctly oriented and synchronized.

*Q*. How many men are required to operate the control station? *A*. Three: observer, azimuth follow-the-pointer operator, and elevation follow-the-pointer operator.

*Q*. What are the duties of each man? *A*. The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked, the follow-the-pointer men cause the searchlight to search around the sound locator data by manipulating their respective handwheels so as to cause the searchlight pointer to move slowly back and forth within 5° of the sound locator pointer.

*Q*. What type of distant electric control is used by the M-VI searchlight? *A*. A brush shifting type. The handwheel at the comparator positions a d-c step-by-step transmitter which in turn positions a d-c step motor at the searchlight causing the brushes of the training motor to be shifted, imparting a torque to the training motor.

**92. General Electric control station.**—*a. Operation.*—*Q*. Of what does the control station consist? *A*. It consists of a tripod, control unit, and binocular mount.

*Q*. What type of distant electric control is used by the General Electric M1940 searchlight? *A*. A self-synchronous control system which controls the operation of the d-c training motors.

*Q*. How are data transmitted from the sound locator? *A*. From self-synchronous transmitters on the sound locator to receivers on the searchlight, then to zero reading voltmeters on the searchlight and control station.

*Q*. How are the movements of the control station transmitted to train the searchlight? *A*. The rotation of the handwheels at the control station positions a self-synchronous transmitter, which, in turn, causes a rotor on the searchlight self-synchronous receiver to follow the rotation of the transmitter rotor. The rotor on the searchlight receiver positions a heart-shaped cam which controls a contact operating plate in a resistance bridge. Movement of the contact operating plate changes the bridge resistance in such a way as to control the operation of a d-c driving motor on the searchlight. When the searchlight has been rotated the required amount, the heart-shaped cam is set back to its neutral position in the following manner: A system of gears from the searchlight turns the stator housing of the self-synchronous receiver in the opposite direction to that of the receiver rotor. This movement is reflected in a corresponding rotor movement which returns the heart-shaped cam and contact operating plate to the neutral position.

*Q.* How many revolutions of the D. E. C. transmitters and receivers correspond to one revolution of the searchlight? *A.* The D. E. C. transmitters and receivers make 36 revolutions for each revolution of the searchlight. Therefore, the control station and the searchlight will be autosynchronous only in a 10° arc.

*Q.* How many men are required to operate the control station? *A.* Three. An azimuth zero reader operator, an elevation zero reader operator, and an observer.

*Q.* What are the duties of each man? *A.* The zero reader operators turn their respective handwheels to keep the zero pointers on the center or zero position of the azimuth and elevation zero reader indicators. If the target is not flicked when the searchlight goes into action, the zero reader operators cause the searchlight to search in the vicinity of the sound locator data by operating their handwheels so as to cause the pointers of the zero reader meters to move slowly alternately to the right and left of the zero position. When the target is flicked the zero reader operators relinquish control of their respective handwheels, and the observer then takes over the control and follows the target by means of the observer's handwheels.

*Q.* What is actuated when the azimuth zero reader's handwheel or observer's azimuth handwheel is turned? *A.* The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

*Q.* What is actuated when the elevation zero reader's handwheel or observer's elevation handwheel is turned? *A.* The binocular mount is moved in elevation and the elevation D. E. C. transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

*Q*. Is there a means of signaling at the control station? *A*. Yes. There is a push button on the control station which operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

*Q*. What is the color of the control cable plugs and receptacles? *A*. Red.

*Q*. What is the minimum distance that the control station should be placed from the searchlight? *A*. 50 feet.

*b*. *Care*.—*Q*. How should the control station be cleaned? *A*.

(1) The azimuth ring gear and pinion should be cleaned monthly by means of a brush dipped in gasoline. Do not lubricate this gear or pinion since it would tend to accumulate dirt and dust.

(2) The brush holder and rings should be cleaned with alcohol every 6 months. They should be kept clean by wiping from time to time.

(3) All electrical contacts should be clean and polished. Never allow oil or grease to accumulate on the insulation.

*Q*. How should the control station be lubricated? *A*. Most of the bearings are sealed in oil at the factory. However, when the cover is removed for cleaning, inspect the teeth of the gears and bearings and if necessary apply a small quantity of grease to the gears and a few drops of light machine oil to the bearings.

CHAPTER 13

# SUPPLIES



**93. Supply platoon.**—*Q.* What element of a regiment or separate battalion is responsible for the operation of the supply functions (except ammunition) of the unit? *A.* The supply platoon of the regimental or separate battalion headquarters battery.

*Q.* Who supervises the operation of the supply platoon? *A.* The unit supply officer.

*Q.* Of what elements is the supply platoon comprised? *A.* A platoon headquarters and one or more battalion sections. One battalion section is provided for each battalion of the unit of which the supply platoon is a part.

*Q.* What is the purpose of a battalion section? *A.* It supplies a particular battalion. If a battalion is detached from the regiment, its battalion section normally accompanies it and functions for the supply of the battalion under the supply officer of the unit to which the battalion is attached.

**94. Mechanics and methods of supply.**—*Q.* How are supplies delivered to the supply platoon when operating in the field? *A.*

(1) They may be delivered to the camp or bivouac of the supply platoon by the train of the next higher administrative unit.

(2) The trucks of the supply platoon may go in convoy to the designated depot or distributing point to secure the supplies.

*Q.* How are supplies delivered to the batteries? *A.*

(1) The supply platoon trucks may deliver the supplies directly to the batteries.

(2) The supply platoon may establish a distributing point and issue supplies to battery trucks at that point.

(3) Battery trucks may be attached to the supply platoon convoy and go to the depot or distributing point established by the higher administrative unit to receive their supplies.

*Q.* In the field what written requests are necessary to obtain rations? *A.* In the field no requisition is necessary. A record of the number of men present on the morning report of the regiment is forwarded each day to higher headquarters, and rations are issued daily to supply the number of men reported.

*Q.* How are gasoline and oil issued in the field? *A.* A reserve of gasoline and oil in containers is carried in each unit. As far as practicable, initial distribution of this reserve is made to each motor vehicle. After the initial issue of gasoline and oil, each motor vehicle operating between army supply points and unit areas replenishes its supply of gasoline and oil at the most convenient class III supply point established by the army. Vehicles operating in forward areas are resupplied with gasoline and oil by exchanging empty containers for full ones brought forward from army supply points either by regimental or divisional transportation.

*Q.* Name and describe the various field rations. *A.*

(1) *Field ration A.*—This ration corresponds to the peacetime garrison ration and is generally perishable. Being perishable, it is not suitable as a reserve ration.

(2) *Field ration B.*—This ration is the same as field ration A except that nonperishable substitutes replace perishable items. This ration is suitable for reserve purposes.

(3) *Field ration C.*—This ration is a cooked balanced ration in cans. Each ration consists of 3 cans of prepared meats and vegetables and 3 cans of crackers, sugar, and soluble coffee. As this ration is not perishable, it is suitable for use as a unit reserve or as an individual reserve.

(4) *Field ration D.*—This ration consists of 3 4-ounce chocolate bars per ration. It is a nonperishable ration and is suitable for use as an individual reserve.

*Q.* For what purpose is the A ration employed? *A.* It is issued daily from class I railheads to all divisions and other units not actively engaged with the enemy.

*Q.* What ration is issued to units engaged in battle? *A.* One of the nonperishable rations or combinations thereof.

*Q.* What method is sometimes employed by supply officers of regiments (or battalions) engaged in combat to facilitate the issue of rations? *A.* A rear echelon may be established where all kitchens are assembled. From this point trucks are dispatched with cooked meals to locations from which the food can be carried to the troops.

*Q.* What method is employed to determine the quantities of the various articles of the ration which should be issued by the regiment to the various subordinate units? *A.* The components of the prescribed ration are listed in regulations published either by the War Department or by the commander of the field forces. By using this list of ration components and the strength returns submitted by the various batteries, the regimental supply officer can determine the quantity of each item of the ration to which a unit is entitled.

*Q.* What practical difficulties may be encountered in attempting to divide the ration articles equitably? *A.*

(1) Meat is received in the form of large cuts such as fore and hind quarters of beef. In dividing up the meat, consideration must be given to the amount of bone and other waste material in different parts of the cut if an equitable division of the meat is to be made. The problem is further complicated by the difficulty of cutting frozen meat.

(2) Sugar, flour, and similar bulk foods will usually be received in 100-pound sacks which must be broken down into smaller quantities for issue to the various units. Care must be taken to reduce losses to a minimum during this handling.

(3) Where the allowances per man are small as in the case of pepper and similar items, or where the quantity of an item to which a unit is entitled is slightly less or greater than the size of the container in which the item is issued, it may be desirable to issue the item in whole containers, making the necessary adjustment on succeeding days.

(4) In the case of canned articles equitable division is complicated by the size of the smallest unit of issue, as a No. 10 can. This may result in a shortage or overage for a particular unit of a considerable portion of that component. The supply officer may solve this problem by having units provide suitable containers in which portions of the contents of opened cans may be placed, thereby permitting an accurate division of the canned items. If this is not done, units receiving overages will build up a supply of remnants that usually will not be readily usable.

*Q.* How are supplies secured in peacetime in garrison? *A.*

(1) Rations are drawn by each battery from the commissary.

(2) Clothing is drawn by each battery from the quartermaster warehouse.

(3) Other supplies are drawn from quartermaster, ordnance, engineer, or signal warehouses by the supply officer and issued to the batteries.

**95. Handling and storing supplies, including safety precautions.**—*Q.* What points should be considered when storing supplies? *A.*

(1) They should be reasonably secure against theft.

(2) They should be protected from the deteriorating effects of weather including excessive heat, excessive cold, or moisture.

(3) They should be conveniently placed and segregated to facilitate handling.

(4) Maximum permissible floor load must not be exceeded.

(5) When supplies must be stored in the open, they should be kept off the ground by placing them on dunnage such as logs, stones, old crates, or any other suitable material available, and kept covered with paulins or other waterproof coverings.

*Q*. What provision must be made for the storage of inflammable materials? *A*. They must be segregated from other supplies, preferably in a separate building.

*Q*. How is woolen clothing protected from moths? *A*. When woolen clothing is unpacked and placed on shelves or in bins for issue, sprinkle napthalene around the clothing in ample quantities. If the clothing is repacked, line the box with wrapping paper and sprinkle napthalene between the folds of the clothing and between layers. Similar precautions should be taken with woolen blankets.

*Q*. What safety precautions are necessary when handling and storing gasoline? *A*.

(1) Keep open fires away.

(2) See that each gasoline tank truck has a chain attached which drags on the ground to carry off static electricity which might set fire to the gasoline.

(3) Allow no smoking in the vicinity of places where gasoline is stored or is being handled.

(4) When gasoline is to be stored in cans, the cans of gasoline must be examined for leaks before they are placed in the storehouse.

(5) Special fire-fighting equipment such as sand and carbon tetrachloride types of fire extinguishers should be provided in the storage area.

*Q*. How should trucks be loaded? *A*. Heavy goods should be on the bottom and toward the rear. Top-heavy swaying loads are dangerous. Sacked goods should be firmly placed and pyramided to prevent shifting and wear from friction. Baled goods should never be placed so as to extend over the sides of the truck. Carefully balanced loads will increase the capacity, as most loads are limited by bulk rather than weight.

*Q*. Why is the keeping of used rags in storehouses or storage spaces considered to be a dangerous practice? *A*. The rags may become ignited by spontaneous combustion.

**96. Capacities of vehicles.**—*Q*. Where is the maximum pay load, road and cross-country, and the maximum tow load for a particular vehicle shown? *A*. On the vehicle name and caution plate on the dashboard. These loads should never be exceeded except in case of emergency, and then only when specially authorized.

*Q.* How can overloading of a vehicle be determined when no scales are available and no weights are shown on the cargo? *A.* By noting the position of the rear springs. The driver should be familiar with the appearance of the springs when the truck is carrying its maximum authorized load. Any position of the spring ends below this point indicates that the vehicle is overloaded.

CHAPTER 14

# GENERAL SUBJECTS



SECTION I

## INDICATION, IDENTIFICATION, AND CHARACTERISTIC FEATURES OF WARSHIPS



**97. Indication of targets.**—*Q*. How are naval targets indicated? *A*. By stating the subarea and the name (or type and class) of a

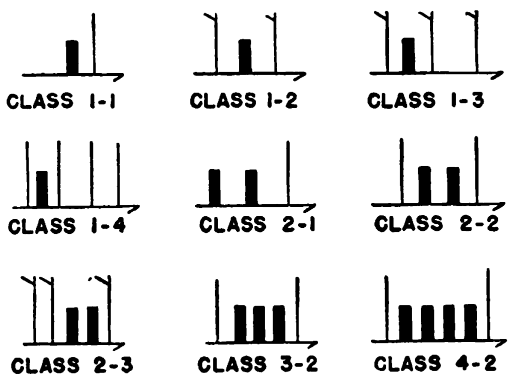



FIGURE 142.—Classification of ships.

single ship; or subarea, type, formation, direction of movement, ship number and class, when target is one of a group of ships.

*Q*. How would one of a column of destroyers in water subarea Rudy be assigned as a target? *A*. 1. TARGET, 2. RUDY, 3. DESTROYER

DIVISION IN COLUMN, 4. LEADING SHIP (observers, spotters, and gun pointers report on target), 5. TRACK.

*Q*. How may ships be classified by the number of funnels and masts? *A*. By stating the number of funnels followed by the number of masts. Thus, a ship with 3 funnels and 2 masts would be designated as "Class 3-2."

**98. Identification and characteristic features of targets.**—*Q*. How may warships be classified? *A*. Warships are classified broadly as follows:

(1) Capital ships mounting guns of a caliber exceeding 8 inches, including battleships, and battle cruisers.

(2) Noncapital ships, mounting guns 8 inches and smaller, including cruisers, destroyers, aircraft carriers, and submarines.

*Q*. What are the purpose and characteristic features of each type? *A*.

(1) *Capital ships.*—(*a*) Battleships (BB) form the first line of battle. They are the most formidable type of war vessel and combine powerful weapons with the greatest protection possible. To carry the heavy guns and armor required to give maximum offensive and defensive power, speed has to be sacrified to a certain extent. Characteristic features of battleships are great size, moderate speed, heavy armor, large guns in turrets, massive appearance, low to medium freeboard, and broad beam. Their main batteries are of caliber exceeding 8 inches and may include 16-inch guns with an effective range of 35,000 yards.

(*b*) Battle cruisers (CC) are similar in appearance to the battleships although their lines are finer. They carry the maximum caliber guns practicable, though fewer in number, and their armor protection is less than that of a battleship. This saving in weight is used to gain greater speed, permitting them to leave the battle line to gather information and yet be able to return in time to join the main action.

(*c*) Pocket battleships are lightly armored ships mounting guns of large caliber. They have greater fire power than cruisers. They are capable of greater speed than most battleships. Other capital ships include those provided for coast defense, carrying large caliber guns but having a very limited speed and cruising radius. Monitors are an example of this type.

(2) *Noncapital ships.*—(*a*) Airplane carriers (CV) are large ships of considerable displacement, moderate to high speed, some of them armored, armed with moderate sized guns, and carrying a large number of airplanes which are launched from and landed on specially

constructed decks. The landing deck and the peculiar arrangement of the funnels and superstructure render these ships unmistakable. They are vulnerable to gunfire on account of their size and limited protection.

(*b*) Cruisers vary from fairly fast, heavily armed, moderately armored large ships to fast, lightly armed, unarmored ships of moderate displacement. First-line cruisers are from 7,500 to 10,000 tons displacement, mount guns up to 8 inches in caliber, have up to 5 inches in side armor, and are capable of speeds in excess of 32 knots. They are intended for scouting, screening fleet movements, raiding, and similar purposes. Cruisers may be further classified as—

*1.* Heavy (CA), armed with 8-inch or near 8-inch guns.

*2.* Light (CL), armed with guns usually 6 inches or less.

*3.* Antiaircraft, whose total armament may be used against aircraft.

(*c*) Destroyers (DD) are high-speed unarmored naval vessels of approximately 1,500 tons displacement armed principally with torpedoes. In addition to making torpedo attacks, they may employ depth charges against submarines and may be used as mine layers. They mount guns of less than 6-inch caliber for their own defense and to attack unarmored enemy vessels.

(*d*) Submarines (SS) operate either under water or awash (on the surface). They are armed with the torpedo. In addition, the larger ones are armed with mines and guns. Aside from raiding operations, reconnaissance, and attempts against vessels within a fortified harbor, submarines have little use against coast defenses.

(*e*) Torpedo boats (PT) are similar to, but generally inferior to, destroyers.

(*f*) Minor war vessels consist of gunboats, mine layers (CM), escort vessels, and patrol vessels.

(*g*) Auxiliary vessels consist of such ships as transports (AP), hospital ships, tenders, mine sweepers (AM), and tugs. Transports and mine sweepers are usually commercial vessels with no armor and with but a few guns of 6-inch or smaller caliber. All vessels of this type are exceedingly vulnerable to the fire of all types of seacoast armament.

(*h*) Small craft consists of small auxiliary vessels and the modern motor torpedo boat, a small vessel of great speed armed with torpedoes, mines, and automatic weapons.

(*i*) Landing boats may vary from small, fast surf boats with a capacity of one squad, to large self-propelled lighters capable of landing light tanks. All may be armed with automatic weapons.

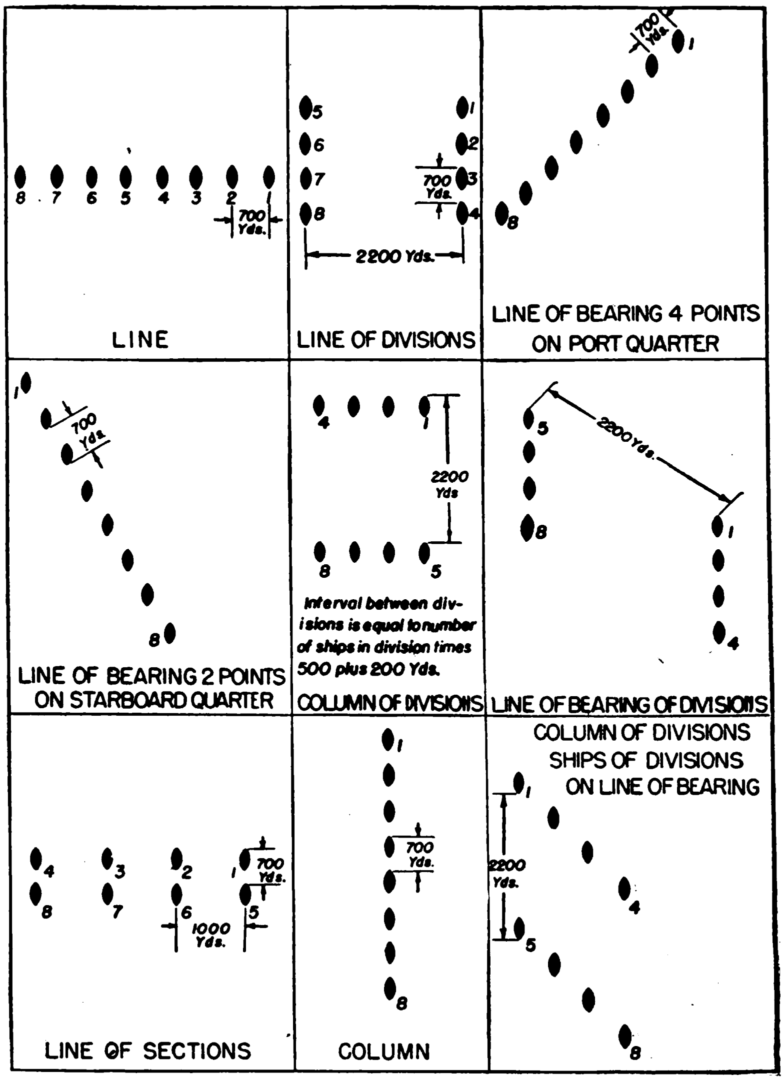
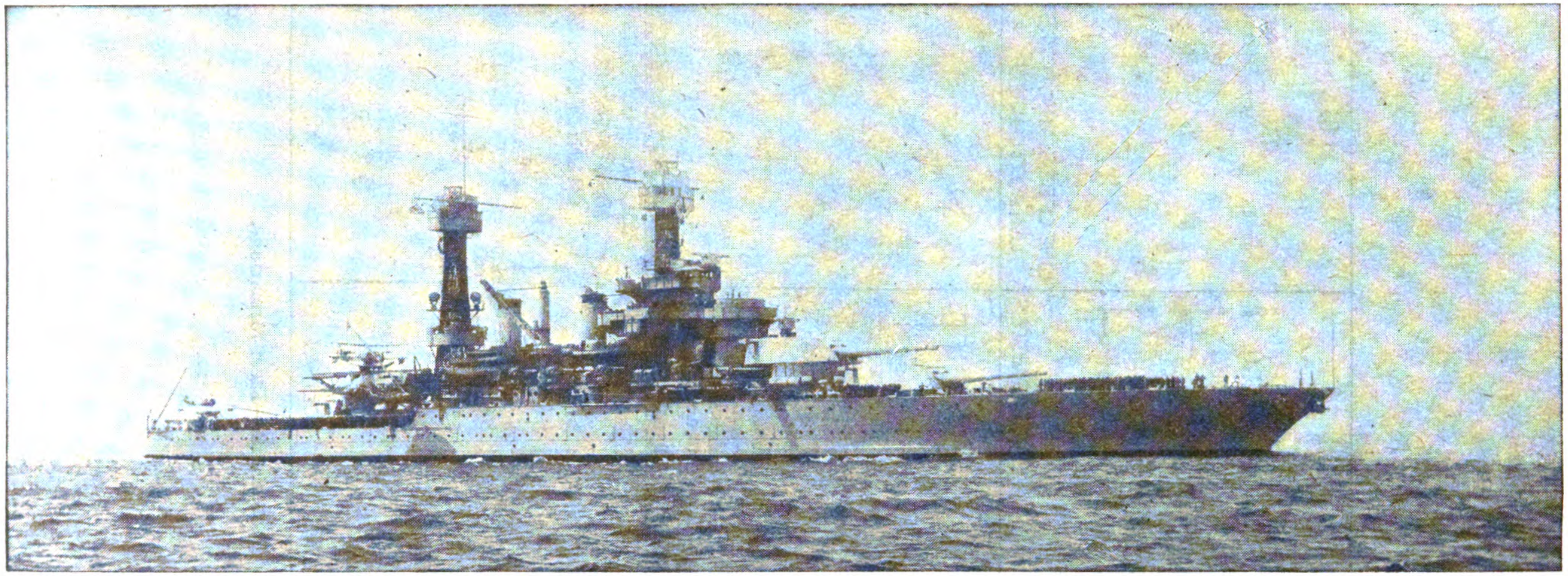


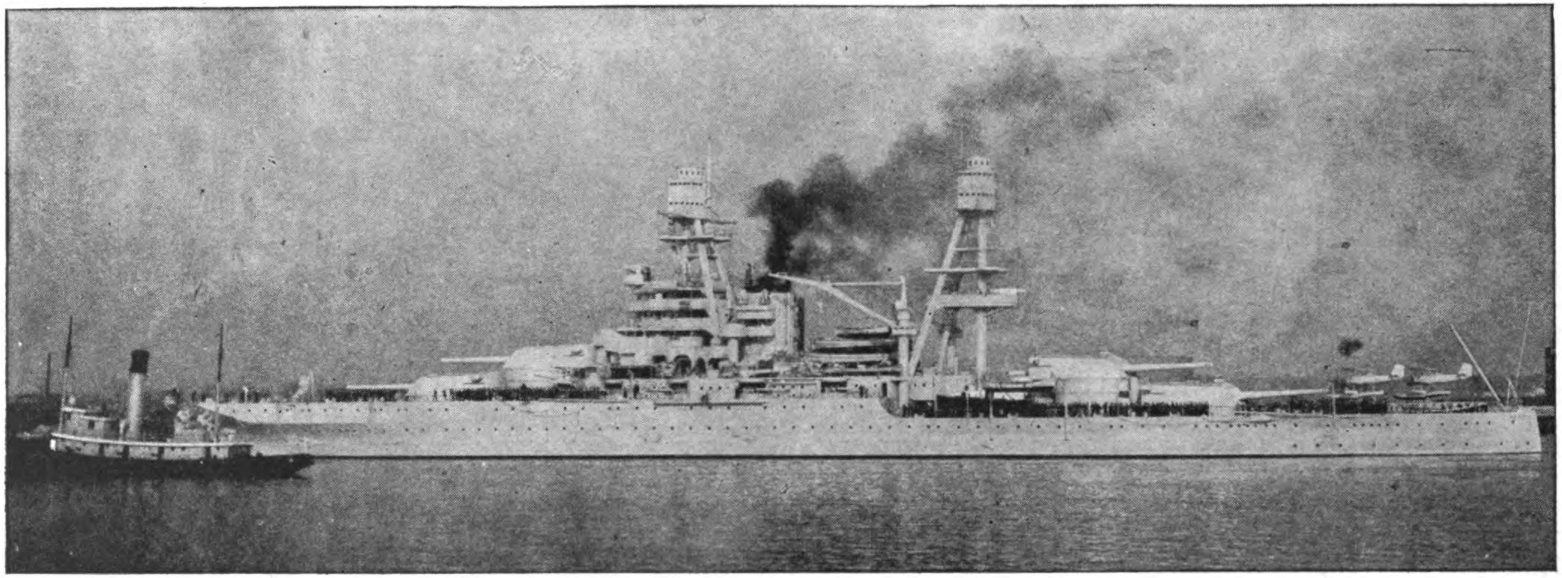

FIGURE 143.—Fleet formations.



Displacement: 32,000 tons.
Length: 624 feet.
Beam: 97 feet.
Draft: 31¼ feet.
Guns: Eight 16-inch; twelve 5-inch; eight 5-inch (AA).

Armor: Belt, 16- to 14-inch; deck, 3-inch; turrets, 18- to 9-inch; conning tower, 16-inch.
Torpedo tubes: Two 21-inch, submerged.
Speed: 21 knots.
Sister ships: *Colorado* and *Maryland*. The *California* and *Tennessee* are similar.

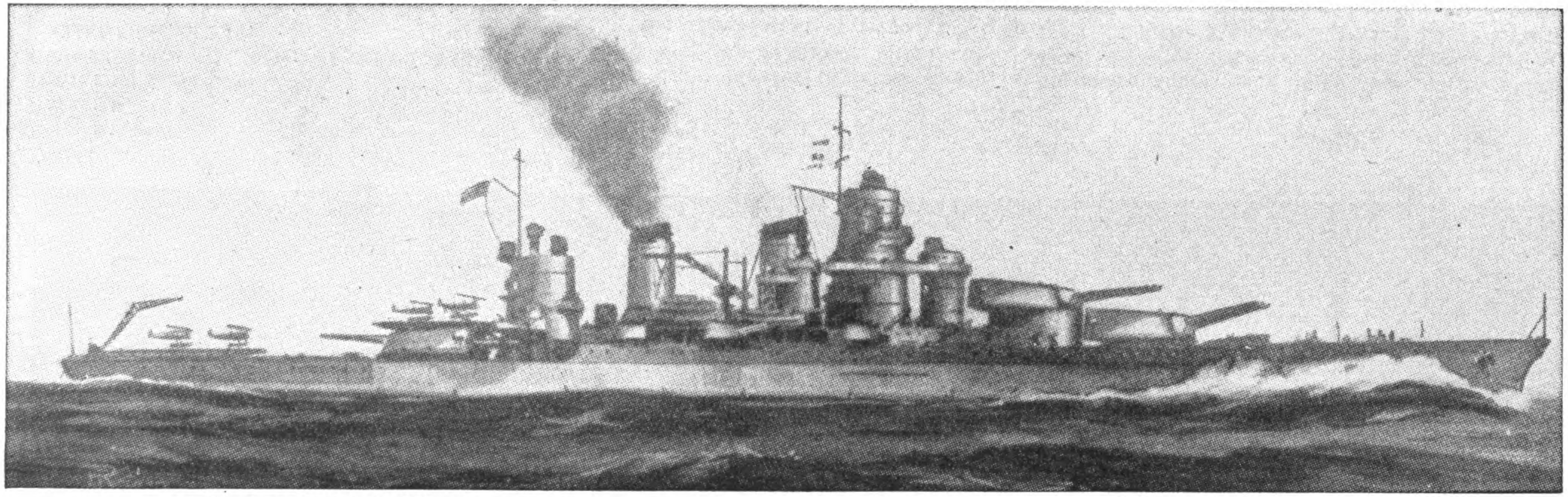
FIGURE 144.—United States battleship *West Virginia*.



Displacement: 32,100 tons.
Length: 608 feet.
Beam: 97 feet.
Draft: 29⅝ feet.
Guns: Twelve 14-inch; fourteen 5-inch; eight 5-inch (AA).
Armor: Belt, 13½-inch; deck, 3-inch; turrets, 18- to 9-inch; conning tower, 16-inch.
Torpedo tubes: Two 21-inch, submerged. (Probably removed now.)
Speed 21 knots.
Sister ship; *Pennsylvania.*

NOTE.—Ships of the class shown in the above figure, as well as those of the *Nevada* and *New Mexico* classes, either have been or are being remodeled. The alterations consist of the substitution of tripod for cage masts, 5-inch, 25-caliber AA guns for 3-inch AA, increased under-water protection, additional protective deck armor, and a certain amount of rearrangement of the torpedo defense and AA batteries. Because of these modifications the data given above may not be exactly correct. New engines have been installed to compensate for any increased weight in order to maintain the designed speed.

FIGURE 145.—United States battleship *Arizona.*



Displacement: 35,000 tons.
Speed: 30 knots.
Guns: Nine 16-inch; twenty 5-inch dual purpose.
Aircraft: 4.
Armor: Belt, 16-inch; upper deck, 6-inch; lower deck, 4-inch.
Length: 750 feet.

FIGURE 146.—United States battleship *Washington*.

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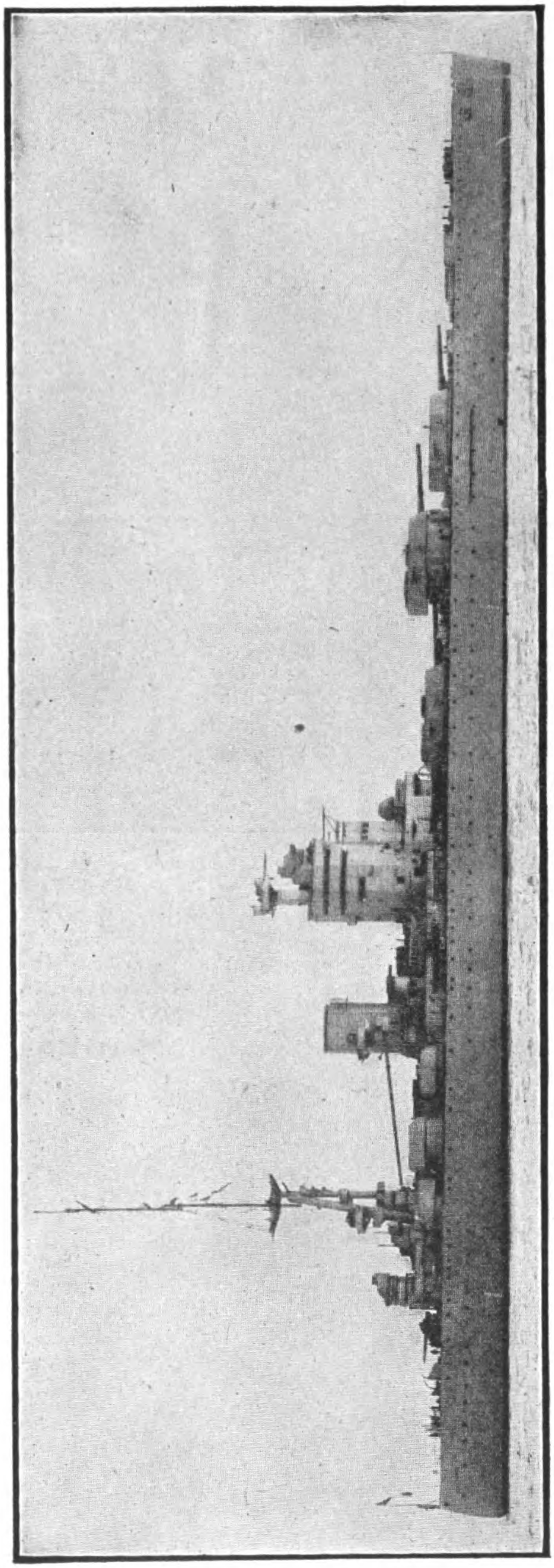
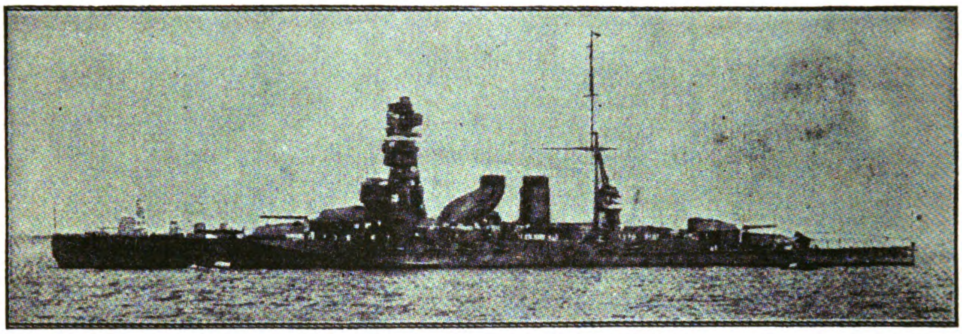


②

Displacement: 35,000 tons.
Length: 710 feet.
Beam: 106 feet.
Draft: 32 feet.
Torpedo tubes: Two submerged.

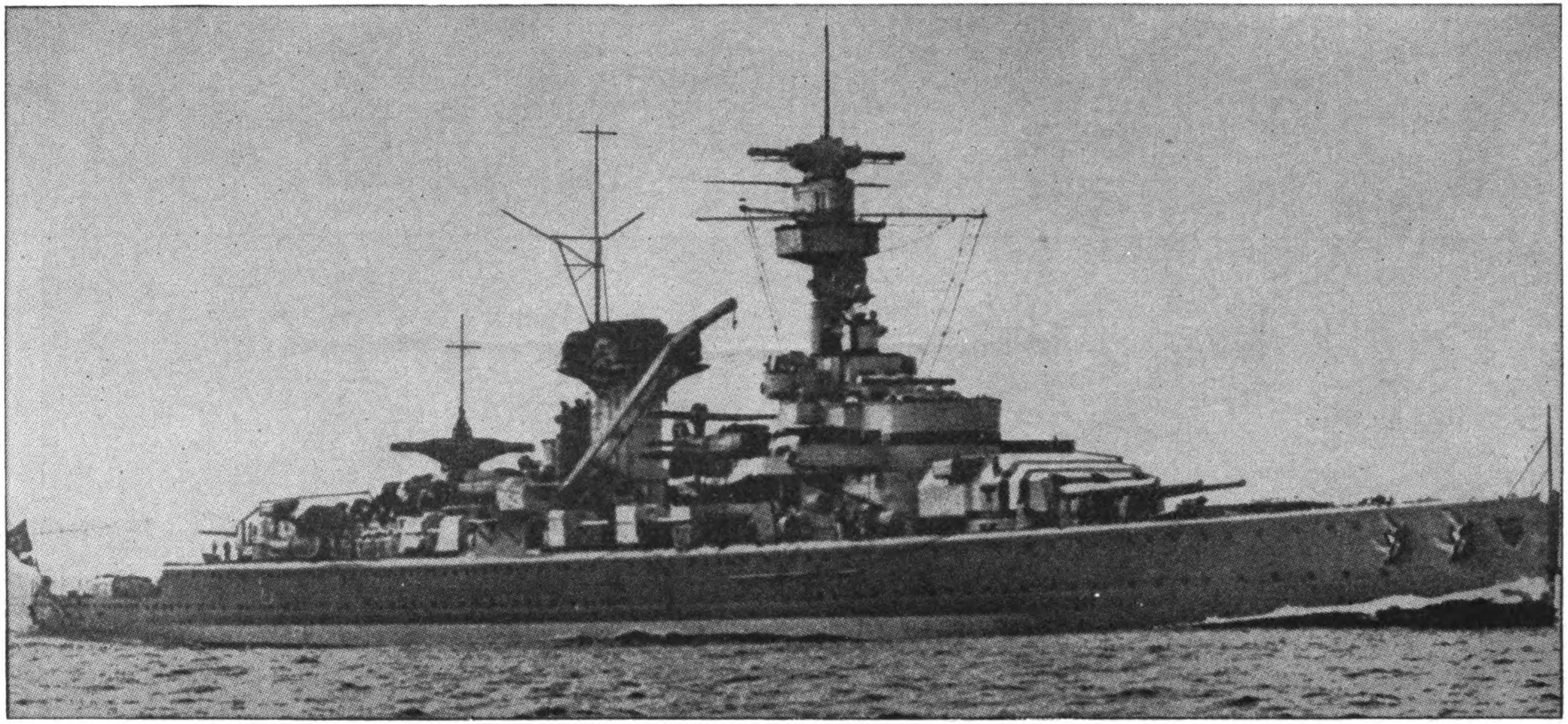
Speed: 23 knots.
Guns: Nine 16-inch; twelve 6-inch; six 4.7-inch (AA).
Armor: Belt, 14-inch; turrets, 16- to 9-inch; deck, 6¼-inch.

FIGURE 147.—British battleship *Nelson* (sister ship *Rodney*).



Displacement: 32,720 tons.
Length: 700 feet.
Beam: 95 feet.
Draft: 30 feet.
Guns: Eight 16-inch; twenty 5.5-inch; four 3.3-inch (AA).
Armor: Belt, 13- or 12-inch; deck, 3½-inch (7-inch above magazines, boilers, and engine room); turrets 14-inch, conning tower 12-inch.
Torpedo tubes: Four 21-inch submerged, four above the water.
Speed: 23 knots.

FIGURE 148.—Japanese battleship *Mutsu.*

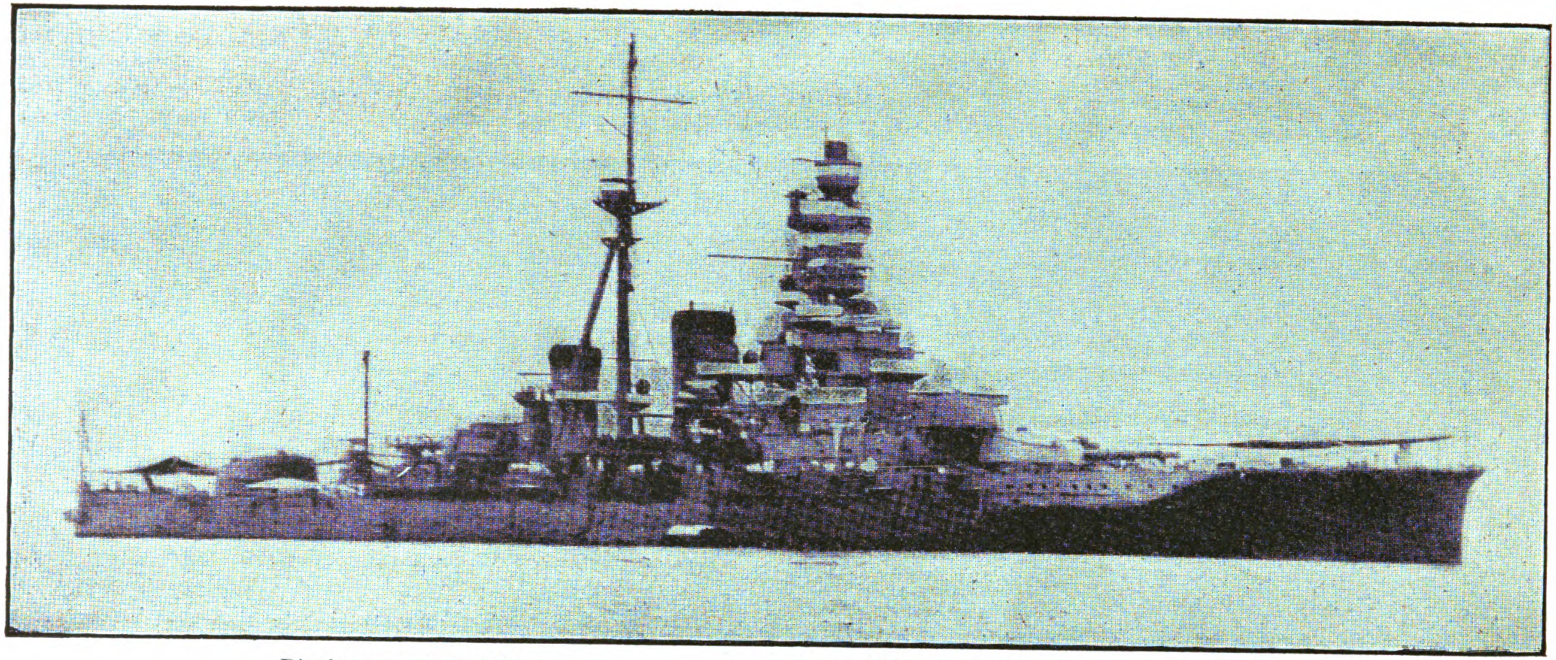


Displacement: 10,000 tons.
Length: 593 feet.
Beam: 67½ feet.
Draft: 21⅜ feet.
Speed: 26 knots.

Guns: Six 11-inch; eight 5.9-inch; six 4.1-inch (AA); eight 3-pounder (AA) ton MG.
Torpedo tubes: Eight 21-inch.
Aircraft: Two.

Armor: Belt, 4-inch with 1½-inch internally; turrets, 4-inch bases, 7-inch faces, 2- to 3-inch sides; conning tower, 5-inch, 2-inch roof; deck, 1½- to 2¼-inch, 3-inch over magazine.

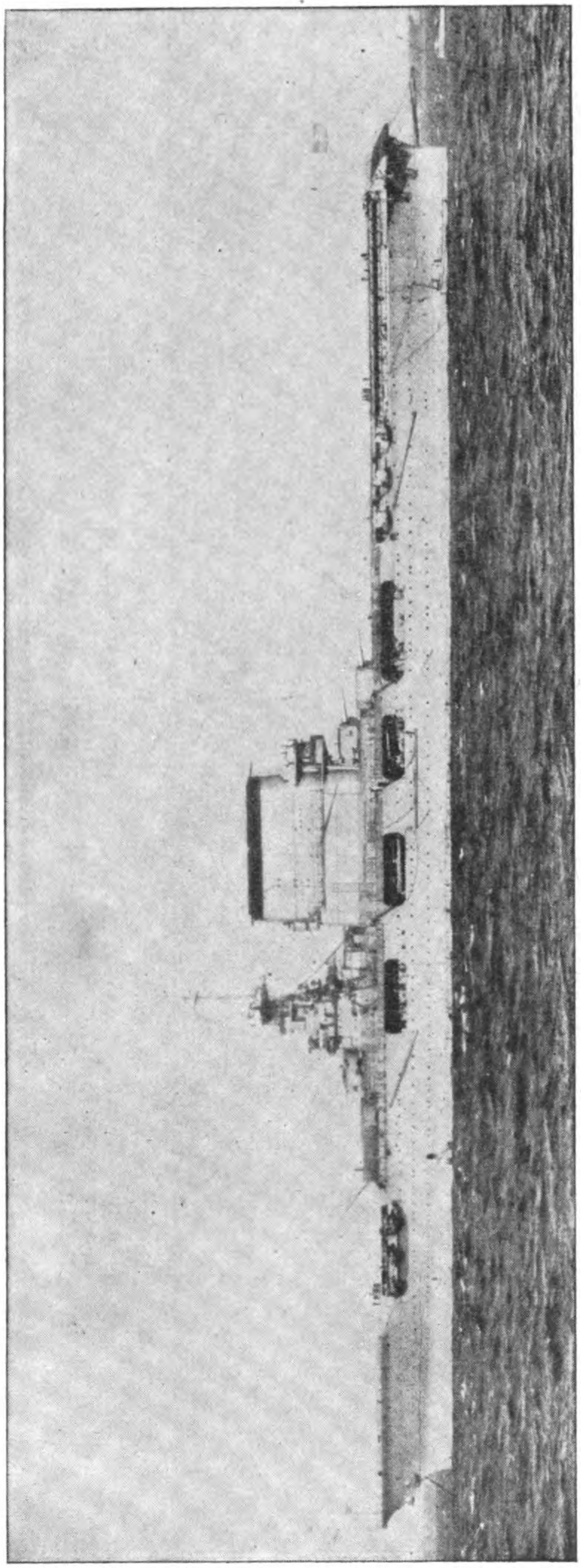
FIGURE 149.—German pocket battleship *Lutzow* (ex-*Deutschland*).



Displacement: 32,330 tons.
Length: 704 feet.
Beam: 95 feet.
Draft: 27½ feet.
Torpedo tubes: Four 21-inch, submerged.
Speed: 28 knots.

Guns: Eight 14-inch; sixteen 6-inch; four 3-inch (AA).
Armor: Belt, 8-inch; turrets, 10- to 9-inch; conning tower, 10- to 9-inch; deck 6¾-inch.

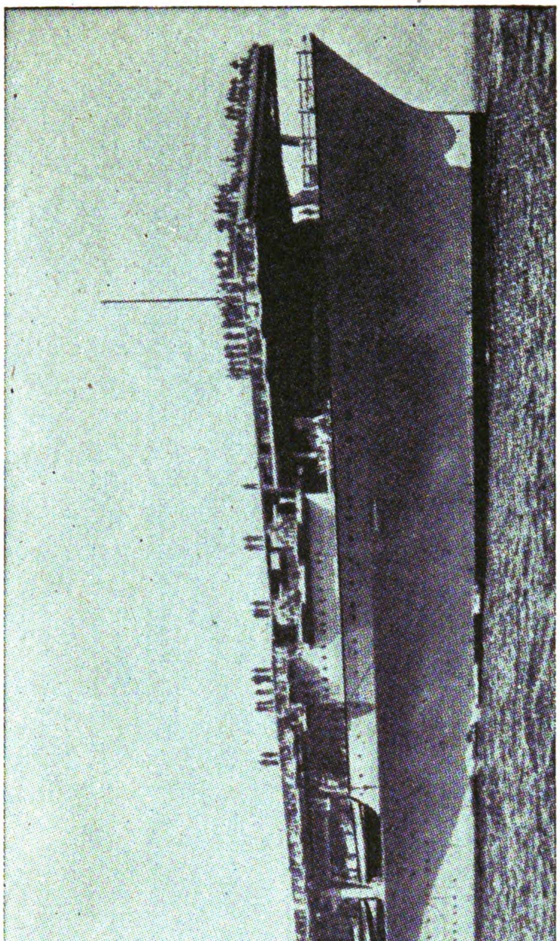
FIGURE 150.—Japanese battle cruiser *Haruna*.



Displacement: 33,000 tons.
Length: 888 feet.
Beam, over flight deck: 90 feet.
Draft: 25½ feet.
Guns: Eight 8-inch; twelve 5-inch (AA).

Armor: Belt, 6-inch; deck, 3-inch; triple hull and bulge protection.
Airplanes: 120.
Speed: 33 knots.
Sister ship: *Saratoga*.

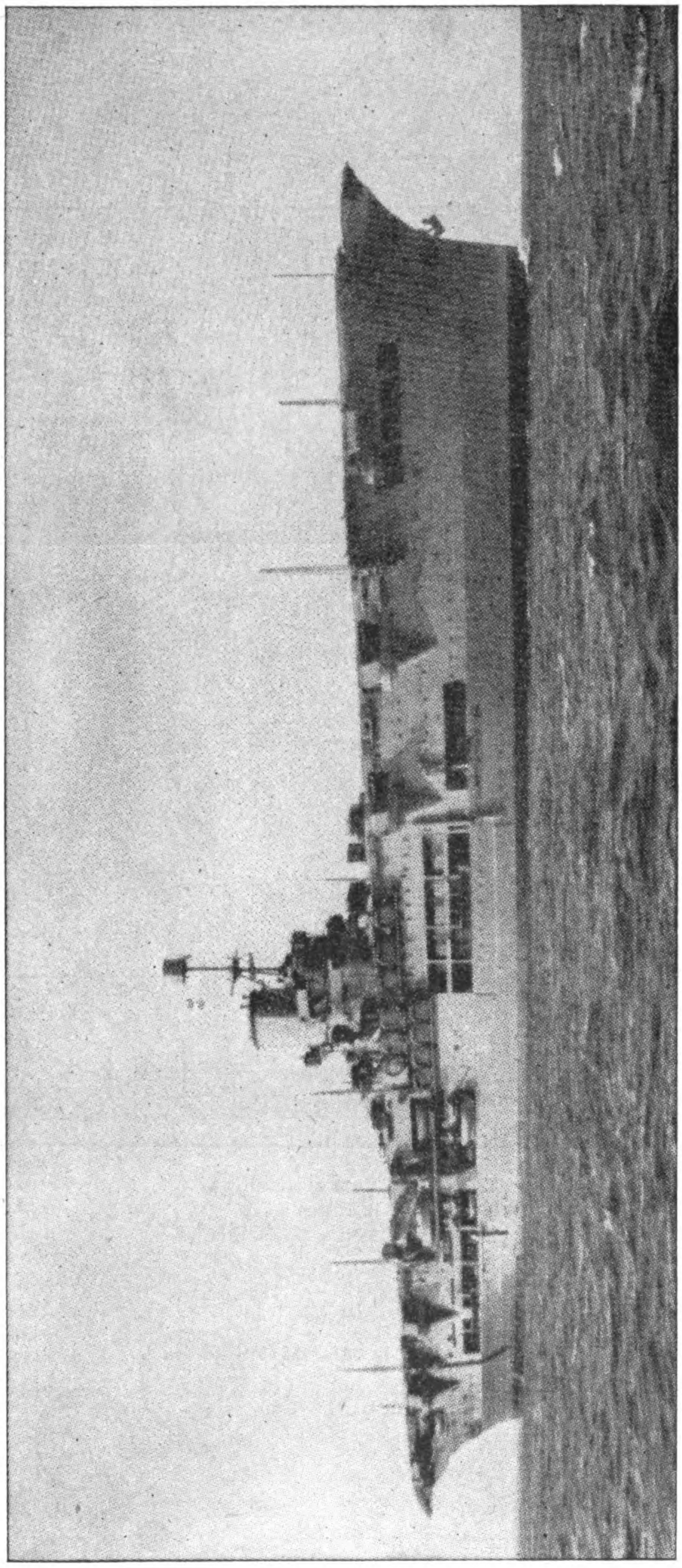
FIGURE 151.—United States aircraft carrier *Lexington*.



Displacement: 14,500 tons.
Length: 769 feet.
Beam: 80 feet 1 inch.
Draft: 19⅔ feet.

Speed: 30 to 35 knots.
Guns: Eight 5-inch (AA).
Aircraft: 75.

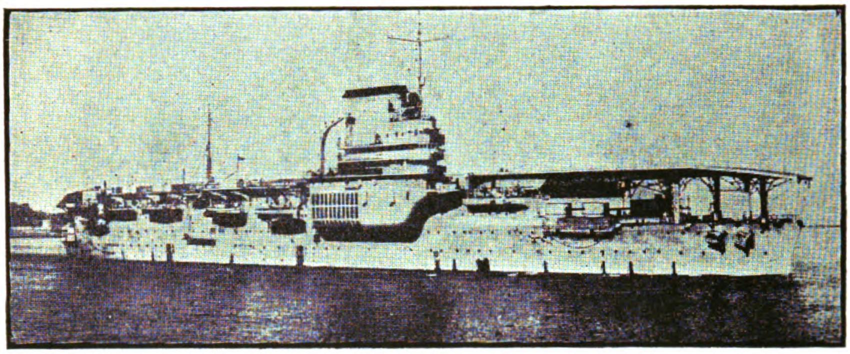
FIGURE 152.—United States aircraft carrier *Ranger*.



Displacement: 22,000 tons.
Length: 800 feet.
Beam, over flight deck: 94 feet.
Draft: 22⅝ feet.

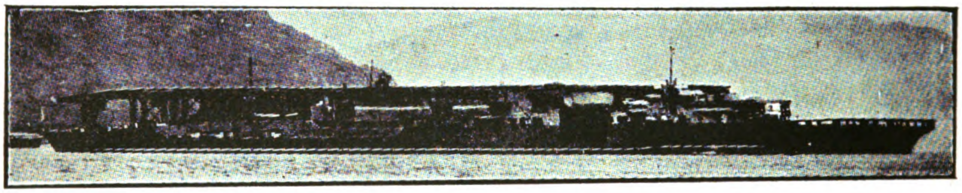
Guns: Sixteen 4.5 inch (dual purpose); four 3-pounders; six multiple pompoms.
Airplanes: 60.
Speed: 31 knots.

FIGURE 153.—British aircraft carrier *Ark Royal*.



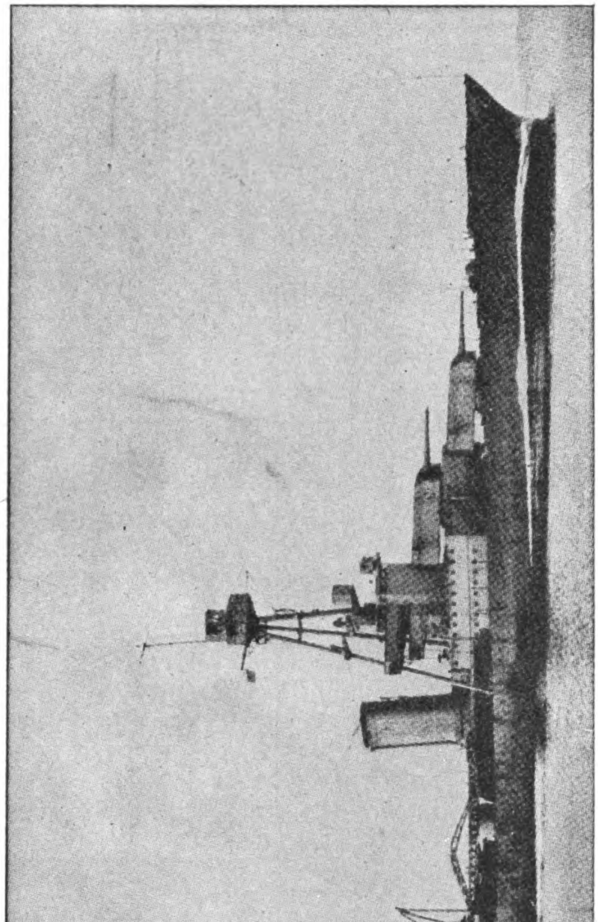
Displacement: 22,150 tons.
Length: 580 feet.
Beam, over flight deck: 89 feet.
Draft: 26 feet.
Guns: Eight 6.1-inch; six 14-pounder (AA); eight 3-pounder (AA).
Armor: Side, 3¼-inch; deck (main and flight), 1-inch.
Airplanes: 40.
Speed: 21 knots.

FIGURE 154.—French aircraft carrier *Bearn.*



Displacement: 28,100 tons.
Length: 780 feet.
Beam: 92 feet.
Draft: 21¼ feet.
Guns: Ten 8-inch; four 4.7-inch; twelve 4.7-inch (AA).
Armor: Unknown.
Airplanes: 50.
Speed: 28.5 knots.

FIGURE 155.—Japanese aircraft carrier *Akagi.*



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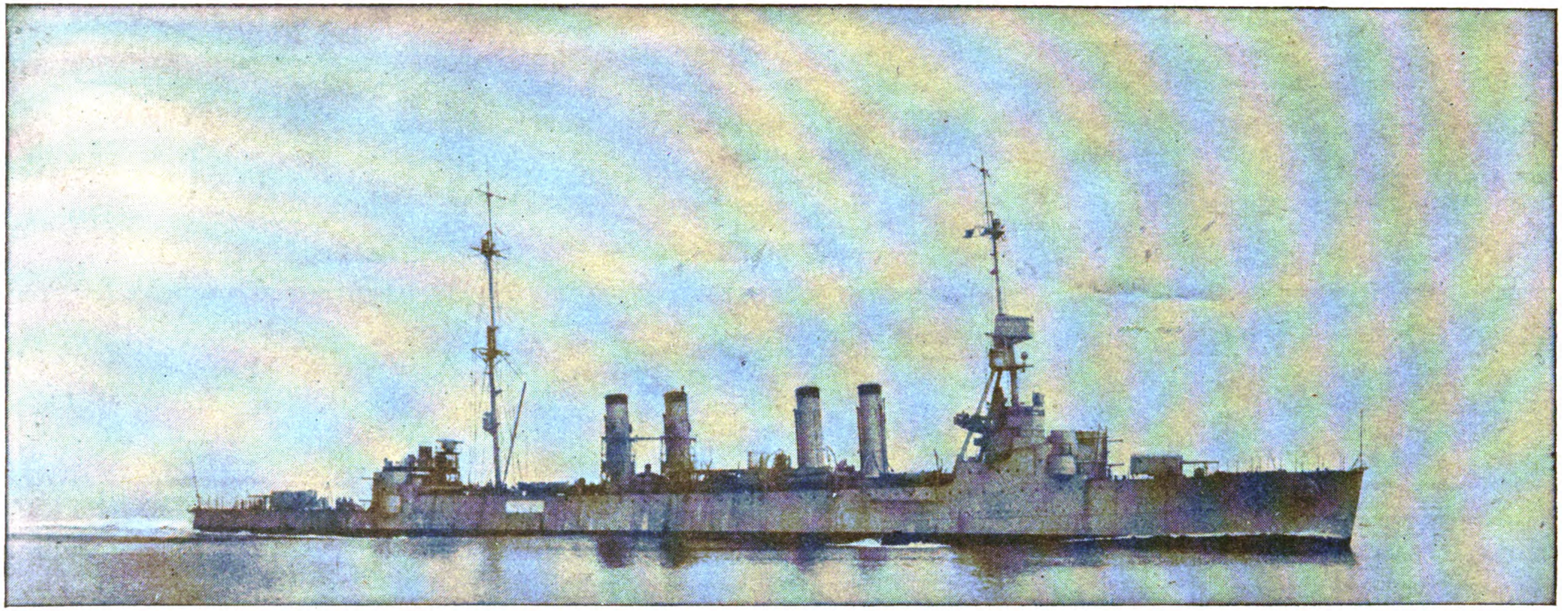
Displacement : 10,000 tons.
Length : 585 feet.
Beam : 64 feet.
Draft : 19 feet.
Torpedo tubes : Six 21-inch.

Speed : 33 knots.
Guns : Ten 8-inch, four 5-inch (AA).
Armor : Side, 1½-inch ; gunhouse, 1½-inch ; deck, 3-inch.

FIGURE 156.—United States cruiser *Salt Lake City.*



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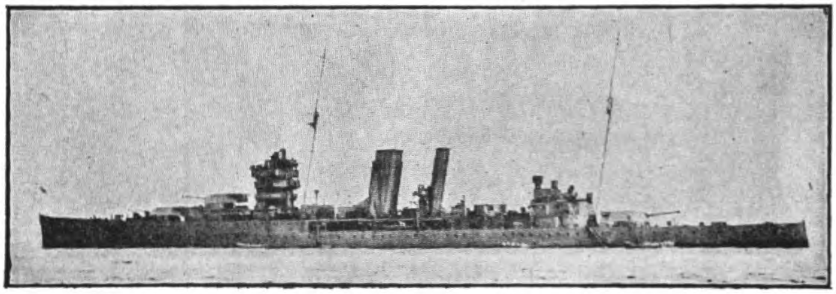
Displacement: 7,500 tons.
Length: 555 feet.
Beam: 55 feet.
Draft: 15½ feet.

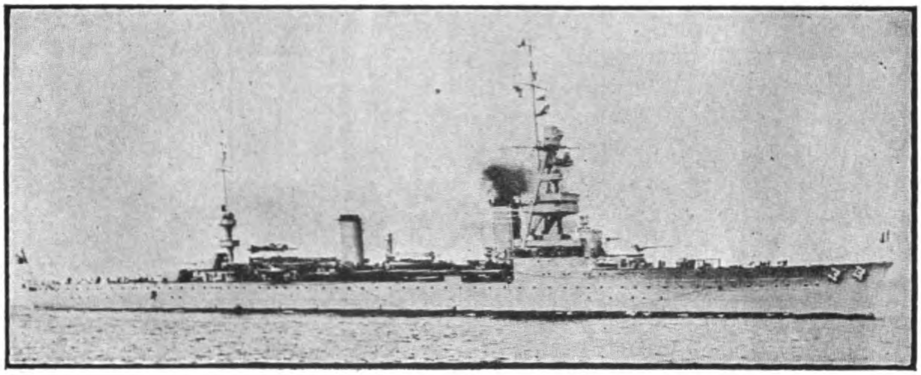
Torpedo tubes: Six 21-inch.
Speed: 34 knots.
Guns: Twelve 6-inch; four 3-inch (AA).
Armor: Side, 3-inch; deck, 1½-inch.

FIGURE 157.—United States cruiser *Marblehead*.



**Displacement : 8,400 tons.**
**Length : 575 feet.**
**Beam : 57 feet.**
**Draft : 17 feet.**
Guns : Six 8-inch ; four 4-inch (AA).
Armor : Deck, 2-inch ; conning tower, 3-inch.
Torpedo tubes : Six 21-inch.
Speed : 32 knots.

FIGURE 158.—British cruiser *York*.

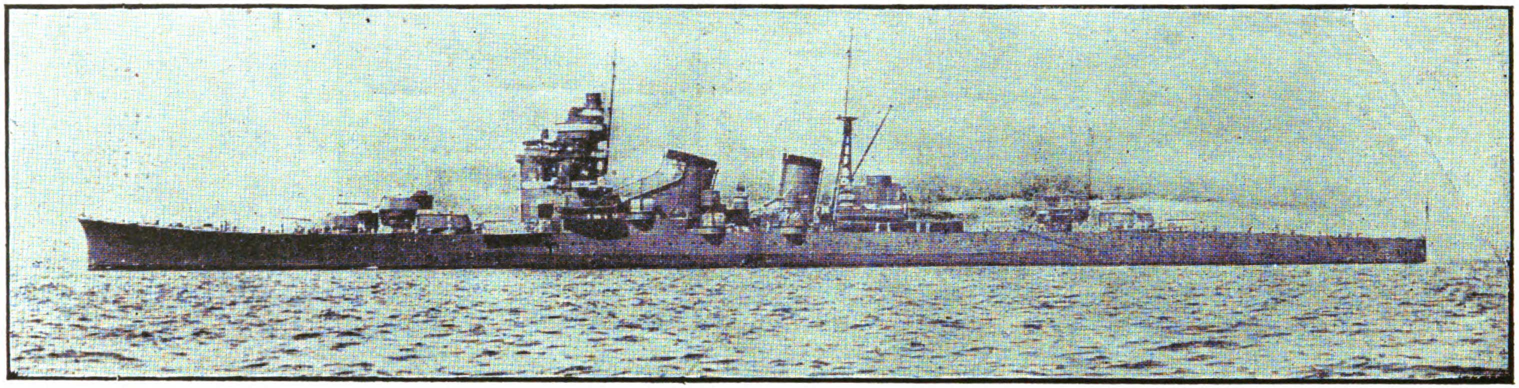


**Displacement : 9,940 tons.**
**Length : 617 feet.**
**Beam : 65 feet.**
**Draft : 20 feet.**
**Guns : Eight 8-inch ; eight 3.5-inch (AA).**
Armor : Thin over engine and boiler spaces ; fitted with external bulges.
Torpedo tubes : Six 21-inch.
Speed : 33 knots.

FIGURE 159.—French cruiser *Suffern*.

①

FIGURE 160.—Japanese cruiser *Nachi.*



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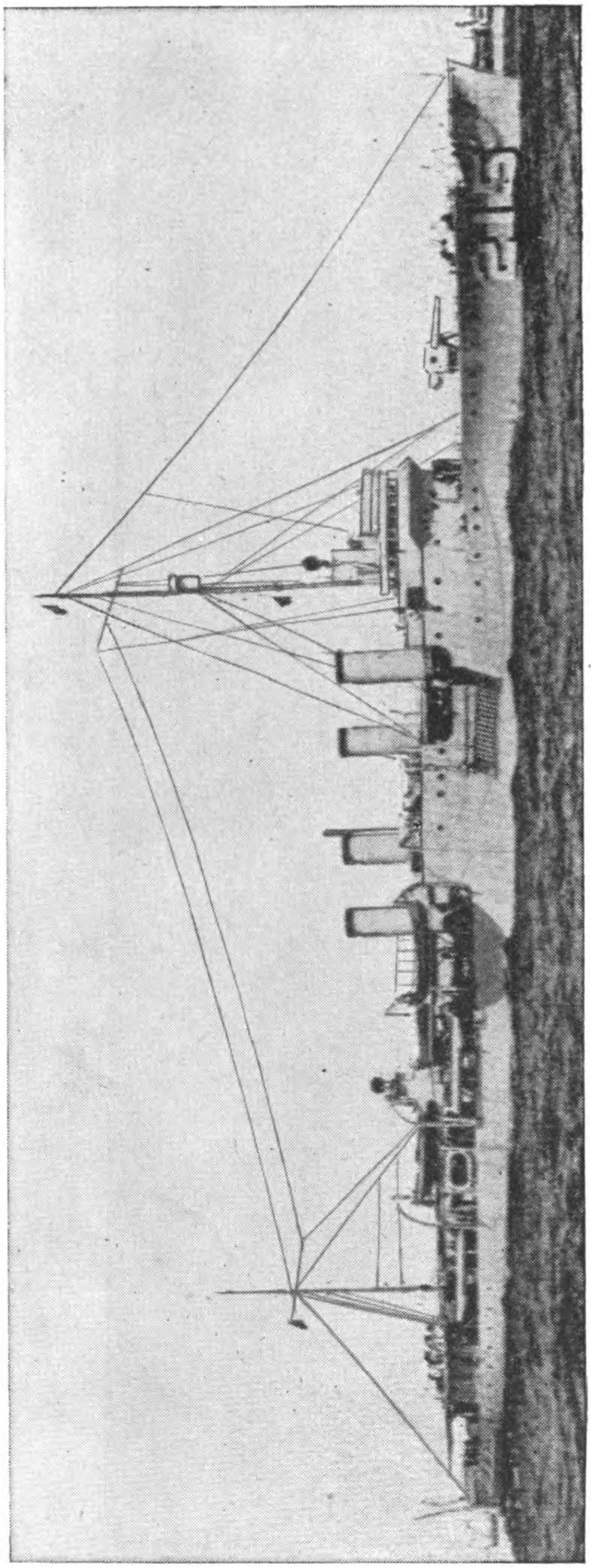
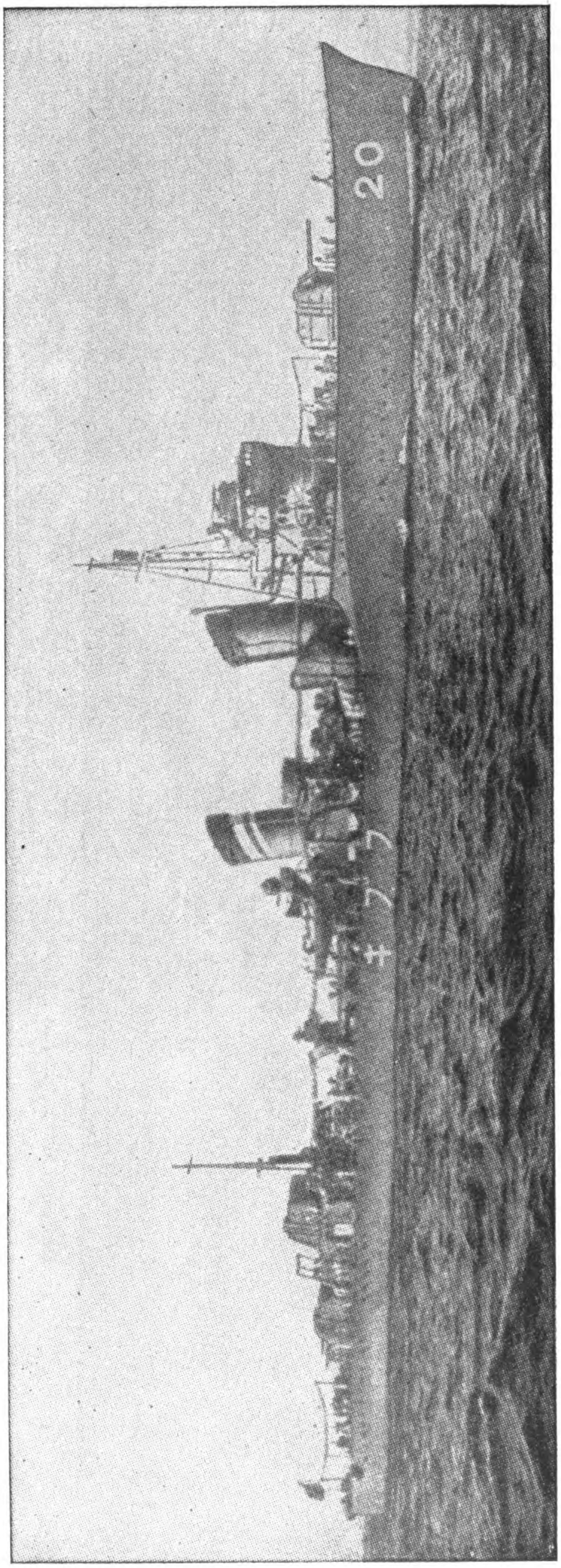
Displacement : 10,000 tons.
Length : 640 feet.
Beam : 57 feet.
Draft : 16½ feet.
Torpedo tubes : Twelve 21-inch, above water.

Speed : 33 knots.
Guns : Ten 8-inch ; six 4.7-inch (AA).
Armor : Belt, 3- to 4-inch ; deck unknown ; turrets, unknown.



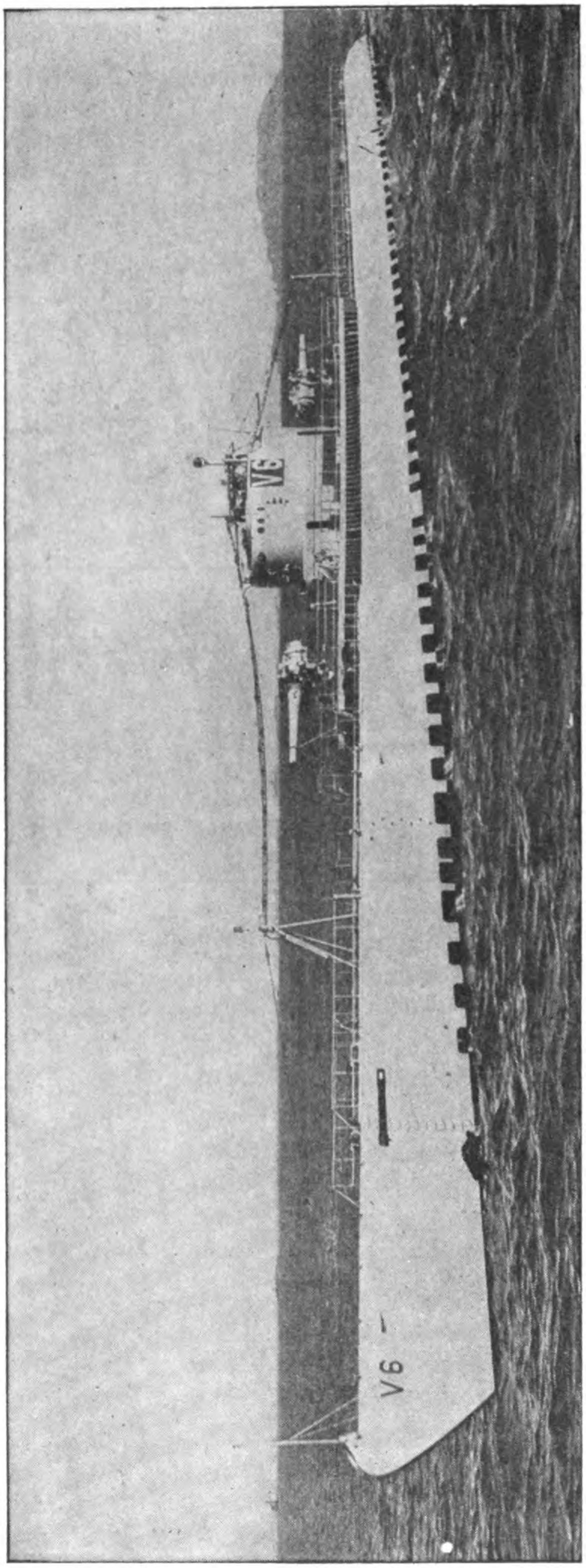

Displacement : 1,020 to 1,190 tons. Speed : 35 knots.

FIGURE 161.—United States destroyer *Borie* (flush decker).




Displacement : 1,700 tons. Speed : 34 knots.

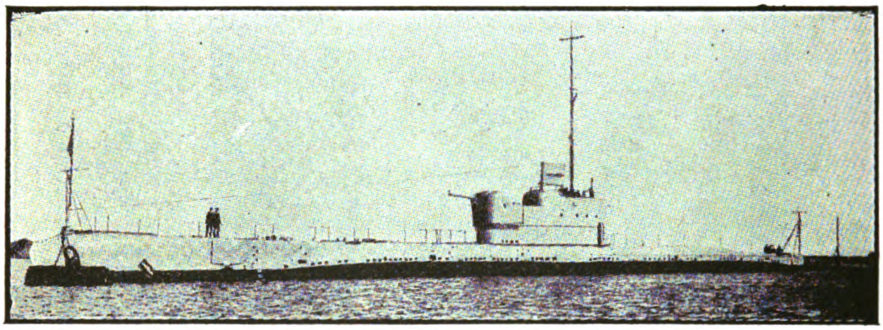
FIGURE 162.—Japanese destroyer *Hubuki.*




Displacement: 2,760 tons.
Length: 371 feet.
Guns: Two 6-inch.
Torpedo tubes: Six 21-inch.

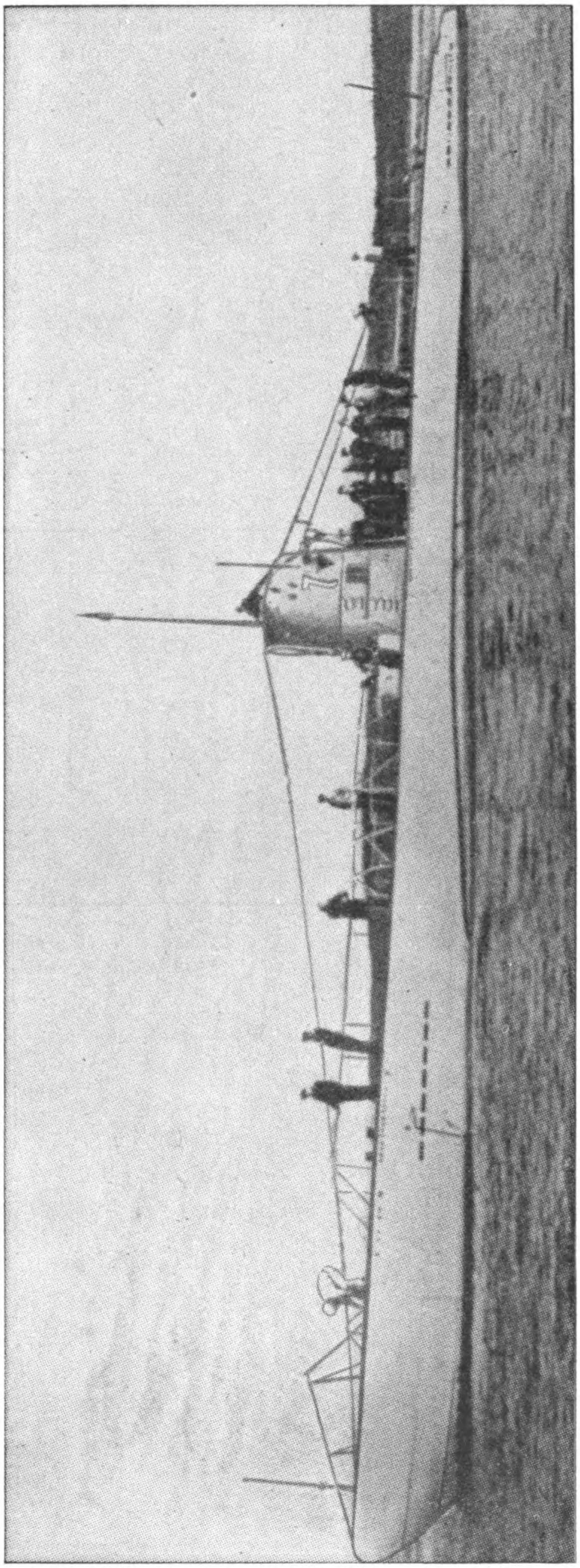
Speed: 17/8.5 knots.
NOTE.—The speed given indicates the surface and submerged speeds in the order given.

FIGURE 163.—United States submarine *Nautilus N-2* (ex-*V-6*).



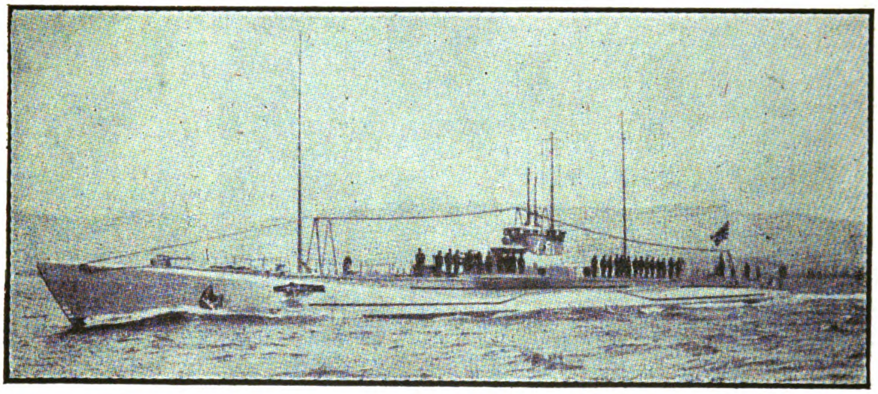
Displacement: 1,475 tons.
Length: 260 feet.
Torpedo tubes: Eight 21-inch.
Speed: 17.5/9 knots.
Guns: One 4.9-inch.

FIGURE 164.—British submarine *Perseus.*



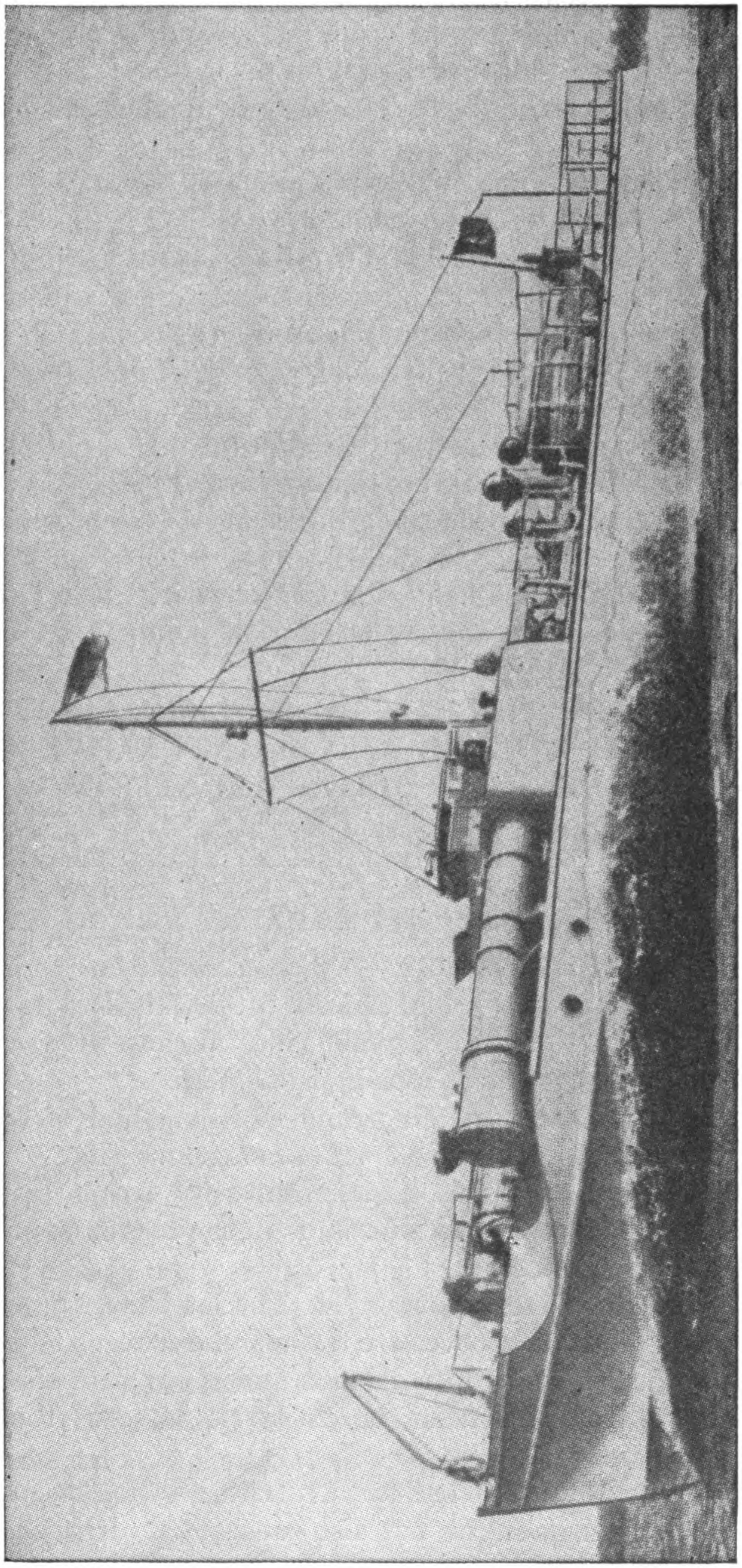
Displacement: 250 to 330 tons. Speed: 13/7 knots.
Length: 136½ feet. Guns: One 1-pounder (AA).
Torpedo tubes: Three 21-inch.

FIGURE 165.—German submarine *U–7*, coastal type, Nos. 1–24.



Displacement: 1,635 tons.
Length: 320 feet.
Torpedo tubes: Six 21-inch.
Speed: 19/10 knots.
Guns: One 4.7-inch.

FIGURE 166.—Japanese submarine *Mitsu Bishi* type.



Displacement : 62 tons.
Length : 93 feet.
Speed : 30–36 knots.

Torpedo tubes : Two 19.7-inch.
Guns : One 1-pounder (AA).

FIGURE 167.—German motor torpedo boat S6–25 (*Schnellboote*).

In addition to the identification and indication of naval targets as prescribed for first class gunner, the candidate should be prepared to answer the following questions pertaining to his battery.

*Q*. What are the limits of the water subareas in the field of fire of this battery?

*Q*. Where are the main channels leading past this battery?

*Q*. Where are the areas of shoal water?

*Q*. What are the limits of field of fire of this battery, right and left?

*Q*. What are the maximum and minimum ranges?

*Q*. What local shipping, if any, makes daily trips past this battery?

*Q*. What are the approximate boat schedules?

*Q*. What are the distinguishing marks of these ships?

*Q*. What other commercial boats are frequently seen while at drill?

*Q*. What time of day is the field of fire most nearly clear?

*Q*. What are the ranges to the various datum points?

## SECTION II

## NOMENCLATURE, ACTION, AND MAINTENANCE OF SMALL ARMS AND THEIR AMMUNITION



**99. U. S. caliber .30 rifle M1903.**—*a. Nomenclature and action.*—*Q*. By what other name is the M1903 rifle often called? *A*. It is popularly referred to as the "Springfield rifle," because it was first made at the Springfield Armory, Springfield, Mass.

*Q*. How would you classify it according to its method of operation? *A*. It is a breech-loading, bolt action, magazine rifle.

*Q*. What is meant by caliber .30? *A*. Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 30/100 of an inch.

*Q*. What are the lands and grooves? *A*. The lands are the raised portions of the bore and the grooves are the spaces between the lands.

*Q*. What direction of twist do the lands and grooves in the bore give the bullet? *A*. A right twist, or clockwise as seen from the breech.

*Q*. How does this affect the bullet? *A*. The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the right.

*Q*. In firing, should any allowance be made for drift? *A*. No. This is automatically corrected for in the construction of the rear sight leaf.

*Q*. What ranges can be set on the sight leaf? *A*. Ranges from 100 to 2,850 yards.

*Q*. What is the weight of the rifle? *A*. About 8¾ pounds.

*Q*. What is the length of the rifle? *A*. About 43 inches.

*Q*. What is the muzzle velocity of the ball cartridge? *A*. 2,700 feet per second.

*Q*. What is the muzzle velocity of the guard cartridge? *A*. 1,200 feet per second.

*Q*. How many shots can be fired without reloading? *A*. The magazine of the rifle will hold five cartridges and one additional cartridge may be inserted in the chamber, thus making the maximum capacity of the rifle, for any one loading, six shots.

*Q*. What is meant by the balance of the rifle and where is it located? *A*. As the name implies it is where the rifle balances when held in the hand. It is just below the windage scale and in front of the floor plate.

*Q*. Point out the following parts:

| | | |
|---|---|---|
| Barrel. | Slide screw. | Ejector. |
| Front sight. | Range scale. | Magazine. |
| Stacking swivel. | Bolt. | Floor plate. |
| Stock. | Bolt handle. | Guard. |
| Upper band. | Floor plate. | Trigger. |
| Lower band swivel. | Sleeve. | Lower band. |
| Grasping groove. | Firing pin. | Butt swivel. |
| Hand guard. | Firing pin sleeve. | Butt plate. |
| Rear sight. | Striker. | Bayonet. |
| Movable base. | Main spring. | Bayonet guard. |
| Windage screw. | Extractor. | Bayonet grip. |
| Windage scale. | Safety lock. | Bayonet catch. |
| Drift slide. | Cut-off. | Oiler and thong case. |
| Slide. | Cocking piece. | Brush and thong. |

*A*. See accompanying figures and the rifle itself.

*Q*. What does the letter "U" on the lower band mean? *A*. If the band is taken off it should be put back with the "U" up, as the band is tapered to fit the barrel and stock.

*Q*. Explain the working of the extractor. *A*. In loading from the magazine the hook of the extractor catches in the groove on the cartridge case as the follower pushes it up from the magazine. The hook of the extractor continues to hold the cartridge case against the head of the bolt until the bolt is drawn fully to the rear. When the bolt is rotated and drawn to the rear, the extractor brings the cartridge case back with it.

*Q*. What does the ejector do? *A*. When the bolt is almost fully back, the top locking lug strikes the heel of the ejector and throws the point of the ejector suddenly to the right. As the bolt continues to

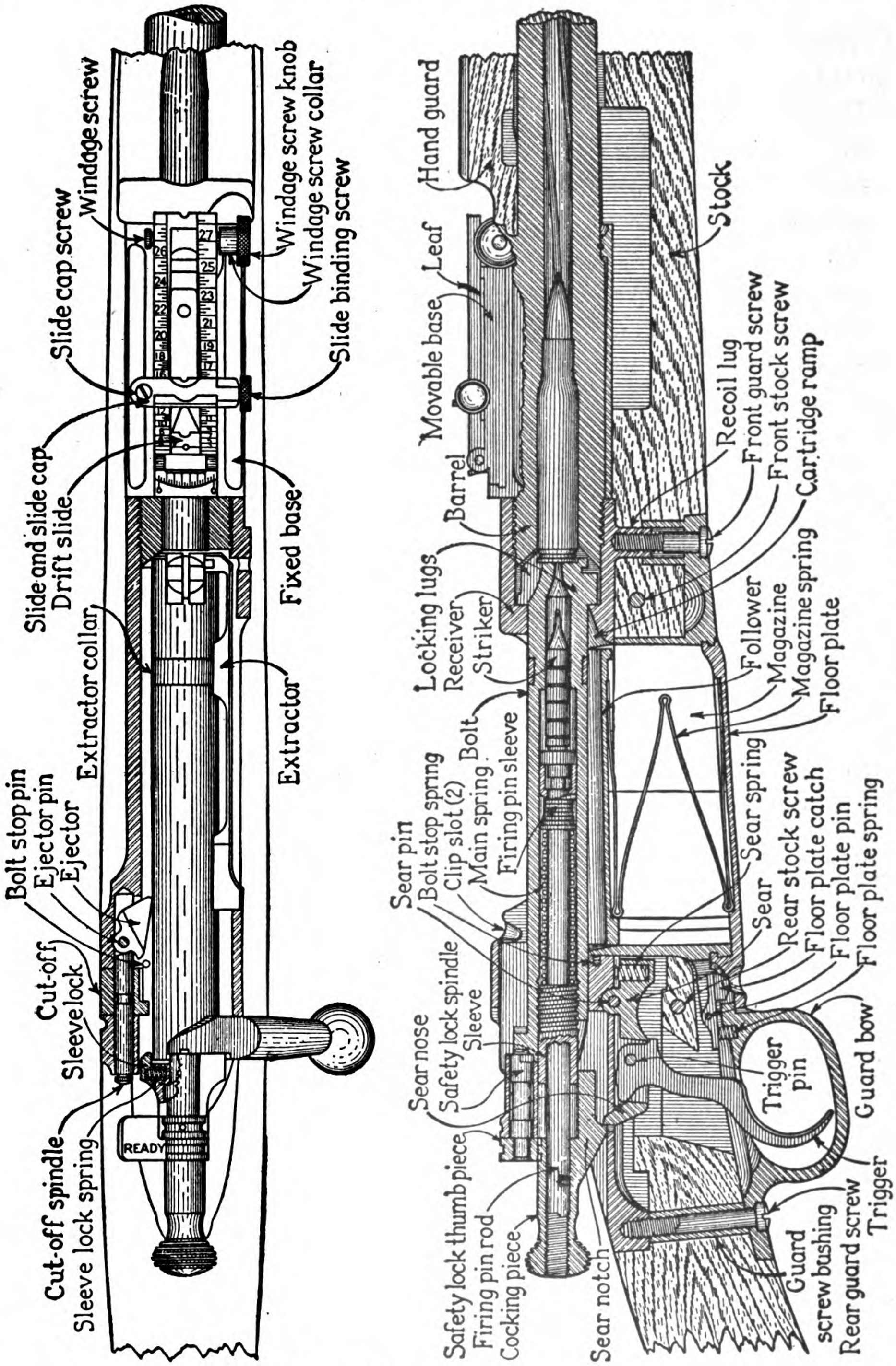


FIGURE 168.—Mechanism of M1903 rifle.

move back, carrying the cartridge case with it, the ejector hits the rear face of the cartridge case and throws it out of the receiver.

*Q*. When firing how can you tell when the last cartridge in the magazine has been fired? *A*. After the last cartridge has been fired and the bolt drawn fully to the rear, the follower rises and holds the bolt open to show that the magazine is empty.

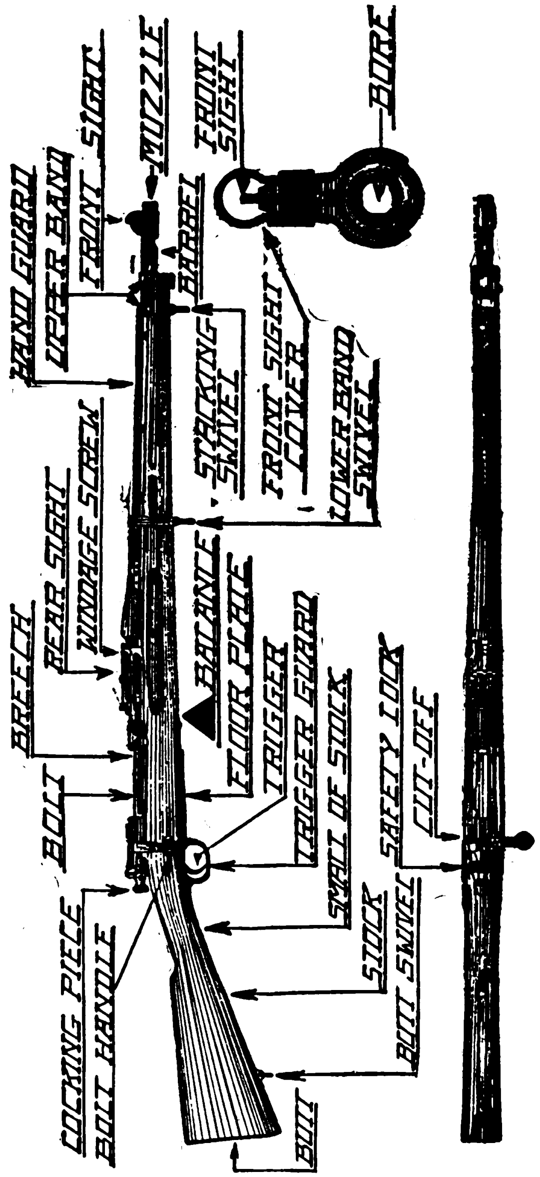



FIGURE 169.—External parts of M1903 rifle.

*Q*. Describe the normal open sight. *A*. The top of the front sight appears to be even with the top of the rear sight slide, and the front sight appears in the middle of the rear sight notch.

*Q*. Describe the normal peep sight. *A*. The top of the front sight appears to be in the center of the peep.

*Q*. What is battle sight, and what range is battle sight? *A*. The sight when the sight leaf is *down*—range about 547 yards. The sights are alined as for the normal open sight.

*Q*. In firing with battle sight, how high is the trajectory above the line of sight at 300 yards? *A*. 2½ feet.

FIGURE 170.—Standing position showing hasty sling adjustment.

*Q*. What preparatory instructions should be held before going on the range? *A*. The six steps of preparatory instructions are—

(1) Sighting and aiming exercises (with sighting bar and rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

*Q*. What do you mean by the "zero" of a rifle? *A*. The point at which the rear sight must be set for both elevation and windage for any particular range, in order to hit the center of the bull's-eye on a normal day when there is no wind.

*Q*. What do you mean by "cant" and what is its effect? *A*. It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

*Q*. Where do you focus your eye when aiming a rifle? *A*. On the target.

*Q*. In firing at a vertical target what is the rule for correcting your fire in elevation? *A*. Square the range expressed in hundreds of yards. The result is the number of inches on the target that the next shot will strike above (or below) if the rear sight is raised or lowered 100 yards.

FIGURE 171.—Kneeling position showing loop sling adjustment.

Example: When firing at the 200-yard range, raising the rear sight 100 yards will move the next shot 4 inches up on the target.

*Q*. To shoot to the right (or left), which way would you move the sight? *A*. To shoot to the right move the movable base of the sight to the right. To shoot to the left move the movable base of the sight to the left.

*Q*. How much does one point on the windage scale correct for? *A*. 4 inches for every 100 yards of range; so at 300 yards' range one point corrects for about 12 inches.

*Q*. How do you figure the effect of a cross wind? *A*. Multiply the range in hundreds of yards by velocity of the wind divided by 10 to find the number of quarter points correction necessary.

Example: When firing at the 200-yard range, a 10-mile wind calls for ½ point correction.

*Q*. What is the smallest graduation on the windage scale? *A*. A point—*not* a quarter point.

*Q*. In what direction do you move the sight to correct for wind effect? *A*. Always into the wind.

*Q*. How do you aim when using guard ammunition? *A*. Use battle sight and aim at the hips.

*Q*. What are the positions for rifle firing? *A*. Standing, kneeling, sitting, and prone.

FIGURE 172.—Sitting position.

*Q*. Describe and demonstrate the firing position. *A*. For all positions face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly directly under the rifle as possible. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right foot. Sitting position—feet 12 to 24 inches apart and dug into ground, upper arms braced against inside of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 170 to 173, incl.)

FIGURE 173.—Prone position.

*Q*. What is the purpose of the sling? *A*. It is used to carry the rifle on long marches, and to afford a steady position and thus improve aim in firing.

*Q*. How is the sling used in firing? *A*. There are two adjustments called the hasty sling and the loop adjustment. (See figs. 170 and 171.)

*Q*. What is the most important thing in successful rifle shooting? *A*. Correct trigger squeeze.

*Q*. Explain how to squeeze the trigger correctly. *A*. The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye, and when he has them alined he slowly squeezes the trigger. If the sights wander off the bull's-eye he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two or possibly three squeezings the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

*Q*. What mechanisms is the soldier permitted to disassemble? *A*. The bolt and magazine mechanisms only.

*Q*. Describe how to disassemble and assemble the bolt mechanism. *A*.

(1) *To disassemble bolt mechanism.*—(*a*) Place the cut-off at the center notch.

(*b*) Cock the piece and turn the safety lock to a vertical position.

(*c*) Raise the bolt handle and draw out the bolt.

(*d*) Hold bolt in left hand, press sleeve lock in with thumb of right hand to unlock sleeve from bolt, and unscrew sleeve by turning to the left.

(*e*) Hold sleeve between forefinger and thumb of the left hand, draw cocking piece back with middle finger and thumb of right hand, turn safety lock down to the left with the forefinger of the right hand and allow the cocking piece to move forward in sleeve, thus partially relieving the tension of mainspring.

(*f*) With the cocking piece against the breast, draw back the firing pin sleeve with the forefinger and thumb of right hand, and hold it in this position while removing the striker with the left hand.

(*g*) Remove firing pin sleeve and mainspring.

(*h*) Pull firing pin out of sleeve.

(*i*) Turn the extractor to the right, forcing its tongue out of its groove in the front of the bolt, and force the extractor forward and off the bolt.

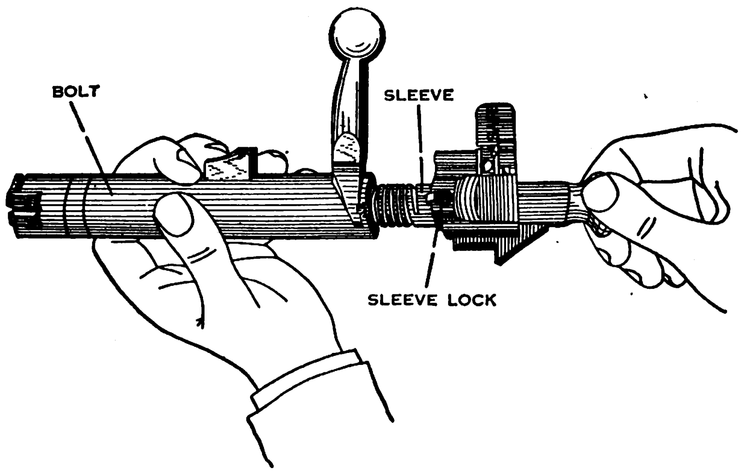



FIGURE 174.—Disassembling bolt mechanism.

(2) *To assemble bolt mechanism.*—(*a*) Grasp with the left hand the rear of the bolt, handle up, and then turn the extractor collar with the thumb and forefinger of the right hand until its lug is on a line with the safety lug on the bolt.

(*b*) Take the extractor in the right hand and insert the lug on the collar in the undercuts in the extractor by pushing the extractor to the rear until its tongue comes in contact with the rim on the face of the bolt (a slight pressure with the left thumb on the top of the rear part of the extractor assists in this operation).

(*c*) Turn the extractor to the right until it is over the right lug.

(*d*) Take the bolt in the right hand and press the hook of the extractor against the butt plate, or some rigid object, until the tongue on the extractor enters its groove in the bolt.

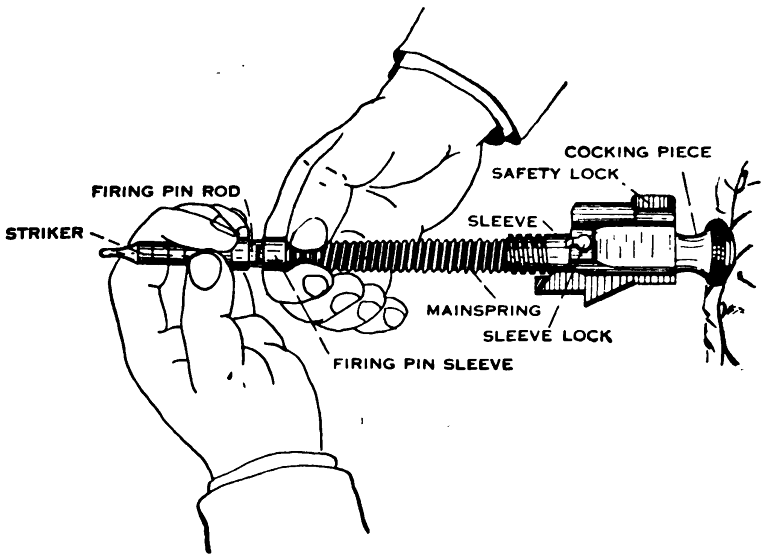



FIGURE 175.—Firing pin.

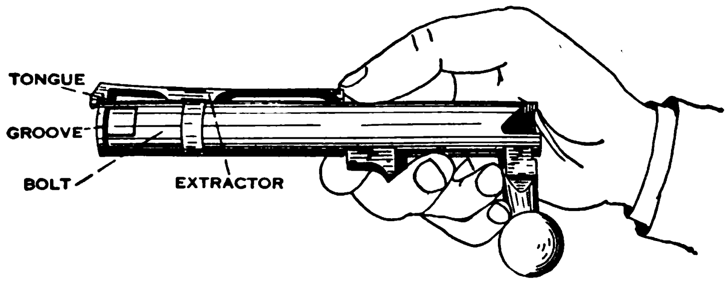



FIGURE 176.—Bolt.

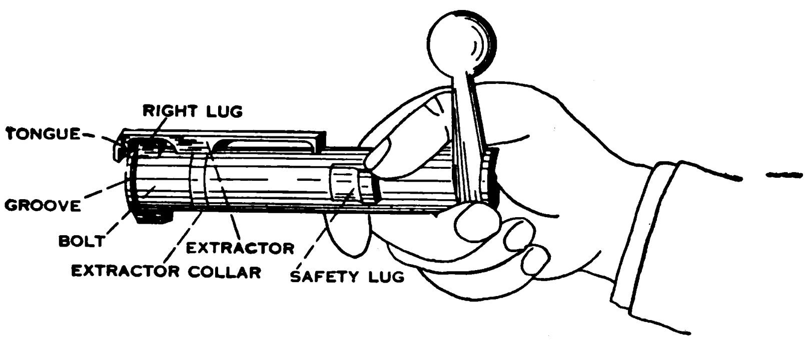



FIGURE 177.—Bolt.

(*e*) With the safety lock turned down to the left to permit the firing pin to enter the sleeve as far as possible, assemble the sleeve and firing pin.

(*f*) Place the cocking piece against the breast and put on main spring, firing pin sleeve, and striker.

(*g*) Hold the cocking piece between the thumb and the forefinger of the left hand, and by pressing the striker point against some substance, not hard enough to injure it, force the cocking piece back until the safety lock can be turned to the vertical position with the right hand.

(*h*) Insert the firing pin in the bolt and screw up the sleeve (by turning it to the right) and until the sleeve lock enters its notch on the bolt.

(*i*) See that the cut-off is at the center notch; hold the piece under floor plate in the fingers of the left hand, the thumb extending over the left side of the receiver; take bolt in right hand with safety lock in a vertical position and safety lug up; press rear end of follower down with left thumb and push bolt into the receiver.

(*j*) Lower bolt handle, turn safety lock and cut-off down to the left with right hand.

*Q*. Describe how to disassemble and assemble the magazine mechanism. *A*.

(1) *To disassemble magazine mechanism.*—With the bullet end of a cartridge press on the floor plate catch (through the hole in the floor plate), at the same time drawing the bullet to the rear; this releases the floor plate. Raise the rear end of the first limb of the magazine spring high enough to clear the lug on the floor plate and draw it out of its mortise; proceed in the same manner to remove the follower.

(2) *To assemble magazine spring and follower to floor plate.*—Reverse operation of disassembling. Insert the follower and magazine spring in the magazine, place the tenon on the front end of the floor plate in its recess in the magazine, then place the lug on the rear end of the floor plate in its slot in the guard, and press the rear end of the floor plate forward and inward at the same time, forcing the floor plate into its seat in the guard.

*b*. *Maintenance of rifle.*—*Q*. What causes the most damage to a rifle when it is not properly cared for? *A*. Water and perspiration. If allowed to remain on the metal parts of a rifle moisture will form rust and the surface of the metal will become "pitted."

*Q*. How is a rifle protected from water and perspiration? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

*Q*. Why should a rifle be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

*Q.* How do you clean a rifle after daily drill? *A.* Rub the outside, including the stock and sling, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab the bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screw heads and crevices with a small clean brush. Immediately after cleaning, swab the bore with a flannel patch saturated with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts including the bolt mechanism and magazine with an oily rag and put a few drops of sperm oil on all cams and working surfaces. Put a teaspoonful of linseed oil in the palm of the hand and polish the stock.

*Q.* Should a rifle be covered when stored in the gun rack? *A.* No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

*Q.* Should a rifle be stored in a gun rack (or any other place) without a protective coating of oil? *A.* No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

*Q.* How is the sling cleaned? *A.* First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

*Q.* What tool should be used to swab the bore of a rifle? *A.* A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

*Q.* From what end of the rifle should the bore be swabbed? *A.* From the breech, removing the bolt to allow cleaning. Never swab the bore from the muzzle end because of possible damage to the muzzle.

*Q.* What parts of a rifle should be removed for cleaning? *A.* Front sight cover; floor plate and follower; gun sling; oiler and thong case; and the bolt, which may also be taken apart.

*Q.* What tool may be used for tightening or loosening screws? *A.* Only a properly fitting screw driver. Never use a bayonet or other substitute because it will damage the screw heads.

*Q.* Should a rifle be cleaned before firing? *A.* Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

*Q*. What are the three main forms of the residue left in the bore after a rifle is fired? *A*.

(1) A coating of chemicals left by the burned powder.

(2) Particles of unburned or partially burned powder, called *powder fouling*.

(3) Particles of metal from the jacket of the bullet, called *metal fouling*.

*Q*. How do they damage a rifle if not removed? *A*. The chemicals attract moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath against the bore. The moisture causes rusting and pitting of the bore.

*Q*. How is a rifle cleaned after firing? *A*. The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents are available.)

(1) Remove the bolt and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about 1 minute.

(2) Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necessary to remove the powder fouling thoroughly.

(3) Next remove the brush from the rod and swab several more times with the dissolving solution.

(4) Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry, clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly.

(5) Finally inspect the bore for metal fouling. If no metal fouling is present prepare the weapon for storage as is done after daily cleaning and place it in the gun rack. The bore must similarly be cleaned and regreased each day for the next succeeding 3 days to insure that no trace of fouling remains.

*Q*. How is the bore inspected for metal fouling? *A*. Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore this is metal fouling. It usually occurs within about 6 inches from the muzzle.

*Q*. What is done in case metal fouling is found? *A*. Take the rifle to the supply sergeant and ask for instructions.

*Q*. How is metal fouling removed? *A*. It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

*Q*. How soon after firing should a rifle be cleaned? *A*. As soon as possible after firing. A weapon should never be put away for the night without being cleaned.

*Q*. What oils can be used on rifles? *A*.

(1) *For metallic surfaces.*—Sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

(2) *For stock.*—Raw linseed oil. When in the field the stock may be wiped off occasionally with a cloth moistened with sperm oil.

*Q*. State some of the things one is prohibited from doing with a rifle. *A*.

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifles must not be polished.

(3) All mutilations such as carving are prohibited.

(4) Nothing except the authorized oils may be used on a rifle.

(5) Weapons must be unloaded before being taken into barracks or tents.

*c*. *Ammunition.*—*Q*. What are the parts of a ball cartridge? *A*. Cartridge case, primer, powder, bullet.

*Q*. What is the purpose of the primer? *A*. To ignite the smokeless powder.

*Q*. Describe the bullet for ball cartridge. *A*. It has a core of lead and tin composition inclosed in a jacket of gilding metal, covered with a tin wash. The point is very sharp so as to offer little resistance to the air.

*Q*. Describe the dummy cartridge. *A*. The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with 6 long straight grooves along it and 3 holes through it.

*Q*. Describe the guard cartridge. *A*. The guard cartridge is distinguished from the ball cartridge by having either 5 grooves around the case (old style) or 6 short grooves at the shoulder (new style).

*Q*. What other type of ammunition may be used for guard purposes? *A*. Where the supply of guard cartridges has been exhausted, the gallery practice cartridge M1919 may be issued for guard purposes.

*Q*. What is the weight of the ball cartridge? *A*. About an ounce; 100 rounds weigh about 5½ pounds.

*Q*. How is ammunition packed? *A*. In wooden chests (metal lined) containing 1,200 rounds; in cloth bandoleers holding 60 rounds, and metal clips of 5 rounds each.

*Q*. What types of service ammunition are used with the M1903 rifle? *A*.

(1) Ball M2 and M1906.

(2) Tracer M1.

(3) Armor-piercing M1.

*Q*. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A*.

(1) Armor-piercing is painted black for ¼ inch from the point.

(2) Tracer is painted red for ¼ inch from the point.

*Q*. At what distance is it dangerous to fire at personnel representing an enemy with rifles loaded with blank ammunition? *A*. never fire at personnel representing an enemy at distances less than 20 yards.

*Q*. What is the standard type of ball ammunition? *A*. Ball cartridge caliber .30 M2 is standard.

**100. U. S. caliber .30 rifle M1.**—*a. Nomenclature and action.*—*Q*. Briefly describe the U. S. caliber .30 rifle M1. *A*. It is a gas operated, clip fed, self loading, shoulder weapon. The gas generated in a cartridge fired in the rifle is utilized to compress the operating rod spring and compensating spring, to extract and eject the fired case, and to cock the hammer. The operating rod spring and compensating spring, which are meantime forcing the cartridges up in the clip, completes the cycle by closing and locking the bolt. The bolt as it goes forward strips the top cartridge from the clip and chambers it. The rifle is then ready to fire.

*Q*. What is meant by caliber .30? *A*. Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 30/100 of an inch.

*Q*. What are the lands and grooves? *A*. The lands are the raised portions of the bore and the grooves are the spaces between the lands.

*Q*. What direction of twist do the lands and grooves in the bore give the bullet? *A*. A right twist, or clockwise as seen from the breech.

*Q*. How does this affect the bullet? *A*. The rotation keeps the bullet from tumbling in flight, but also causes it to drift slightly to the right.

*Q*. In firing, should any allowance be made for drift? *A*. No. This is automatically corrected for in the construction of the rear sight.

*Q*. How many cartridges may be loaded in this rifle at one time? *A*. Eight cartridges are loaded in a reversible clip.

*Q*. What limits the rate of fire? *A*. The rate of fire is limited only by the proficiency of the soldier in marksmanship and his dexterity in inserting clips into a magazine.

*Q*. What is the weight of this rifle? *A*. Approximately 9 pounds and the bayonet an additional pound, while the weight of a loaded clip of cartridges (8 cartridges M1) is slightly in excess of 0.5 pound.

*Q*. What is the maximum range graduation on the rear sight? *A*. 1,200 yards.

*Q*. What is the muzzle velocity of the ball cartridge? *A*. 2,700 feet per second.

*Q*. What is the muzzle velocity of the guard cartridge? *A*. 1,200 per second.

*Q*. Point out the following parts:

Butt plate.
Rear sight base.
Rear sight elevating knob screw.
Rear sight elevating knob.
Clip latch.
Bolt.
Rear hand guard band.
Rear hand guard.
Lower band.
Front hand guard.
Front sight.
Gas cylinder plug.
Gas cylinder plug screw.
Barrell.
Extractor.
Operating rod.
Rear sight cover.
Aperture.
Stock.
Comb.
Heel.
Toe.
Rear sight nut.
Rear sight windage knob.
Receiver.
Front hand guard ferrule.
Front sight screw.
Gas cylinder.
Stacking swivel.
Stacking swivel screw.
Stock ferrule.
Stock ferrule screw.
Stock ferrule swivel.
Gun sling keeper.
Gun sling hook.
Gun sling long strap.
Gun sling.
Safety.
Trigger.
Trigger guard.
Gun sling loop.
Gun sling short strap.
Butt swivel.

*A*. See figure 178.

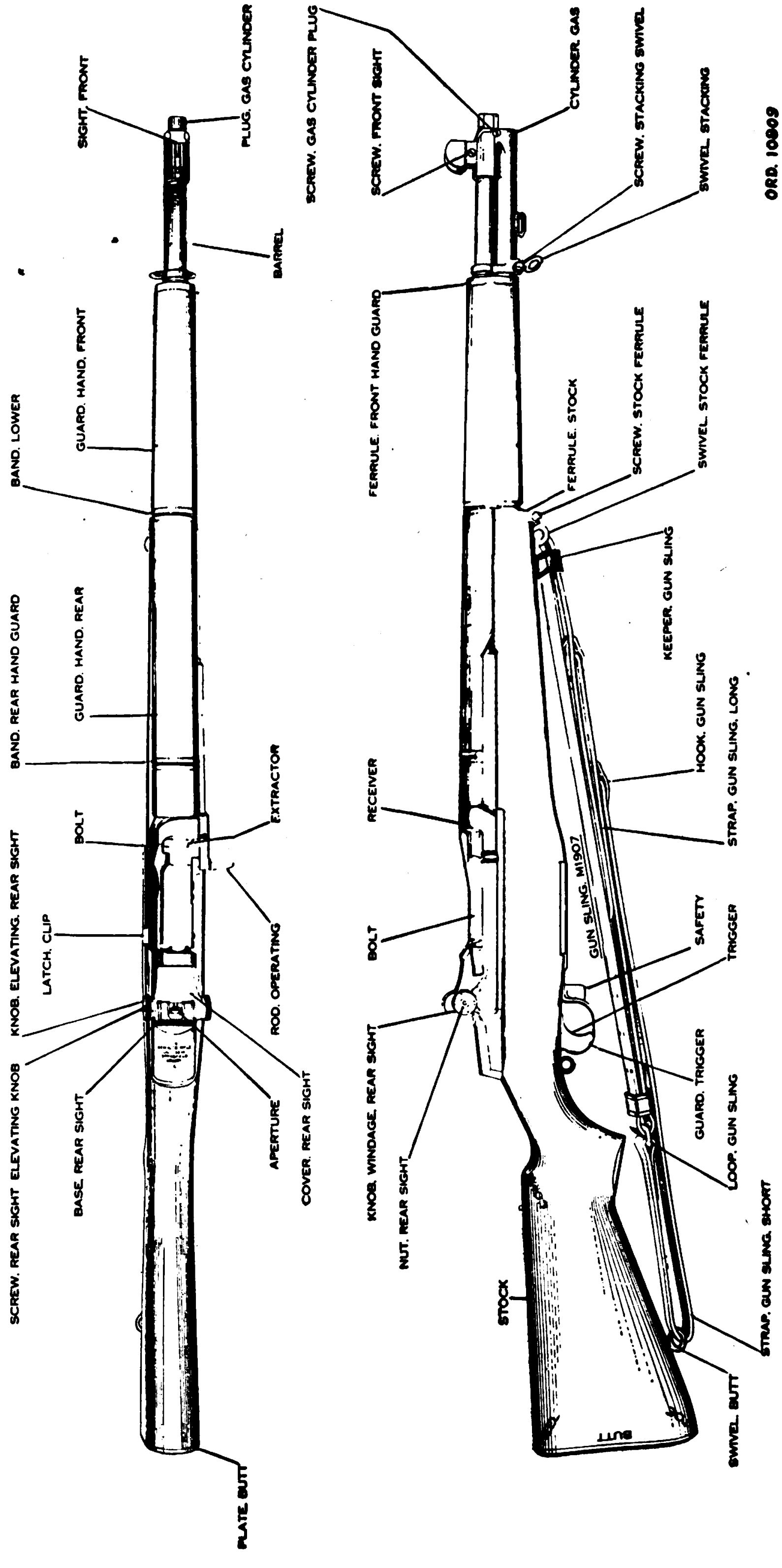



FIGURE 178.—U. S. caliber .30 rifle, M1 (right side and top views).

*Q.* How is the ammunition loaded into the cartridge clip? *A.* A clip loading machine (no more to be issued) is sometimes used to load ammunition into clips. In loading the cartridge clip by hand care must be taken to see that the base of each cartridge is close to the rear wall of the clip so that the inner rib of the clip engages the extractor groove in the cartridge, and that each clip is fully loaded with eight cartridges. For ease in inserting the clip it is preferable to have the uppermost cartridge on the right side of the clip.

*Q.* How is the clip loaded into the rifle? *A.* The operation of loading is performed with the piece locked, that is, with the safety of the piece in its rearmost position, except in sustained firing. Hold the rifle at the balance in the left hand. With the forefinger of the right hand, pull the operating rod handle smartly to the rear until the operating rod is caught by the operating rod catch. With the right hand

FIGURE 179.—Cocking hammer without unlocking bolt.

take a fully-loaded clip and place it on top of the follower. Place the right side of the right hand against the operating rod handle and with the thumb of the right hand press the clip down into the receiver until it engages the clip latch. Swing the thumb to the right so as to clear the bolt in its forward movement and release the operating rod handle. The closing of the bolt may be assisted by a push forward on the operating rod handle with the heel of the right hand.

*Q.* How is the rifle fired? *A.* The trigger must be squeezed for each shot. After the eighth shot has been fired, the empty clip is automatically ejected upward out of the receiver to the right and the bolt remains open ready for the insertion of another clip. Should the gun be permitted to recoil in such a manner as to cause the trigger to be released and then by a rebound of the shoulder force the gun forward, causing the trigger to strike the trigger finger and be pulled a second time, the firing of a second round may result. *Caution should be exercised against this.*

*Q.* Can the hammer be cocked without unlocking the bolt? *A.* Yes. In case of misfire or other occasion when it is desired to cock the hammer without unlocking the bolt, unlatch the trigger guard and swing it to its extreme downward position (see fig. 179). Close and latch the trigger guard and the rifle is ready to be fired.

*Q.* How is the rifle set at safe? *A.* The rifle being loaded, if it is not desired to fire at once, is set at safe by pulling to the rear on the front surface of the safety until it occupies its rearmost position inside the trigger guard. In this position the trigger cannot be pulled. The rifle may be loaded and operated by hand when the safety is on but it cannot be fired. It can only be set at safe when the hammer is cocked. To set the rifle at ready, push safety to its extreme forward position.

*Q.* How is a loaded clip removed from the magazine without firing the rifle? *A.* To remove a loaded cartridge clip from the magazine of the rifle without firing, hook the right forefinger over the operating rod handle, pull and hold in the extreme rear position, with the left hand over the magazine, using the left thumb to release the clip latch. The clip with contained cartridges will then be ejected upward out of the magazine into the hand. Do *not* allow the bolt to move forward after pulling it to the rear, as the top cartridge will be moved forward out of its position in the clip, and will prevent the normal ejection.

*Q.* How is the rifle unloaded? *A.* Pull operating rod handle to rearmost position, thus extracting and ejecting cartridge from the chamber. Hold the operating rod full to the rear and proceed as when removing a loaded clip from the magazine. If it is desired to close the bolt on an empty chamber and retain a partially loaded clip in the magazine, press down on the top cartridge in the clip allowing the bolt to slide forward, being sure that it is fully closed. *This procedure is exceptional as the rifle is normally either loaded or "clear."*

*Q.* Describe the adjustment of the rear sight. *A.* The rear sight is adjusted vertically by turning the elevating knob, which is on the left side and has numbered graduations for 200, 400, 600, 800, 1,000, and 1,200 yards' range. Index lines between the numbered lines correspond to 100, 300, 500, 700, 900, and 1,100 yards' range. Adjustment for windage is made by windage knob on the right, each windage graduation representing 4 minutes of angle. The elevating and windage knobs are provided with "clicks" which represent approximately 1 minute of angle or 1 inch at 100 yards. Arrows on knobs indicate direction of rotation for desired changes in point of impact. The rotation of the elevating knob may be eased by forcing the knob outward, away from receiver, while turning.

*Q*. What safety precautions must be taken with the M1 rifle? *A*. While any cartridges remain in the magazine after a round has been fired, the rifle is ready to fire, and the gun is safe only when it is "cleared." In other words, the gun is never *known* to be safe when the bolt is closed. To clear the gun, pull operating rod fully to the rear, extracting and ejecting cartridge from the chamber, and remove the clip from the magazine *leaving the bolt open*. When the rifle is hot from repeated firing, *a cartridge must not be left in the chamber*. When for any reason firing is suspended for any considerable time *clear the gun*. Overheated cartridges produce abnormal pressures, are liable to preignition, and increase extraction effort to such an extent that the rim of the cartridge case is likely to be pulled off leaving the case in the chamber.

*Q*. What preparatory instructions should be held before going on the range?

*A*. The six steps of preparatory instructions are—

(1) Sighting and aiming exercises (with sighting bar and rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

*Q*. What do you mean by the "zero" of a rifle? *A*. The point at which the rear sight must be set for both elevation and windage for a particular range, in order to hit the center of the bull's-eye on a normal day when there is no wind.

*Q*. What do you mean by "cant" and what is its effect? *A*. It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

*Q*. Where do you focus your eye when aiming a rifle? *A*. On the target.

*Q*. What are the positions for rifle firing? *A*. Standing, kneeling, sitting, and prone.

*Q*. Describe and demonstrate the firing positions. *A*. For all positions, face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly directly under the rifle as possible. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right foot. Sitting position—feet 12 to 24 inches apart and dug into the ground, upper arms against insides of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 170 to 173, incl.)

*Q*. What is the purpose of the sling? *A*. It is used to carry the rifle on long marches, and to afford a steady position and thus improve aim in firing.

*Q*. How is the sling used in firing? *A*. There are two adjustments, called the hasty sling and the loop adjustment. (See figs. 170 and 171.)

*Q*. What is the most important thing in successful rifle shooting? *A*. Correct trigger squeeze.

*Q*. Explain how to squeeze the trigger correctly. *A*. The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye, and when he has them alined he slowly squeezes the trigger. If the sights wander off the bull's-eye he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two or possibly three squeezings the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

*b*. *Maintenance of rifle*.—*Q*. What causes the most damage to a rifle when it is not properly cared for? *A*. Water and perspiration. If allowed to remain on the metal parts of a rifle moisture will form rust and the surface of the metal will become "pitted."

*Q*. How is a rifle protected from water and perspiration? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

*Q*. Should a rifle be covered when stored in a gun rack? *A*. No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

*Q*. Should a rifle be stored in a gun rack (or any other place) without a protective oil coating? *A*. No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

*Q*. How is the sling cleaned? *A*. First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

*Q*. Why should a rifle be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

*Q*. What tool should be used to swab the bore of a rifle? *A*. A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

*Q*. What tool may be used for tightening or loosening screws? *A*. Only a properly fitting screw driver. Never use a bayonet or other substitute because it will damage the screw heads.

*Q*. Describe the care and cleaning of the M1 rifle in garrison and camp. *A*. Rifles should be disassembled only to the extent necessary to insure proper condition and cleanliness. The bore of the rifle is always cleaned with a cleaning rod from the muzzle. If the length of the cleaning rod is such that contact can be made with the face of the retracted bolt, *the bolt must be protected.* To clean the bore push a lightly oiled patch through it and out the breech end. This should be followed with dry patches until several successive ones come out absolutely clean. Push through the bore a patch saturated with oil to protect its surface. If local climatic conditions necessitate, bores and chambers may be coated with standard rust-preventive compound. To clean screw heads and crevices use a small cleaning brush or small stick. To clean metal surfaces wipe with a dry cloth to remove moisture, perspiration, and dirt. Then wipe with a lightly oiled cloth using aircraft instrument and machine-gun lubricating oil. This protective film must be maintained *at all times.* To clean the outer surface of the rifle, including the stock, hand guards, and sling, wipe off dirt with a lightly oiled cloth, and clean with a soft, dry one. In cleaning the bore, care must be taken not to foul the cleaning patch in the gas port. Repeat until several successive patches come out absolutely clean. Saturate a patch in sperm oil and push it through the bore, holding the rifle, top up, so that some sperm oil will flow into the gas port.

*Q.* Describe the care and cleaning of the M1 rifle preparatory to firing. *A.* This differs from the procedure described in the care and cleaning of the M1 rifle in garrison and camp in that Dixon's graphite cup grease No. 3 is substituted for aircraft machine-gun lubricating oil on many of the moving parts of the weapon. The rifle is disassembled and the bore is cleaned and oiled very lightly (*the chamber is not oiled*). Any carbon which may have formed on the gas cylinder plug and the piston head is removed. After thoroughly cleaning and lightly oiling all metal parts a thin, uniform coating of the graphite cup grease, referred to above, is applied to the following parts: bolt lugs including locking and operating, bolt guides, cocking cam on bolt, compensating spring, contact surfaces of barrel and operating rod, cam, operating rod guide groove in receiver, and the operating rod spring. *The graphite cup grease should under no circumstances be applied to the follower slide or the under surface of the bolt as the introduction of graphite into the chamber may lead to the generation of excessive pressures.* After the rifle has been assembled all outer surfaces should be rubbed lightly with an oiled rag.

*Q.* What are the three main forms of residue left in the bore after a rifle is fired? *A.*

(1) A coating of chemicals left by the burned powder and primer.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

*Q.* How do they damage a rifle if not removed? *A.* The chemicals attract moisture from the air which collects in the bore. The powder fouling and metal fouling trap moisture underneath against the bore. The moisture causes rusting and pitting of the bore.

*Q.* How do you inspect the bore for metal fouling? *A.* Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore this is metal fouling. It usually occurs within about 6 inches from the muzzle.

*Q.* Describe the care and cleaning of the M1 rifle after firing? *A.* The bore of the rifle must be thoroughly cleaned by evening of the day on which it is fired, and similarly cleaned for the next 3 days. Under no circumstances is the use of any metal fouling solution in the rifle permitted. After disassembling the rifle, the barrel and receiver assembly *with the bolt removed* should be supported at an angle of about 45° with the barrel down. *The bore is always cleaned from the muzzle.* A flannel patch saturated with water is pushed through the bore and out the breech end. This is repeated with several patches followed with dry patches until they come out clean and dry. Then one patch saturated with oil is pushed through the bore and two patches inserted in the slot in the chamber cleaning tool, wrapped smoothly about it, and the chamber scrubbed by twisting the tool. If the rifle is not to be fired the following day, proceed as in care and cleaning in garrison and camp. However, if the rifle is to be used the next day the procedure described in care and cleaning of the M1 rifle preparatory to firing should be followed. If the rifle is not to be fired for a considerable period, or if local conditions cause excessive formation of rust, a rust preventive should be applied to the bore and chamber after cleaning; for storage all metal parts should be protected in the same manner. Heavy oil and grease must be removed from the bore and chamber before firing.

*Q.* Describe the care and cleaning of the M1 rifle on the range. *A.* The rifle must never be fired with any dirt, mud, or snow in the bore, and the chamber should be kept free and clean from any oil or dirt. A patch plug or other obstruction must never be allowed to remain in the chamber or bore and neglect of this precaution may result in serious injury.

*Q.* Describe the care and cleaning of the rifle in the field. *A.* The rifle must be kept clean and free from dirt, and properly lubricated with graphite cup grease. To obtain maximum efficiency the chamber must be kept clean; additional graphite cup grease is applied to the parts, as prescribed in care and cleaning *preparatory to firing*, at the first opportunity after indications of excessive friction occur; a light coating of oil is kept on all other metal parts; and carbon is removed from the gas cylinder plug and piston head. In general it should not be necessary to remove any parts of the rifle in the field except the trigger housing group and the gas cylinder plug.

*Q.* State some of the things one is prohibited from doing with a rifle. *A.*

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifle must not be polished.

(3) All mutilations such as carving are prohibited.

(4) Nothing except the authorized oils may be used on a rifle.

(5) Weapons must be unloaded before being taken into barracks or tents.

TABLE OF STOPPAGES

| Malfunction | Cause | Correction by soldier |
|---|---|---|
| Clip jumps out on seventh round. | Bent follower rod | Replace. |
| Failure to extract | (1) Dirty or rough chamber. | (1) Clean chamber. |
| | (2) Restricted gas port | (2) Clean gas port. |
| Failure to feed | (1) Dirty or rough chamber. | (1) Clean chamber. |
| | (2) Restricted gas port | (2) Clean gas port. |
| | (3) Dirty rifle or improper lubrication. | (3) Clean rifle and lubricate. |
| | (4) Bent clip | (4) Replace clip. |
| | (5) Ruptured cartridge case in chamber. | (5) Remove ruptured cartridge case. |
| Fires automatically | Sear broken or remains in open position. | Replace trigger assembly or hammer spring housing. |
| Safety releases when pressure is applied on trigger. | Round heel on safety, or broken safety. | Replace safety. |
| Pull on trigger does not release hammer. | (1) Deformed hammer or trigger or worn trigger pin. | (1) Replace defective part. |
| | (2) Trigger strikes trigger housing. | (2) Turn in to ordnance. |
| Hammer releases but gun does not fire. | (1) Bolt not all way seated | (1) Clean and lubricate. |
| | (2) Defective ammunition. | (2) Discard round. |
| | (3) Broken firing pin | (3) Replace. |
| Rear sight elevation jumps. | Loose rear sight nut | Tighten. |
| Creep in trigger | Burs on trigger or hammer lugs. | Turn in to ordnance. |

*c. Ammunition.*—*Q.* What are the parts of the ball cartridge? *A.* Cartridge case, primer, powder, bullet.

*Q.* What is the purpose of the primer? *A.* To ignite the smokeless powder.

*Q.* Describe the bullet for ball cartridge. *A.* It has a core of lead and tin composition inclosed in a jacket of cupro-nickel. The point is very sharp so as to offer little resistance to the air.

*Q*. Describe the bullet for the dummy cartridge. *A*. The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with 6 long straight grooves along it and 3 holes through it.

*Q*. Describe the guard cartridge. *A*. The guard cartridge is distinguished from the ball cartridge by having 5 grooves around the case (old style) or 6 short straight grooves at the shoulder (new style).

*Q*. What other type of ammunition may be used for guard purposes? *A*. Gallery practice cartridge.

*Q*. What is the weight of the ball cartridge? *A*. About an ounce; 100 rounds weigh about 5½ pounds.

*Q*. What types of service ammunition are used with the M1 rifle? *A*.

(1) Ball M2 and M1906.

(2) Tracer M1.

(3) Armor-piercing M1.

*Q*. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A*.

(1) Armor piercing is painted black for ¼ inch from the point.

(2) Tracer is painted red for ¼ inch from the point.

*Q*. At what distance is it dangerous to fire at personnel, representing an enemy, with rifles loaded with blank ammunition? *A*. 20 yards or less.

*Q*. What type of dummy cartridge may be used with the M1 rifle? *A*. The corrugated type of dummy cartridge (caliber .30 M1906) may be used for instructional purposes. *The use of the slotted type of dummy cartridge* (*range*, *caliber .30*, *M1*) *is prohibited.*

*Q*. What is the standard type of ball ammunition? *A*. Ball cartridge, caliber .30, M2, is standard.

**101. U. S. caliber .45 automatic pistol M1911 and M1911A1.**—*a. Nomenclature and action.*—*Q*. What are the four main requirements for a military pistol? *A*. Accuracy within short ranges; power sufficient to stop an enemy instantly; rapidity of fire; and dependability.

*Q*. What models of the automatic pistol are used in the military service? *A*. Caliber .45, M1911 and M1911A1.

*Q*. What markings are on the pistol? *A*. On the right side, "Model of 1911 (or 1911A1), U. S. Army"; on the left side, "United States Property." All pistols are also marked with a serial number.

*Q*. What is meant by caliber .45? *A*. Caliber .45 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 45/100 of an inch.

*Q.* What are the lands and grooves? *A.* The lands are the raised portions of the bore and the grooves are the spaces between the lands.

*Q.* For what use is this pistol intended? *A.* For emergency use at short range.

*Q.* What is its effective range? Its maximum effective range? Its extreme range? *A.* Its ordinary effective range is 25 yards. Its maximum effective range is placed at 75 yards. Its extreme range, if held at an angle of 30°, is about 1,600 yards.

*Q.* What is the muzzle velocity of the pistol, and what penetration is obtained? *A.* It has a muzzle velocity of 800 feet per second. A penetration of 1 inch in white pine corresponds to a dangerous wound. At a range of 25 yards this pistol will drive a bullet 6 inches into white pine.

*Q.* How many shots can be fired without reloading? *A.* Seven.

*Q.* How fast can it be fired? *A.* Starting with the pistol unloaded, it has been fired 21 times in 12 seconds.

*Q.* Which direction of twist do the lands and grooves in the bore give the bullet? *A.* A left twist, or counterclockwise as seen from the breech.

*Q.* How does this affect the bullet? *A.* The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the left.

*Q.* In firing should any allowance be made for this drift? *A.* No. At the short ranges at which the pistol is used the drift is so small that it is negligible.

*Q.* Name the three principal parts of the pistol. *A.* Receiver, barrel, and slide.

*Q.* Point out the following parts:

Receiver.
Extractor.
Barrel.
Ejector.
Slide.
Firing pin.
Slide stop.
Hammer.
Rear sight.
Disconnector.
Front sight.
Trigger.
Link.
Grip safety.
Link pin.
Safety lock.
Barrel bushing.
Magazine.
Recoil spring.
Magazine spring.
Recoil spring guide.
Magazine catch.
Plug.

*A.* See figure 180.

*Q.* Why is this pistol called the automatic pistol? *A.* Because on being fired, the work of opening the breech, cocking the hammer, extracting and ejecting the empty shell, and forcing a new cartridge into the chamber is done automatically by the force of recoil.

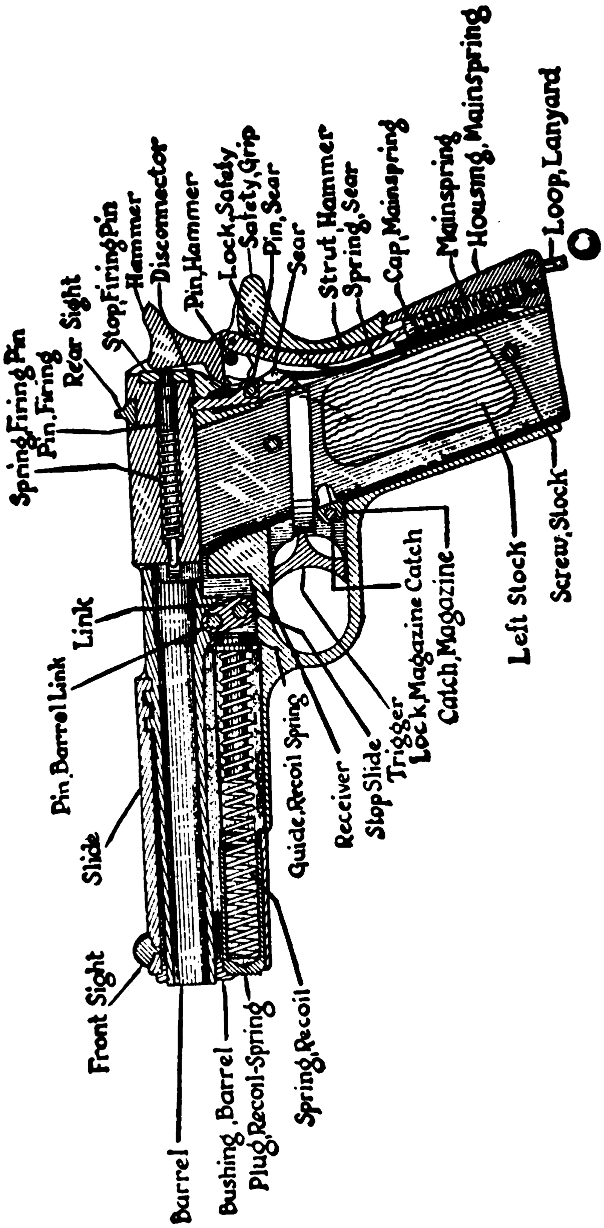



FIGURE 180.—Automatic pistol M1911.

*Q.* Describe briefly the functioning of the pistol. *A.* The force of the explosion causes the barrel to recoil slightly. It moves rearward and down until it is stopped by the lug holding link. The slide, having been unlocked from the barrel, moves to the rear extracting and ejecting the old shell compressing the recoil spring, and cocking the hammer. The greatly compressed recoil spring then forces the slide to the forward position. During this movement the slide pushes the new bullet, which has been raised into the chamber by the action of the magazine follower, into the barrel and pushes the barrel forward slightly and up, locking into the locking ribs ready for firing again.

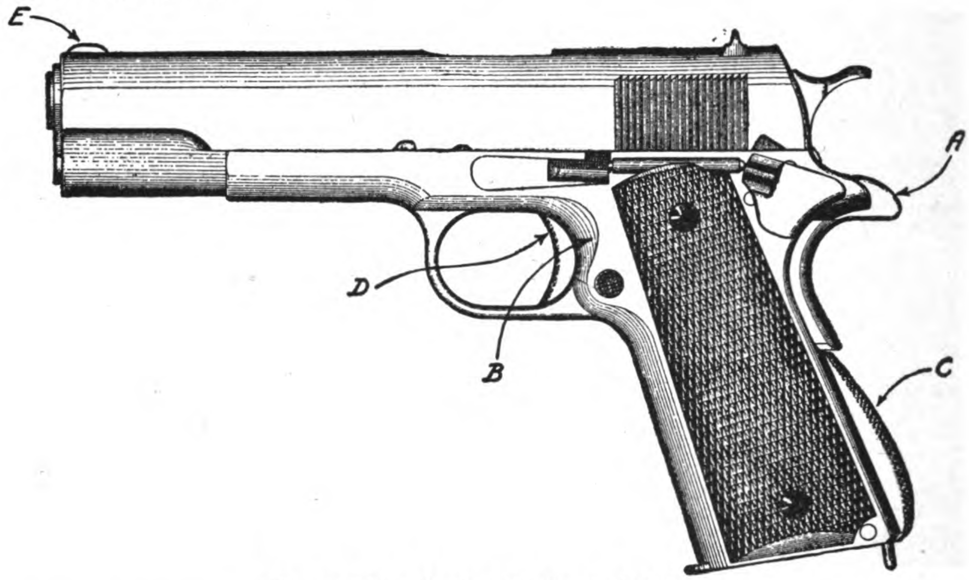



FIGURE 181.—Automatic pistol M1911A1.

NOTE.—Modifications over the M1911 automatic pistol are shown and indicated by letters A, B, C, D, and E.

*Q*. How is the pistol loaded? *A*. A loaded magazine is placed in the stock and the slide drawn fully back and released, thus bringing the first cartridge into the chamber. The hammer is thus cocked and the pistol is ready for firing.

*Q*. How is the pistol fired? *A*. The trigger is pulled, releasing the hammer which falls and strikes the firing pin, driving the latter forward against the percussion primer. This primer ignites the powder which propels the bullet.

*Q*. How is the pistol loaded again? *A*. The loading is automatic as long as a cartridge remains in the magazine. On recoil the slide is driven to the rear and the recoil spring is compressed. The slide moves forward again, driven by the recoil spring, and another cartridge is carried into the chamber.

*Q*. What are the two automatic safety devices? *A*. The *disconnector*, which positively prevents the release of the hammer unless the slide and the barrel are in the forward position and safely interlocked; this device also controls the firing and prevents more than one shot from following each pull of the trigger. The *grip safety*, which at all times locks the trigger unless the stock is firmly grasped and the grip safety pressed in.

*Q*. What other safety devices does the pistol have? *A*. The *safety lock*, by which the closed slide and the cocked hammer can be locked positively at will; the *half cock*, which prevents firing until the pistol is fully cocked.

*Q*. What is the purpose of the locking ribs on the barrel? *A*. To engage in the locking grooves in the slide, thereby securely locking slide to barrel in the firing position, and preventing it from rotating when the pistol is fired.

*Q*. What is the function of the link? *A*. To pivot the barrel, allowing it sufficient play to rise on its slight forward movement and lock into slide, and also to fall on its rearward movement and disengage from locking grooves, letting the slide continue its movement to the rear. It holds the barrel to its position in the receiver.

*Q*. What is the function of the magazine-follower lip? *A*. When the last bullet in the magazine has been fired, the shell is pushed up into chamber through the action of the magazine-follower spring. As the slide moves to the rear upon recoil, the lip engages the pawl on the slide stop and forces it up into slide-stop slot on the lower edge of slide, locking the latter in the rearward position. This serves to remind the firer that the last shot has been fired.

*Q*. What is the difference between the functioning of the extractor and the ejector? *A*. The extractor catches just in front of the shell rim and pulls it back out of the barrel when the slide moves to the rear after firing. The shell strikes against the ejector, which throws it out through the breech opening.

*Q*. How is the pistol disassembled for cleaning? *A*.

(1) Remove the magazine by pressing the magazine catch.

(2) Press the recoil spring plug inward and turn the barrel bushing to the right until the plug and the end of the recoil spring protrude from their seat, releasing the tension of the spring.

(3) Draw the slide to the rear until the smaller rear recess in its lower left edge stands above the projection on the thumb piece of the slide stop; press gently against the end of pin of the slide stop which protrude from the right side of the receiver above the trigger guard, and remove the slide stop.

(4) This releases the barrel link, allowing the barrel, with the link and the slide, to be drawn forward together from the receiver, carrying with them the barrel bushing, recoil spring, plug, and recoil spring guide.

(5) Remove these parts from the slide by withdrawing the recoil spring guide from the rear of the recoil spring and drawing the plug and the recoil spring forward from the slide.

(6) Turn the barrel bushing to the left until it may be drawn forward from the slide.

(7) This releases the barrel which, with the link, may be drawn forward from the slide and by pushing out the link pin, the link is released from the barrel.

*Q.* How is the pistol assembled? *A.* Proceed in the reverse order. When replacing the slide and barrel on the receiver, care must be taken that the link is tilted forward as far as possible and that the link pin is in place.

*Q.* How should one grasp the pistol for firing? *A.* To take the grip, hold the pistol in the left hand and force the grip safety device down and back into the crotch formed by the thumb and forefinger of the right hand. The thumb is carried parallel with or slightly higher than the forefinger; it should never be lower. Close the three lower fingers on the stock firmly but not with too tight a grip. The muscles of the arm are held firm but not rigid.

*Q.* How should one hold the breath while firing? *A.* To hold the breath, draw into the lungs a deep breath, let out a little of the air and stop the rest by closing the throat. Do not hold the breath with the throat open or by muscular effort of the diaphragm.

*Q.* What should be the position of the body? *A.* The body is a little more than half faced to the left, the feet 12 to 18 inches apart, depending on the man, and the body is perfectly balanced when the pistol is held in the shooting position. The whole position should be natural and comfortable.

*Q.* How should one squeeze the trigger? *A.* The trigger is squeezed with a steady increase of pressure so as not to know when the hammer will fall. It is squeezed only when the sights are alined on the target.

*Q.* How should the sights and the bull's-eye appear when the pistol is fired? *A.* The front sight should appear vertically in the center of the rear sight with its top level with the top of the rear sight. The bull's-eye should appear to rest on the top of the front sight.

*b. Maintenance of pistol.*—*Q.* What causes the most damage to a pistol when it is not properly cared for? *A.* Water. If allowed to remain on the metal parts of a pistol it will form rust and the surface of the metal will become "pitted."

*Q.* How is a pistol protected from water? *A.* By removing all moisture from the metal parts and covering them with a coating of oil or grease.

*Q*. How is a pistol cleaned after daily drill? *A*. Rub the outside, including the stock, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab the bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screw heads and crevises with a small clean brush. Immediately after cleaning, swab the bore with a flannel patch saturated with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts, including the mechanism and magazine, with an oily rag and put a few drops of sperm oil on all cams and working surfaces.

*Q*. Should a pistol be stored in a gun rack (or any other place) without a protective coating of oil? *A*. No. Even a perfectly clean and dry weapon will soon collect moisture, which will damage the metal parts unless they are protected with oil or grease.

*Q*. Why should a pistol be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

*Q*. What tool may be used for tightening or loosening screws? *A*. Only a properly fitting screw driver. Never use a substitute because it will damage the screw heads.

*Q*. Should a pistol be cleaned before firing? *A*. Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

*Q*. What are the three main forms of the residue left in the bore after a pistol is fired? *A*.

(1) A coating of chemicals left by the burned powder.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

*Q*. How do they damage a pistol if not removed? *A*. The chemicals attract moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath against the bore. The moisture causes rusting and pitting of the bore.

*Q*. How is a pistol cleaned after firing? *A*. The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents are available.) Remove the barrel of the pistol and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about 1 minute. Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necessary to remove the powder fouling thoroughly. Next remove the brush from the rod and swab several more times with the dissolving solution. Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly. Finally, inspect the bore for metal fouling (see below.) If no metal fouling is present prepare the weapon for storage as you do after daily cleaning and place it in the gun rack.

*Q.* How is the bore inspected for metal fouling? *A.* Hold the butt of the pistol pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore this is metal fouling.

*Q.* What is done in case metal fouling is found? *A.* Take the pistol to the supply sergeant and ask for instructions.

*Q.* How is metal fouling removed? *A.* It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

*Q.* How soon after firing should a pistol be cleaned? *A.* When a pistol has been fired, the bore should be cleaned thoroughly not later than the evening of the day on which it is fired. Thereafter, it will be cleaned and oiled each day for at least the next three succeeding days.

*Q.* What oils can be used on pistols? *A.* Sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

*Q.* State some of the things one is prohibited from doing with a pistol. *A.*

(1) Except for the removal of those parts permitted for cleaning, a pistol will not be disassembled except by permission of a commissioned officer and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of pistols must not be polished.

(3) All mutilations are prohibited.

(4) Nothing except the authorized oils may be used on a pistol.

(5) Weapons must be unloaded before being taken into barracks or tents.

*c. Ammunition.*—*Q.* What are the parts of the cartridge? *A.* Cartridge case, primer, powder, bullet.

*Q.* What is the purpose of the primer? *A.* To ignite smokeless powder.

*Q.* Of what does the bullet consist? *A.* A core of lead and tin composition inclosed in a jacket of cupro-nickel, weight 230 grains.

*Q.* What is the weight of the cartridge and bullet complete? *A.* About ¾ ounce; 100 rounds weight about 4½ pounds.

*Q.* How is ammunition packed? *A.* The cartridges are packed in pasteboard boxes containing 20 cartridges each. One hundred pasteboard boxes, or 2,000 cartridges, are packed in one zinc case, hermetically sealed, with handle for tearing open. The whole is inclosed in a wooden chest, the cover of which is fastened with screw hooks and thumb nuts and sealed.

*Q.* What types of cartridges are provided for this pistol? *A.*

(1) Ball cartridge, caliber .45, M1911.

(2) Dummy cartridge, caliber .45, M1921.

The dummy cartridge case is tinned and has a ⅛-inch hole in the body.

## Section III

## NOMENCLATURE, ACTION, SERVICE, AND DRILL OF ANTIAIRCRAFT MACHINE GUN; ITS MOUNT, AMMUNITION, AND TARGETS



**102. Nomenclature of gun and mount.**—*a. Gun.*—*Q.* What is a machine gun? *A.* A weapon which fires small-arms ammunition automatically.

*Q.* What is the name of the machine gun in use in antiaircraft units which fires caliber .30 ammunition? *A.* Browning, caliber .30 machine gun, M1917.

*Q.* Point out and state the uses of the important parts shown in figure 182. *A.* See figure 182.

*Q*. Point out and state the uses of the important parts shown in figure 183. *A*. See figure 183.

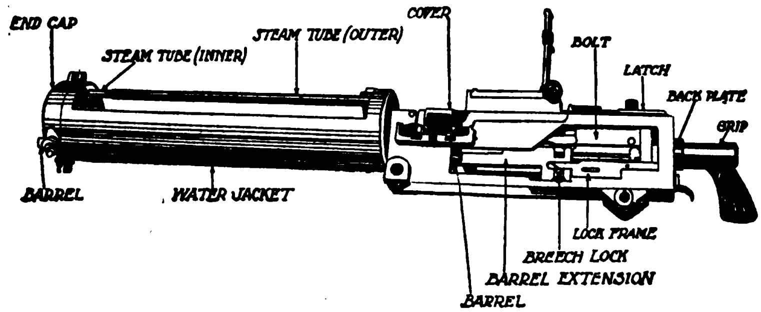



FIGURE 182.—Browning, caliber .30 machine gun, M1917.

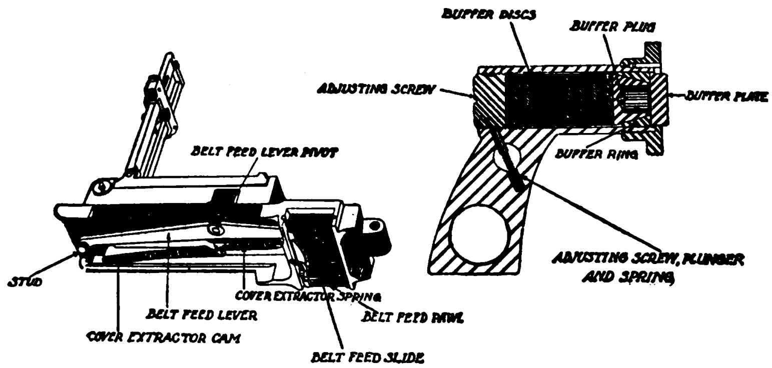



FIGURE 183.—Cover and backplate buffer groups.

*Q*. Point out and state the uses of the important parts shown in figure 184. *A*. See figure 184.

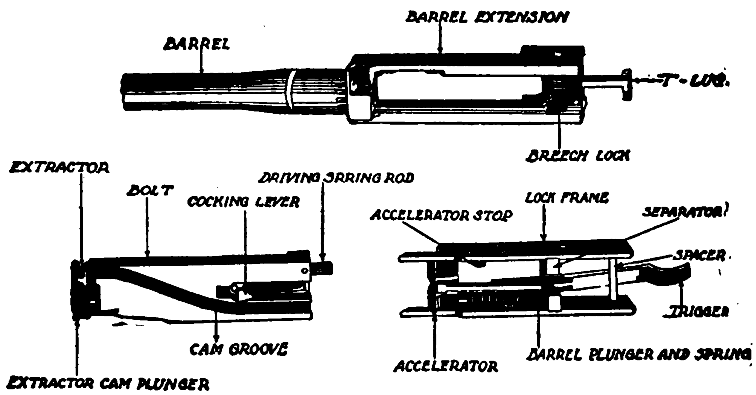



FIGURE 184.—Barrel extension, bolt, and lock frame groups.

*Q*. What is the standard antiaircraft machine gun? *A*. The Browning caliber .50 machine gun, M2.

*Q*. Compare the caliber .50 machine gun with the caliber .30 machine gun. *A*. Mechanically they are very similar. The main differences are—

(1) The caliber .50 gun has an oil buffer in place of the lock frame.

(2) The extractor feed cam, just back of the extractor cam, is pivoted, actuated by a spring, and called the switch in the caliber .50 gun.

(3) The caliber .50 gun has a water circulating system for cooling the gun while the caliber .30 gun depends on the water in the water jacket to cool the gun properly.

(4) The caliber .50 gun is provided with a side-plate trigger to permit the gun to be fired by depressing a lever on the M2 mount. The gun may also be fired by depressing the butterfly trigger in the backplate.

(5) The caliber .50 gun may be assembled to fire either with right-hand or left-hand feed.

*Q.* What are the rates of fire? *A.* Caliber .30, 400–525 shots per minute; caliber .50, 400–650 shots per minute. These are the cyclic rates. The usable rates for sustained fire are much lower.

*Q.* Describe the sights with which the guns in your organization are equipped. *A.* ———.

*b. Mount.*—*Q.* What is the present standard antiaircraft machine-gun mount? *A.* The M2 pedestal mount.

*Q.* Is this mount used for both caliber .30 and caliber .50 machine guns? *A.* Yes. However, a special subcradle or adapter must be used for the caliber .30 gun.

*Q.* What other mount is sometimes employed for both caliber .30 and caliber .50 machine guns? *A.* The M1 tripod mount.

*Q.* What means is provided to help the gunner steady the gun for antiaircraft fire? *A.* A back rest or shoulder stock. The back rest is preferable.

**103. Action of gun and mount.**—*Q.* Describe antiaircraft machine guns as to their operation, ammunition feed, and cooling. *A.* They are recoil operated, belt fed, and water cooled.

*Q.* What does the belt-feed mechanism do? *A.* As soon as a cartridge is withdrawn it feeds the belt forward one loop and puts the next cartridge in place.

*Q.* What does the extractor do? *A.* As the bolt comes back the extractor pulls a cartridge out of the belt and drops it into the T-slot in the face of the breech, the ejector on the end of the extractor having knocked the empty cases out of the T-slot ahead of the full cartridge. As the bolt goes forward the extractor rises to grip the next cartridge in the belt while the bolt pushes the preceding one into the chamber.

*Q*. What is the purpose of the breech locking mechanism? *A*. To keep the breech closed tightly after the shot is fired until it is safe to open it.

*Q*. How is this done? *A*. By means of the breech lock, which locks the bolt to the barrel extension and does not release it until the barrel and bolt assembly have recoiled together a short distance.

*Q*. What are the main parts of the firing mechanism? *A*. The trigger, sear, sear slide (caliber .50), sear spring, firing pin and extension, and cocking lever.

*Q*. How does the firing mechanism work? *A*. When the trigger is operated, the sear is tripped allowing the firing pin to go forward and strike the rear end of the cartridge, firing the gun. Actuated by the shock of firing, the bolt moves to the rear, recocking the gun. If the gunner continues to hold the trigger in the firing position, the gun will fire automatically each time the bolt returns to its forward position.

*Q*. What is the purpose of the buffer mechanism? *A*. To cushion the blow of the bolt when it is stopped at the end of its recoil.

*Q*. What are the main parts of the buffer mechanism of the caliber .30 machine gun? *A*. Grip, buffer plate, buffer ring (which is split on one side), a number of fiber washers (buffer disks), and the adjusting screw. The caliber .50 mechanism is similar.

*Q*. What other shock absorbing device is there in the caliber .50 gun? *A*. The oil buffer, which corresponds to the lock frame in the caliber .30 gun.

*Q*. What is its purpose? *A*. To cushion the shock of the recoil of the barrel and bolt assembly before the bolt is unlocked and opened. It is necessary on the caliber .50 gun because of its high power and heavy recoil.

*Q*. How can the rate of continuous fire of the caliber .50 gun be regulated? *A*. By inserting a screw driver blade into the slot in the rear of the oil buffer tube. Turn the tube clockwise to reduce the rate of fire, and counterclockwise to increase the rate of fire.

NOTE.—The continuous rate of fire of the caliber .30 machine gun may be increased by adding one or more buffer disks to the shock-absorbing group in the back plate grip.

*Q*. What is the purpose of the driving mechanism? *A*. To return the moving parts to the closed position after they have recoiled.

*Q*. Why is the cooling system necessary and important? *A*. Because the gun gets very hot if fired continuously. It would be damaged badly if there were no way to cool the barrel. Proper cooling of the gun is also required to reduce erosion of the bore to a minimum. Consequently it is very important to keep enough water in the water jacket.

*Q.* How can steam escape from the water jacket when the water gets hot? *A.* The inner steam escape tube runs lengthwise at the top of the water jacket and has a hole at each end. It has an outer tube sliding freely on it just short enough to uncover one of the end steam holes at a time. If the gun is elevated the outer tube slides back and covers the rear hole, preventing the water from running out, but uncovering the front hole and allowing the steam to escape.

**104. Service of gun and mount.**—*a. Gun.*—*Q.* What is head space? *A.* The distance from the face of the bolt to the base of the cartridge when the latter is fully seated in the chamber.

*Q.* What is the purpose of head space adjustment? *A.* To obtain the proper distance between the forward part of the bolt and the rear end of the barrel. This distance is not the actual head space.

*Q.* How is the head space adjustment made? *A.* It is made without removing the working parts of the machine gun from the casing. To head space the caliber .50 M2 gun, screw barrel by hand into barrel extension until it comes in contact with the bolt. Check to make sure that the end of the barrel extends through the barrel extension. Then unscrew the barrel two notches. If the gun operates sluggishly, unscrew the barrel one additional notch.

*Q.* What happens if head space is too small (adjustment too tight)? *A.* The breech lock will not fully enter its recess in the bolt. The gun operates sluggishly and the barrel extension, bolt, or breech lock may become damaged.

*Q.* What happens if head space is too great? *A.* A separation of the cartridge case may occur. If there is any weakness in the head of the cartridge case, such as a split case, the possibility of a rupture is increased by excessive head space.

*Q.* How is the buffer mechanism in the backplate adjusted? *A.* By increasing or decreasing the number of fiber buffer disks in the grip. When the backplate is reassembled, the adjusting screw must be screwed tightly against the buffer disks.

*Q.* What is a stoppage? *A.* Any unintentional cessation of fire.

*Q.* What is immediate action? *A.* The procedure used for the prompt reduction of common stoppages.

*Q.* What are some possible stoppages? *A.*

(1) Misfire due to defective primer.

(2) Short round.

(3) Bulged round.

(4) Tight link or loop in belt.
(5) Thin rim, permitting nose of bullet to drop below chamber.
(6) Stretched or torn belt (fabric).
(7) Empty loop in belt.
(8) Ammunition improperly alined in belt.
(9) Battered or thick rim of cartridge.
(10) Failure to remove round from chamber.
(11) Set-back primer.
(12) Separated case which is removed from chamber by new round when bolt is pulled to rear.
(13) Separated case which stays in chamber when bolt is pulled to rear.
(14) Bullet loose in cartridge case. Cartridge case extracted from belt but bullet remains in belt.
(15) Short or broken firing pin.
(16) Weak or broken firing pin spring.
(17) Faulty engagement of firing pin and sear notch.
(18) Broken sear spring.
(19) Bent or worn belt feed lever.
(20) Belt feed pawl spring missing or weak.
(21) Belt feed pawl pin missing or out of position.
(22) Cover extractor spring missing or weak.
(23) Belt feed lever bent up (stud on lever jumps out of cam groove).
(24) Broken or damaged extractor.
(25) Belt holding pawl missing or spring weak.
(26) Broken or damaged ejector.
(27) Broken or damaged T-slot causing misalinement and buckling of cartridge as bolt moves forward.
(28) Weak ejector spring, causing misalinement and buckling of cartridge as bolt moves forward.
(29) Broken barrel extension.
(30) Defective trigger mechanism.
(31) Defective bolt switch.
(32) Bent or broken belt feed pawl arm.
(33) Cover not latched.

*Q*. Describe the procedure for immediate action. *A*.

Gun fails to fire

Pull the bolt to the rear, release it, and attempt to fire.

If the gun still fails to fire,

See if cover is latched, straighten ammunition belt, place hand to feel rounds entering feedway, and pull the bolt to the rear and release it.

If belt feeds,

attempt to fire.

If gun still fails to fire,

change bolt.

If belt does not feed,

raise the cover, remove the first round from the belt, and lock or feel for a cartridge in the gun.

If a cartridge is

In the gun,

remove it,

reload, re-lay, and fire.

Not in the gun,

reload, re-lay, and fire.

NOTE.—If application of this procedure does not remedy the stoppage, the gunner must examine the feed mechanism and other parts of the gun in order to locate and remedy the trouble.

*Q*. Explain and demonstrate the removal and replacement of the groups of the caliber .30 machine gun. *A*.

(1) *Removing groups.*—(*a*) *Backplate.*—Pull back on latch and raise cover. With the left hand pull back the bolt handle and hold it in the rearmost position. Insert the rim of a cartridge in the slot in the rear of the driving spring rod. With the slot horizontal, push in the driving spring rod as far as it will go and turn it clockwise 1/4 turn until the slot is vertical so that the lugs on it will engage in the undercut recesses in the bolt. Then push the bolt handle forward about an inch to free the rear end of the driving spring rod from the backplate. Push the latch forward and lift out the backplate.

(*b*) *Bolt.*—Pull the bolt all the way back and remove the bolt handle. Then pull the bolt out of the rear end of the receiver.

(*c*) *Lock frame.*—Push in on the trigger pin through hole on the right side of the receiver with the point of a bullet or the combination tool. Pull lock frame, barrel extension, and barrel out through the rear of the gun until the lower rear lugs on the barrel extension are clear of the casing. Hold the lock frame firmly and push forward on the accelerator with the thumbs. This separates the lock frame from the barrel extension.

(*d*) *Barrel extension and barrel.*—Pull the barrel extension and barrel out to the rear. Unscrew the barrel extension from the barrel.

(*e*) *Cover.*—Remove latch and latch spring. Turn the cover pin spring up. Draw the assembled pin out to the right of the casing. Remove the cover.

(2) *Replacing groups.*—The groups are replaced in the reverse order of their removal.

*Q.* Explain and demonstrate the procedure of removal and replacement of the groups of the caliber .50 machine gun. *A.*

(1) *Removing groups.*—(*a*) Release cover latch and raise cover.

(*b*) *Cover.*—The cover may be removed or left assembled to the gun as desired. To remove the cover, withdraw the cotter pin from the cover pin and pull out the cover pin.

(*c*) *Backplate.*—Release the backplate latch lock and latch and lift out the backplate.

(*d*) *Bolt.*—Press forward and away from the side plate on the end of the driving spring rod to release the retaining pin in the head of the rod from the hole in the side plate. Draw the bolt to the rear until the bolt stud can be withdrawn through the opening in the right side of the receiver of the gun. Remove the complete bolt from the rear end of the casing.

(*e*) *Oil buffer, barrel extension, and barrel.*—Compress the oil buffer spring lock, using the point of a bullet or the drift on the combination tool inserted through the hole in the right side plate, and remove the oil buffer, barrel extension, and barrel assembly from the rear of the casing. Detach the oil-buffer group from the barrel extension by pressing the accelerator forward.

(3) *Replacing groups.*—The groups are replaced in the reverse order of their removal. Be sure the backplate latch lock is in the unlocked position while the backplate is being replaced.

*Q.* When replacing the bolt of either a caliber .30 or caliber .50 gun, what precaution must be taken. *A.* Have the cocking lever in the forward position.

*Q*. What points should be observed before firing? *A*. The gun should be inspected to see that all parts of it are clean, sound, oiled where necessary, adjusted and functioning properly, that there is no excessive play or friction, and no leakage. The water jacket should be filled. A sufficient supply of ammunition, oil, spare parts, and tools should be on hand, and all should be inspected to see that they are in good order.

*Q*. What points should be observed during firing or temporary cessations in firing? *A*. The piece should be constantly inspected and kept cleaned, oiled, and adjusted. Leakage should be checked, and the sights and tripod should be kept firmly set. Worn or broken parts should be repaired or replaced. Keep belt in line with feed opening, replace empty belts, and watch the ammunition supply.

*Q*. What points should be observed after firing? *A*. Inspect the piece, clean, oil, test, and adjust all working parts, replacing any that are broken or defective. Renew packing if necessary. Empty and flush out the water jacket. Clean, repair, and refill ammunition belts. Check spare parts, replace any that are missing, and clean and oil them.

*b*. *Mount*.—What precautions must be taken to protect the sight mechanism of the M2 mount? *A*. When central control is used, care must be taken that the cover of the gun is not raised while the sight mechanism is being operated. At the conclusion of drill or action, if the guns and mounts are to remain in position, run the elevating screw of the front sight mechanism down as far as possible to protect it against possible injury. When movements are made from one emplacement to another, remove the sight assembly from the mount and place it in the carrying case.

*Q*. In assembling the M2 mount, what precaution is taken while assembling the legs to the pedestal? *A*. The cover is placed over the top of the pedestal to exclude dirt and grit from the cradle seat.

*Q*. What parts of the M2 mount should never be tampered with by members of the machine-gun squad? *A*. The recoil mechanism and the trigger control mechanism.

**105. Drill of machine-gun squad.**—*Q*. What personnel are provided by Tables of Organization for each machine gun assigned to seacoast artillery units? *A*. Three privates.

*Q*. How are they designated? *A*. Gunner (No. 1), assistant gunner (No. 2), and water chest operator (No. 3). When caliber .30 machine guns are employed, No. 3 acts as ammunition detail.

*Q*. How is the caliber .30 gun loaded? *A*. At the command LOAD, No. 1 advances his right hand opposite the belt exit and holds it in position ready to grasp the brass tag of the belt. No. 2 opens the ammunition chest, holds the brass tag at the point where it joins the fabric, and pushes the tag through the feed opening as far as possible. No. 1 grasps the tag as it is pushed from the belt exit and gives it a quick jerk to the right. He next pulls the bolt handle well to the rear and releases it. He again pulls the bolt handle to the rear and releases it. The gun is now loaded for automatic fire. The caliber .50 gun is loaded similarly. However, it should be noted that the link belt used with the caliber .50 gun is not provided with a brass tag.

NOTE.—Each time the bolt handle is pulled to the rear, it should be released while in its rearmost position so as to give the driving spring full play in driving the bolt forward. If this is not done, the bolt may not go all the way forward, thereby causing a stoppage.

*Q.* How is the piece fired? *A.* The gun being mounted and loaded, at the command or signal COMMENCE FIRING, No. 2 taps No. 1 lightly on the back and calls: FIRE. No. 1 instantly pulls the trigger and continues to pull the trigger until CEASE FIRING is given. He must not disturb the aim or hold while doing so. The eyes must be directly on the target and any tendency to look down at the trigger must be avoided. No. 2 changes the ammunition boxes on the mount when necessary and assists No. 1 in clearing stoppages when they occur. No. 3 operates the water chest, beginning to turn the handle as soon as fire is commenced and continuing to turn the handle for about twenty turns after firing is stopped. When the caliber .30 gun is employed, No. 3 acts as ammunition detail and assists No. 2 in refilling the water jacket when necessary.

*Q.* How is the gun unloaded? *A.* At the command UNLOAD, No. 1 raises the sight leaf with the left hand, if it be lowered, after which he unlatches and raises the cover with the left hand. As soon as No. 1 has raised the cover sufficiently, No. 2 raises the extractor, withdraws the belt, packs it carefully in the ammunition chest, and closes the ammunition chest cover. As soon as No. 2 withdraws the belt, No. 1 lowers the extractor and the cover, pulls the bolt handle to its rearmost position, releases it, pulls the trigger, and lowers the sight leaf. No. 3 checks the water in the water chest (caliber .50 guns) or in the water jacket (caliber .30 guns). All members of the machine-gun squad assist in obtaining ammunition, refilling belts, and loading filled belts in ammunition boxes.

**106. Ammunition and targets.**—*Q.* With what safety precautions particularly applicable to machine guns in peacetime should every member of a machine-gun squad be familiar? *A.*

(1) Before removing the gun from the mount, unload the gun, raise the cover, and examine the chamber to be certain that the gun is empty.

(2) Load the gun only at the command of the officer conducting the firing.

(3) Allow no live ammunition near the emplacement except when firing is to take place.

(4) The covers on all machine guns will be partially raised and the guns unloaded except when the guns are firing or are about to fire.

(5) Always pass in rear of the gun in going from one side to the other.

(6) When tracking a target, the gunner will not touch the trigger until his sights are alined with the target and the field of fire has been indicated as safe.

(7) At the beginning of courses, machine guns must be kept depressed considerably below the elevation of the towing airplane until it has cleared the line of sight.

(8) When a stoppage is being cleared, the machine gun will be pointed at a safe part of the field of fire. This requirement will not prevent continued tracking of the target so long as the field of fire is safe.

(9) If malfunctioning of the gun causes it to fire continuously while the trigger is not being depressed, the firing can be halted by grasping the ammunition belt and twisting it with force so that the rounds cannot enter the feedway.

*Q*. What types of ammunition are used in antiaircraft machine guns? *A*. Ball ammunition and tracer ammunition of caliber .30 and caliber .50.

*Q*. What is the maximum range at which tracers are normally visible? *A*. Caliber .30 can be seen about 1,000 yards. Caliber .50 can be seen about 1,850 yards.

*Q*. What types of ammunition belts are used for machine guns? *A*. Caliber .30 machine guns are fed with fabric belts. Caliber .50 machine guns are fed with disintegrating link belts.

## Section IV

## CORDAGE AND MECHANICAL MANEUVERS

**107. Definitions.**—*a. General.*—Rigging involves the technique of handling manila and wire rope and chains in various block and tackle combinations to raise and move heavy loads. It is closely related to the handling of loads by jacks, levers, and similar mechanical devices.

*b. Special terms.*

*Running end.*—Free end of rope.

*Standing part.*—Whole rope less the running end.

*Paying out.*—Giving slack in rope.

*Bight.*—Loop formed on rope so that the two parts lie alongside each other or cross.

*Frapping.*—Drawing together of several turns by passing a rope around all the turns.

*Whipping.*—Wrapping an end tightly with cord or twine to prevent its unlaying when pulled through a pulley or other small opening.

*Unlaying.*—Untwisting of the strands or cords.

*Seizing.*—Lashing the running end back to the standing part.

*Mousing a hook.*—Securing a load held in the hook by wrapping cord or twine across its mouth in such a way as to close it effectively.

*Transom.*—Horizontal spar.

*Upright.*—Vertical spar.

*Belay.*—To make a turn or turns with a running end of rope around a spar, cleat, or the standing part of the rope.

*Thief.*—Knot commonly mistaken for a reef knot, differing in that the end of each rope turns around the standing part, instead of around the other rope.

**108. Characteristics of knots.**

| Name | Use | Directions for tying |
|---|---|---|
| Overhand | At end of rope to prevent unlaying or to prevent end from slipping through block. | See figure 185. |
| Figure-of-eight | Same as above | See figure 185. |

| Name | Use | Directions for tying |
|---|---|---|
| Square or reef [1] | To join two ropes of same size. | See figure 185. Pass standing and running parts of each rope through loop of the other in the same direction. Ends of each rope turn around end of other, rather than standing part. |
| Single sheet bend or weavers.[2] | To join ropes, especially of unequal size. | See figure 185. |
| Double sheet bend.[3] | To join ropes of unequal size, especially wet ones. | See figure 185. |
| Two half hitches [4] | To belay or make fast end of rope around own standing part. | See figure 185. End may be lashed down or seized to standing part to prevent slipping. |
| Round turn and two half hitches. | Same as above | See figure 185. |
| Fisherman's bend or anchor. | To fasten a rope to a ring or anchor. | See figure 185. Take two turns around the iron, then a half hitch around the standing part and between the ring and the turns, then half hitch round standing part. |
| Clove hitch | To fasten a rope at right angles to a spar or at beginning of lashing. | See figure 185. If end of spar is free, hitch made by first forming two loops, placing right hand loop over other, and slipping the double loop over the end of the spar. Otherwise, pass end of rope around spar, bring it up to the right of standing part, cross over latter, make another turn around spar, bring up the end between spar last turn and standing part. |
| Timber hitch [5] | To haul or lift spar | See figure 186. |
| Telegraph hitch | To hoist or haul spar | See figure 186. |
| Hawser bend | To join two large cables | See figure 186. Each end is seized to own standing part. |

[1] Care must be taken not to tie a thief or granny, as these will slip.
[2] More secure than a reef but more difficult to untie.
[3] More secure than a single sheet bend.
[4] Must not be used for hoisting a spar.
[5] Can be easily loosened when strain is taken off, but will not slip under load. When used for hauling spars, a half hitch is added near end of spar.

| Name | Use | Directions for tying |
|---|---|---|
| Bowline[6] | To form a loop that will not slip. | See figure 186. Make loop standing part underneath, pass end from below through loop, over the part, around the standing part, then down through the loop. |
| Bowline-on-a-bight | To make a comfortable sling for a man. | See figure 186. Make first part as above with double part of rope, then pull bight through sufficiently to allow it to be bent past loop and come up in proper position. |
| Running bowline | To make a slip knot that will not bind. | See figure 186. Pass end around spar. Form a loop around the standing part with the running end. Make a bowline on the standing part below the loop on the running end side. |
| Cat's-paw | To secure a rope to the mouth of a hook. | See figure 187. Form two equal bights; take one in each hand and roll them along the standing part till surrounded by five turns of the standing part; then bring both loops (or bights) together and pass over the hook and mouse the hook. |
| Sheep shank | To shorten a rope or pass a weak spot. | See figure 187. Take a half hitch with the standing parts around the bights. |
| Rolling hitch | To haul a larger rope or cable. | See figure 187. Take two turns around the large rope in the direction in which it is to be hauled, and one half hitch on the other side of the hauling part. |
| Blackwall hitch | To attach a single rope to a hook of a block for hoisting. | See figure 188. |
| Mooring knot | To make fast to a mooring or snubbing post. | See figure 188. Take two turns around the mooring or snubbing post, pass the free end under the standing part, take a third turn above the other, pass the free end between the two upper turns. |

[6] Length of bight depends on purpose for which knot is required.

| Name | Use | Directions for tying |
|---|---|---|
| Carrick bend | To fasten guys to derricks. | See figure 188. |
| Wall knot and crown on wall. | To furnish the end of a rope to prevent unlaying. | See figure 188. |

**109. Splices.**—*Q.* What is the purpose of a short splice? *A.* Short splices are used to join two ropes when an increase in diameter at point of splice is not objectionable.

*Q.* How is a short splice made? *A.* Unlay the strands of each rope for a convenient length. Bring the rope ends together so that each strand of one rope lies between the two consecutive strands of the other rope. Draw the strands of the first rope along the second and grasp with one hand. Then work a few strands of the second rope over the nearest strand of the first rope and under the second strand, working in a direction opposite to the twist of the rope. Apply the same operation to all strands. Splicing may be continued in the same manner to any extent, and the free ends may be cut off when desired. Splice may be tapered by cutting out a few fibers from each strand each time it is passed through the rope. Splice may be made compact by rolling under a board or under the foot.

*Q.* What is the purpose of a long splice? *A.* Long splices are used to join two ropes without an increase in diameter at point of splice.

*Q.* How is a long splice made? *A.* Unlay the rope and bring together as for a short splice. Unlay to a convenient length a strand (*a*) of one rope, laying in its place the nearest strand (*d*) of the other rope. Repeat the operation in the opposite direction with two other strands (*c*) and (*f*). Lay half of one in place of the unlayed half of the other. Pass the tops through the rope. When the splice has been thoroughly stretched, trim off the ends of the strands.

*Q.* What is the purpose of an eye splice? *A.* Eye splices are used for fastening a rope to a ring or for making a permanent loop in the end of a rope.

*Q.* How is an eye splice made? *A.* Unlay a convenient length of rope. Pass one loose strand under one strand of the rope, forming an eye of the proper size. Pass a second strand under the strand of the rope next to the strand which secures the first one. Pass the third strand under the one next to that which secures the second strand. Draw all taut, and continue as for a short splice.

**110. Cordage.**—*Q.* What is a cord rope? *A.* A rope made of vegetable fibers. These fibers are twisted together to form strands, and several strands are twisted together to form a rope.

*Q.* What is a wire rope? *A.* A rope of steel or other metallic wire. A number of wires (usually 19) are twisted into strands and several (usually 6) of these strands are laid around a hemp core.

*Q.* What is the purpose of the hemp core? *A.* To prevent the steel strands from rubbing against and cutting into each other and to give flexibility to the rope.

*Q.* How is a rope designated as to size? *A.* By its circumference or diameter in inches.

*Q.* What is marline and seizing stuff? *A.* Marline and seizing stuff are both small-sized cordage. Marline is usually two stranded and laid up left-handed. Seizing stuff is made of better material and is usually three stranded, right-handed.

*Q.* How should cord rope be stored? *A.* In coils on skids or blocks so as to permit the circulation of air about the coil. Cord rope should never be stored wet.

*Q.* How is the strength of cord rope affected when slung over hooks or fastened by knots? *A.* The strength is lowered about one third.

*Q.* What care should be used in uncoiling new rope? *A.* Care should be used to find the natural lay of the rope and relieve the twist.

*Q.* How can rope be identified as right- or left-handed? *A.* By comparing it with a right- or left-handed screw thread.

*Q.* How should rope be coiled? *A.* Rope should be coiled right- or left-handed according to whether it is right- or left-handed rope.

*Q.* How should rope be cared for while in storage? *A.* It should be taken out at least once each year, dried, stretched, and all weak spots cut out.

*Q.* What precaution should be taken before using old rope? *A.* It should be tested, especially when serious damage might result from its breakage.

*Q.* What should be done before cutting a rope? *A.* A whipping should be placed on each side of the spot where the rope is to be cut. The end of the rope should never be left free to unlay or ravel.

*Q.* Demonstrate a wall knot, figure-of-eight, bowline, anchor knot, bowline-on-a-bight, sheepshank, cat's-paw, square knot, rolling hitch, clove hitch, blackwall hitch, timber hitch, sheet bend. Explain the use of each. *A.* (Practical demonstration.) Explain use as given in paragraph 108.

*Q*. How is wire rope coiled? *A*. Small size wire rope may be coiled in the same manner as cord rope. Large wire rope should be coiled in a figure eight.

*Q*. What is the principal precaution to be taken in using a wire rope? *A*. Never let it become kinked while under a strain.

*Q*. Name the component parts of a clip. *A*. The roddle, the U-bolt, and the U-bolt nuts.

*Q*. How should wire rope be attached? *A*. Normally wire rope should be attached with thimble and clips. The rope may be secured around the thimble by splicing, but this requires expert work. In the absence of clips a seizing of wire may be used.

*Q*. What precautions must be taken when using wire rope attached with thimble and clips? *A*. See that the roddles of all clips are in contact with the *long* end of the rope (fig.196). After the wire rope has been subjected to strain the clip bolts must be tightened.

111. **Blocks and tackle.**—*Q*. What is a block? *A*. A block consists of a shell or frame of metal, or wood and metal, housing a grooved pulley or sheave on which rope runs, and giving support to the ends of a pin on which the sheave revolves. A hook, usually free to revolve (swivel), may be attached to one end of the block and often an eye or becket to the other end.

*Q*. What are the parts of a block? *A*. The parts of a block are the shell or frame, the sheave or wheel upon which the rope runs, and the pin upon which the wheel turns in the shell.

*Q*. How are blocks designated? *A*. Blocks are designated by the length of the shell in inches and by the number of sheaves. Those with one, two, three, or four sheaves are called single, double, triple, and quadruple. The smallest size of block (length in inches) that will take a given rope is nine times the rope diameter. Self-lubricating blocks should be used where obtainable.

*Q*. Define the following:

*Snatch block.*—A snatch block is a single block with the shell open at one side to admit a rope without passing the end through.

*Running block.*—A running block is a block that is attached to the object to be moved.

*Standing block.*—A standing block is a block that is fixed to some permanent object.

*Simple tackle.*—A simple tackle consists of one or more blocks rove with a single rope.

*Return.*—Each part of the rope between the two blocks, or between either end and the block, is called a return.

*Overhaul.*—To overhaul is to separate the blocks.
*Round in.*—To round in is to bring the blocks closer together.
*Chock-a-block.*—When the blocks are in contact, the tackle is said to be chock-a-block.

*Q.* What is the purpose of blocks? *A.* Blocks are used to change the direction of pull and to give mechanical advantage. A man of average weight will pull about 60 pounds horizontally.

*Q.* What is a tackle? What are the different parts? *A.* A tackle is a rope and block or a combination of ropes and blocks working together for use in lifting or moving objects. The standing part of a tackle is that part of the rope between the end which is made fast to one of the blocks, to the weight to be moved, or to some fixed point and the point where it passes over the first sheave. The running part of the rope consists of all the parts moving between the sheaves. The fall is that part of the rope to which the power is applied. A moving block is called a running block and a fixed block is called a standing block.

*Q.* What is meant by the power or mechanical advantage of a tackle? *A.* The ratio of the load to the power required to lift or move it. Thus, if a load of 600 pounds can just be lifted by a pull of 150 pounds, when a certain tackle combination is used, the power of the tackle is four.

*Q.* How is the mechanical advantage of tackle determined? *A.* It is determined by considering the number of ropes that support the load. Thus, when a double movable block is used, four ropes support the load and the mechanical advantage is four.

*Q.* Draw sketches showing: a whip tackle; a whip on a whip; a runner; a gun tackle; a luff tackle; and show the power of each. *A.* See figure 197.

*Q.* Why is a runner a more powerful tackle than a whip? *A.* Because the pull is in the same direction as that in which the load is moved instead of in the opposite direction.

*Q.* Rig a whip tackle. Gun tackle. Luff tackle. *A.* (Practical demonstration.)

*Q.* What is a chain or triplex block? *A.* A chain or triplex block consists of a train of gears operated by a large wheel over which an endless chain passes. Power is applied to this chain. The gears operate a sprocket wheel over which runs a heavy chain, the links of which fit into the sprockets. The heavy chain lifts the weight and is provided with a hook for supporting the weight. Chain blocks are rated according to their lifting capacities and range by half-ton changes from 1 to 5 tons.

**112. Slings.**—*Q*. What are slings made of? *A*. Slings are made of manila rope, wire rope, or chains. The most common is a manila sling made by splicing the two ends together.

*Q*. How is a sling used? *A*. To use a sling, pass it around the article to be lifted. Pass the bight formed by one end through the bight formed by the other and then over the lifting hook. If the sling is the same size as the lifting rope, it should make a minimum angle of 30° with the horizontal. At this angle, the stress in each branch of the sling is equal to the stress in the lifting rope. If the angle is greater than 30°, the load is limited by the strength of the lifting rope; if less than 30°, by the strength of the sling.

*Q*. How do you make a barrel sling? *A*. To sling a barrel horizontally, make a bowline with a long bight. To sling a barrel vertically, make an overhand knot on top of the two parts of the rope; open out the knot and slip each half of it down the sides of the barrel; secure with a bowline.

**113. Lashings.**—*Q*. How should two spars be lashed at right angles? *A*. Make a clove hitch around the upright a few inches below the transom. Bring the lashing under the transom, up in front of it, horizontally behind the upright down in front of the transom, and back behind the upright at the level of the bottom of the transom and above the clove hitch. Keep the following turns outside the previous ones on one spar and inside on the other, not riding over the turns already made. Make four more turns. Make two frapping turns between the spars, around the lashing, and finish the lashing off either around one of the spars or any part of the lashing through which the rope can be passed. Do not make the final clove hitch around the spar on the side toward which the stress is to come, as it may jam and be difficult to remove. While tightening, beat the lashing with a handspike or pick handle. This is called a square lashing.

*Q*. How should two spars be lashed for a pair of shears? *A*. Lay the two spars alongside each other with the points below which the lashing is to be made resting on a skid. Make a clove hitch around one spar, and take the lashing loosely eight or nine turns about the two spars, above the clove hitches, without riding. Make two or more frapping turns between the spars, and finish the lashings off with a clove hitch above the turns on one of the spars. Open the butts of the spars and pass a sling over the fork. Hook or lash a block to this sling. Make fast fore and back guys with clove hitches to each spar just above the fork.

*Q*. How should three spars be lashed for a gin or tripod? *A*. Mark on each spar the location of the center of the lashing. Lay two of the spars parallel to each other with an interval a little greater than the diameter of a spar. Rest their tips on a skid and lay the third spar between them with its butt in the opposite direction so that the marks on the three spars will be in line. Make a clove hitch on one of the outer spars below the lashing and take eight or nine loose turns around the three. Take a couple of frapping turns between each pair of spars in succession and finish with a clove hitch on the central spar above the lashing. Pass a sling over the lashing and the tripod is ready for raising.

**114. Gins and shears.**—*Q.* Describe a gin. *A.* A gin is a tripod of poles or spars. The two outside poles are called legs and the third called the pry pole. A gin requires no guys.

*Q.* What is a gin used for? *A.* For lifting heavy weights vertically.

*Q.* Name the different parts of a garrison gin. *A.* Two legs, pry pole, bolt and clevis, windlass and ratchet, two handspikes, three shoes, two braces, and tackle.

*Q.* How much can be safely lifted with it? *A.* About 17,000 pounds.

*Q.* Explain briefly how a garrison gin is assembled and raised. *A.* The legs and pry pole are laid on the ground with the heads together and in position for assembling. The head is then assembled by putting the pin through the legs, pry pole, and clevis. The windlass is put in place and the braces are brought up and put in their places. The gin is raised, after assembly, by raising the head and bringing up the foot of the pry pole toward the feet of the two legs. (See fig. 195.)

*Q.* Describe the shears. *A.* Shears consist of two spars, of a size suitable for the weight to be raised, lashed together at the fork. A tackle is fastened to the lashing by a strap or otherwise, the hook is moused, and holdfasts are required.

*Q.* What are shears used for? *A.* Shears are used for lifting heavy weights to move them a short distance, as in loading or unloading a ship or railroad car.

*Q.* How are shears held in position after being raised? *A.* By means of guys. (Lines from the top of the shears to holdfasts on the ground.)

*Q.* How are the shears raised? *A.* If not too heavy, lift the head and haul in on the proper guys. If too heavy to raise in this way, form a crutch by lashing together two poles near their upper ends, the feet of the crutch being slightly in rear of the heels of the shears and secured to prevent them from slipping. Lay the rear guy over the crutch and raise the crutch by means of two light guy ropes, until it is inclined at an angle of about 45° to the front. Haul on the rear shear guy, allowing the crutch to rise as the shears rise. After the shears are raised high enough so that the crutch ceases to act, it is lowered by means of its guy ropes. Footings should be prepared for heavy shears on hard ground, and the legs should be connected by a lashing to prevent spreading.

*Q*. How is a load moved horizontally by means of shears? *A*. By slacking off on one guy and taking up on the other. Tackle may be used for this purpose if necessary.

115. **Anchorages.**—*Q*. What is the purpose of an anchorage? *A*. It furnishes a holdfast for the tackles or guy cables in handling heavy loads by means of tackles, gins, shears, etc.

*Q*. Describe two forms of anchorages. *A*. The picket holdfast is a succession of pickets driven into the ground in continuation of the guy or cable and at right angles in a vertical plane to the line of pull, connected from the top of one picket to the bottom of the next, with the direct pull on the bottom of the first picket. A deadman is a log, rail, or other arrangement buried in the ground, horizontally at right angles to the line of pull, which is applied to the center of the deadman.

*Q*. What is the purpose of a holdfast? *A*. Holdfasts are used to anchor a line, for example, a guy to the ground.

*Q*. How is a holdfast made? *A*. Drive stout pickets into the ground, one behind the other, in the line of pull. Secure the head of each picket, except the last, by a lashing to the one behind it. Tighten the lashings by rack sticks, and then drive the points of these into the ground to hold them in position. The distance between pickets should be several times the height of the picket above the ground. A single good ash picket, 3 inches in diameter, driven 5 feet into good solid earth, will stand a pull of about 700 pounds.

*Q*. What is the purpose of a deadman? *A*. A deadman has the same use as a holdfast except that it has greater strength, but requires more labor to construct.

*Q*. How is a deadman prepared? *A*. Lay a log or timber in a transverse trench with an inclined trench intersecting it at its mid point. Pass the cable down the inclined trench, take several turns around the log, and fasten the cable to the log by half hitches and marline stopping. If the cable is to lead horizontally or incline downward, pass it over a log at the outlet to the inclined trench. If the cable is to lead upward, the log is not necessary, but the deadman must be buried deeper. The strength of the deadman depends upon the strength of the log and holding power of the earth.

*Q*. How can you determine the holding power of a deadman? *A*. For given cable pull, the number of square feet of deadman bearing surface required is determined by dividing the total pull to be placed on the deadman by the value given for the depth and cable inclination selected, table LXVI, FM 5-10.

**116. Jacks.**—*Q*. Name two types of jacks. *A*. Screw jacks and hydraulic jacks.

*Q*. What is the usual maximum lift of a screw jack? *A*. Usually from 16 to 18 inches. Care should be taken that it is not screwed too high.

*Q*. What liquid is used for filling hydraulic jacks? *A*. A mixture of alcohol and water.

*Q*. How would you determine what mixture of fluid to put into a hydraulic jack? *A*. Consult the manufacturer's handbook or operational instructions.

*Q*. Can all hydraulic jacks be used in both the horizontal and vertical position? *A*. No. They are manufactured in two classes, horizontal jacks and base jacks. Horizontal jacks may be used in any position. Base jacks are used in the upright position, but may be inclined provided that the head is always kept higher than the base.

*Q*. How may the two classes of jacks be distinguished? *A*. They may be distinguished by the fact that the base jack has the pump and reservoir within the ram while the horizontal jack, which is the shorter one, has a separate piece for the cylinder which has no connection with the reservoir except through the pump and the lowering passage.

*Q*. How is the hydraulic jack filled? *A*. To fill the hydraulic jack start with the ram down. Remove the lowering valve and hexagonal cap. Fill through the large hole. Small amounts necessary to replace liquid which has leaked out may be put in by removing the small screw and filling.

*Q*. How is the hydraulic jack emptied? *A*. To empty, have the ram down, place the finger over the escape hole in the cylinder, pump the ram until the bottom of it is above the hole, then open the lowering valve and remove the finger from the escape hole allowing air to enter under the ram. The ram may now be lifted out. Remove the lowering valve and hexagonal cap and invert the jack to allow the liquid to run out.

*Q*. What general precautions should be taken in using the hydraulic jack? *A*. The ram should be kept down when not in actual use. In raising a weight the lever should be inserted in the socket with the projection down. The lowering valve should be closed. The lever should be worked up and down with a slow steady stroke. A weight is lowered by opening the lowering valve. The speed of lowering is controlled by the valve. It should be lowered slowly and never checked suddenly. The jack is designed to lift its rated load with one man operating the lever.

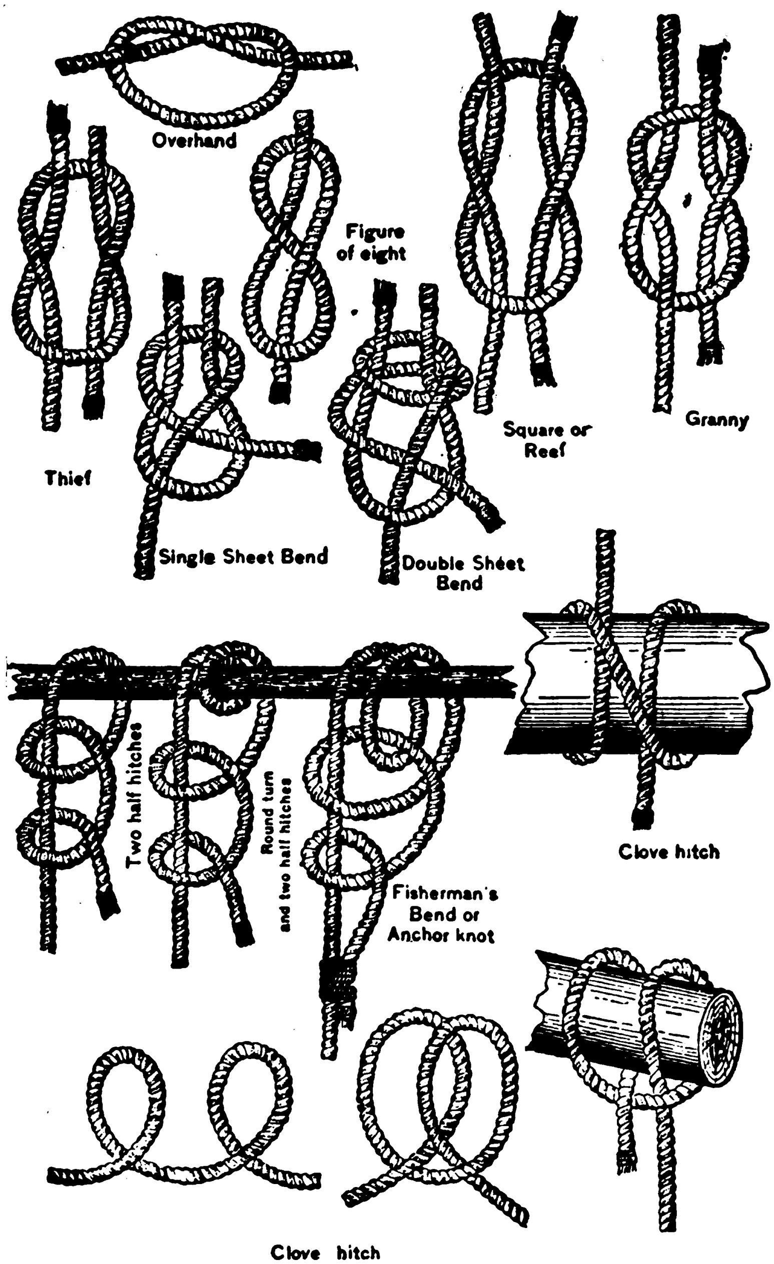



FIGURE 185.—Types of knots—hitches, bends, overhand, etc.

*Q.* What general precautions should be taken in using the screw jack? *A.* It must never be screwed out to the full extent in raising a weight. The threads must be kept clean, lubricated, and free from burs. The jack should not be used to lift weights greater than its rated capacity.

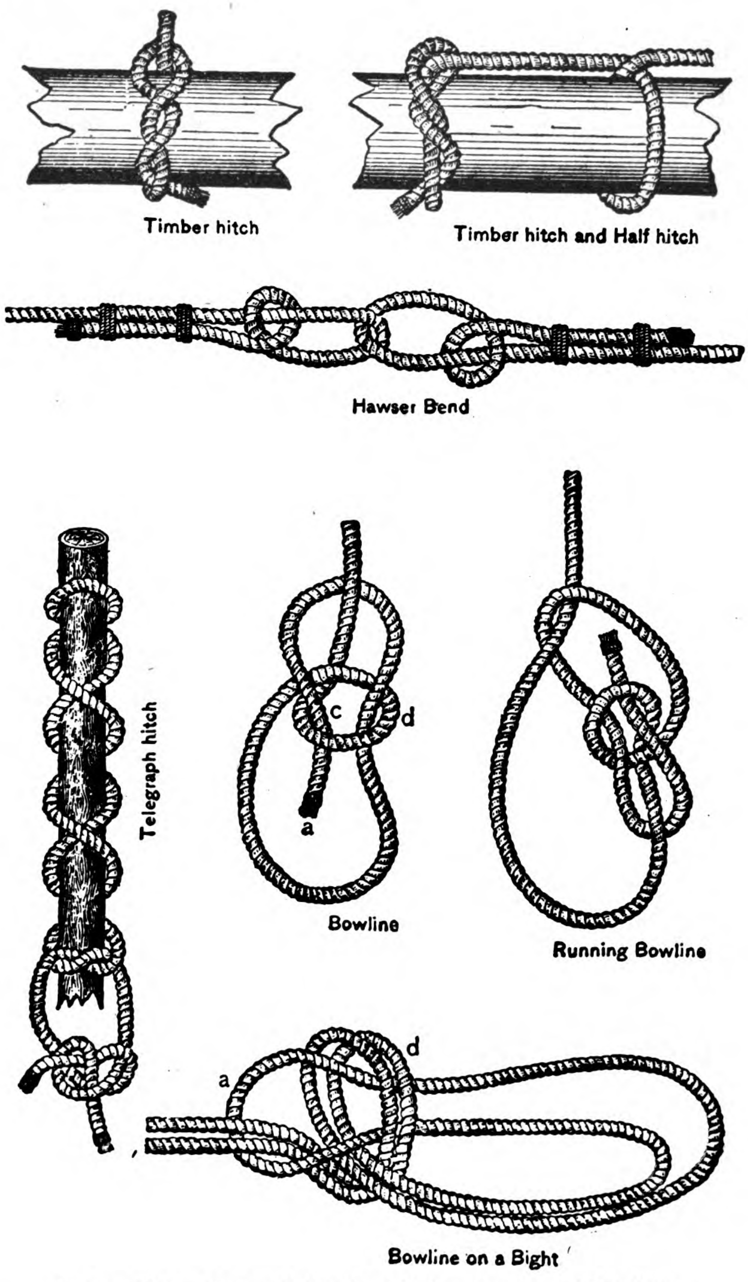



FIGURE 186.—Types of knots—hitches, bends, and bowlines.

**117. Blocks and wayplanks.**—*Q.* What are the requirements of blocks? *A.* Blocks should be sound, free from knots, unpainted, and free from grease. Edges should not be splintered or rounded.

*Q*. What precaution should be used in erecting a crib? *A*.

(1) The foundation should be level.

(2) Large enough blocks should be selected.

(3) The blocks should then be laid crossing each other in alternate tiers, and the weights supported should be made to bear equally upon all sides of the base.

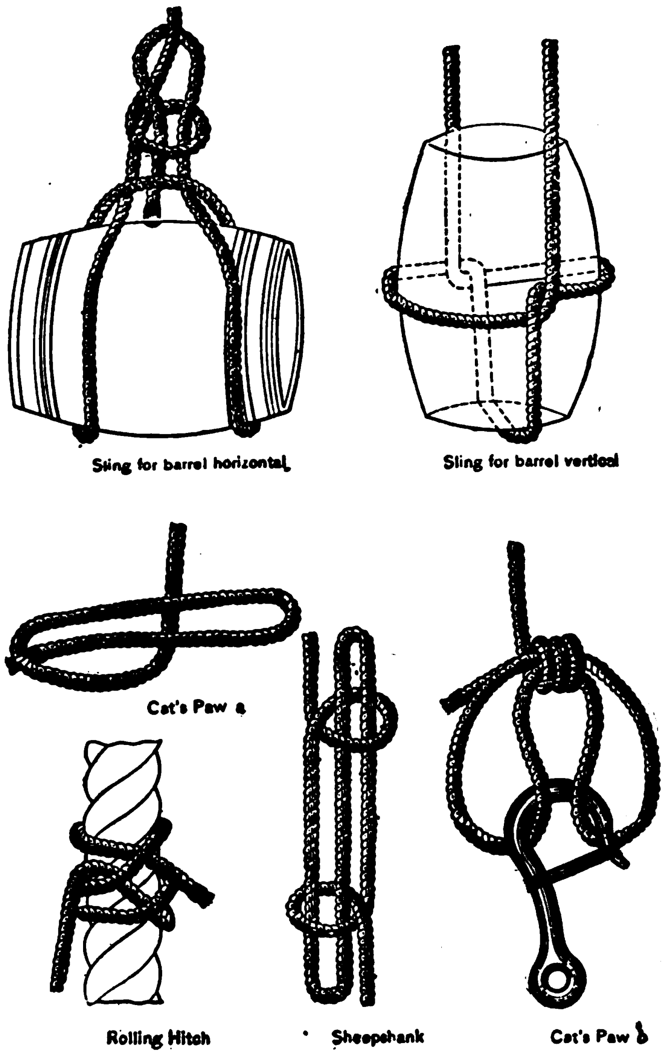



FIGURE 187.—Miscellaneous knots.

*Q*. What is a wayplank and how is it used? *A*. A wayplank is a hard plank, preferably of oak, usually about 15 feet long, 12 inches wide, and 3 inches thick. Each end is beveled for a distance of 6 inches, the bevel on one end being on the side opposite the bevel on the other end. These planks are used chiefly for forming temporary tramways for rollers, or for the wheels of carriages bearing heavy weights, especially in crossing weak bridges.

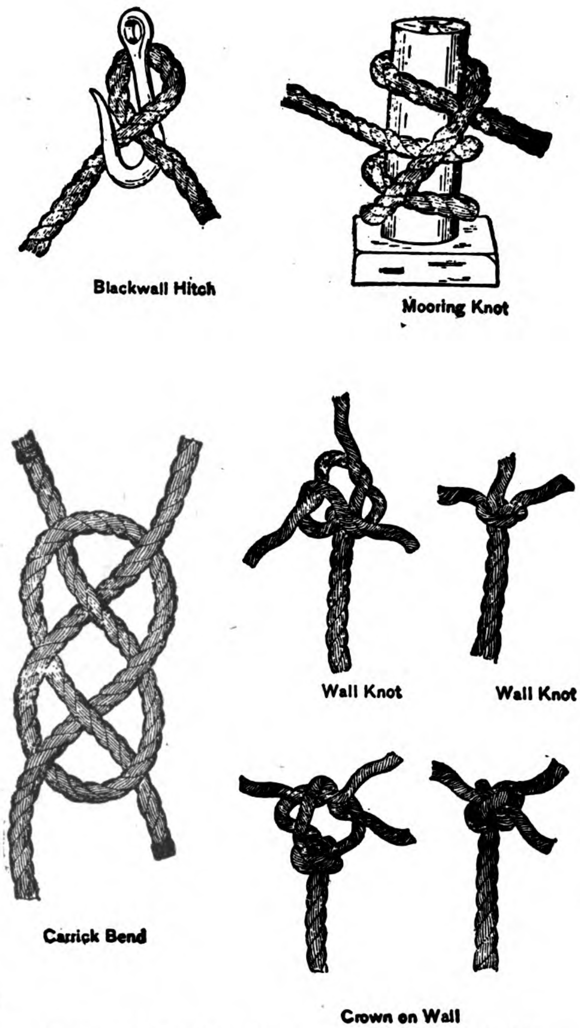



FIGURE 188.—Miscellaneous knots and hitches.

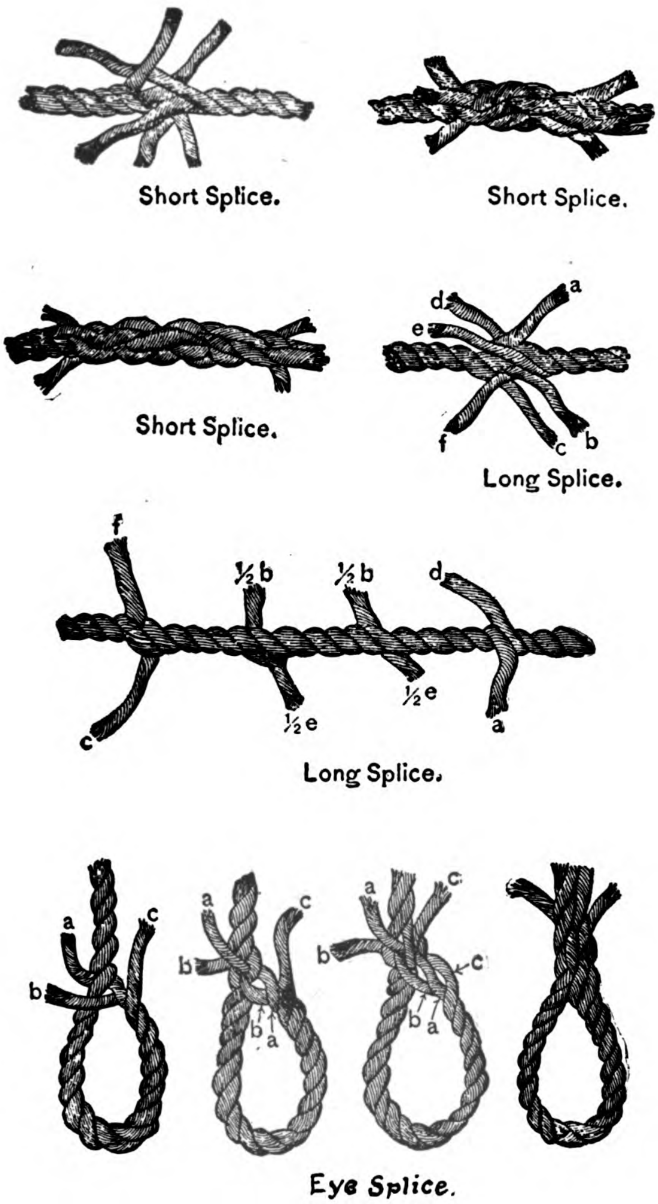



FIGURE 189.—Splices.

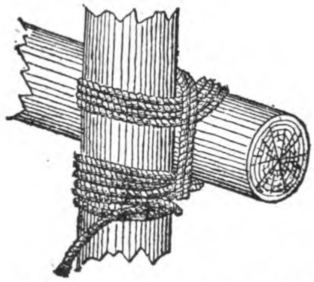


FIGURE 190.—Square lashing.

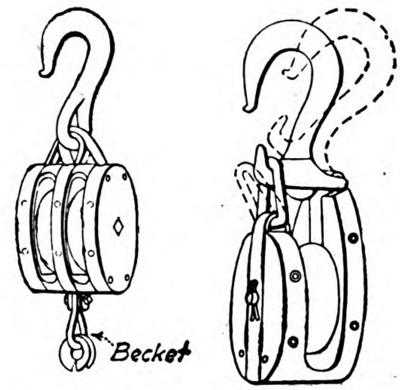



FIGURE 191.—Double wooden block and snatch block.

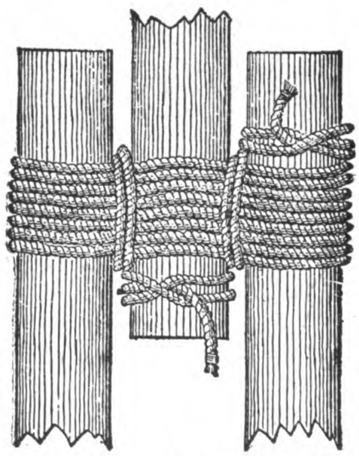
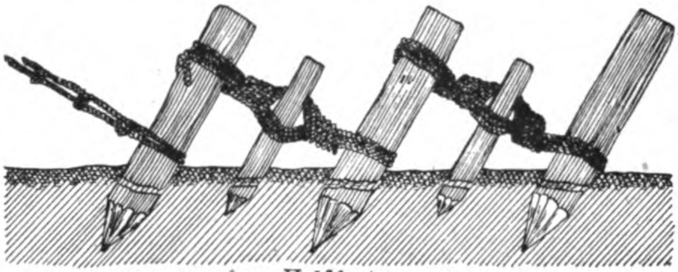


FIGURE 192.—Lashing for tripod.



Holdfasts.

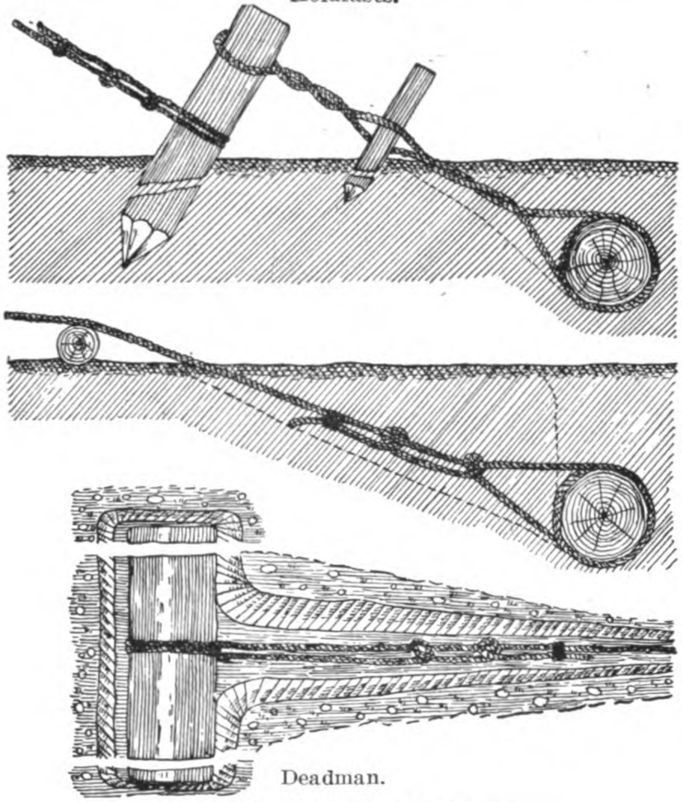



FIGURE 193.—Anchorages.

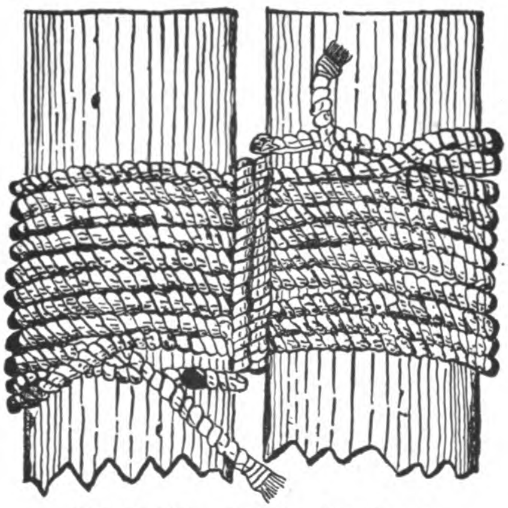


FIGURE 194.—Lashing for shears.

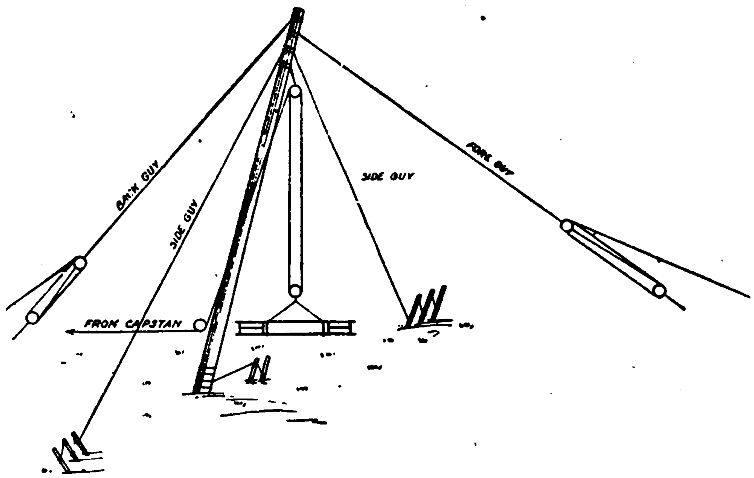



FIGURE 195.—Gin pole.

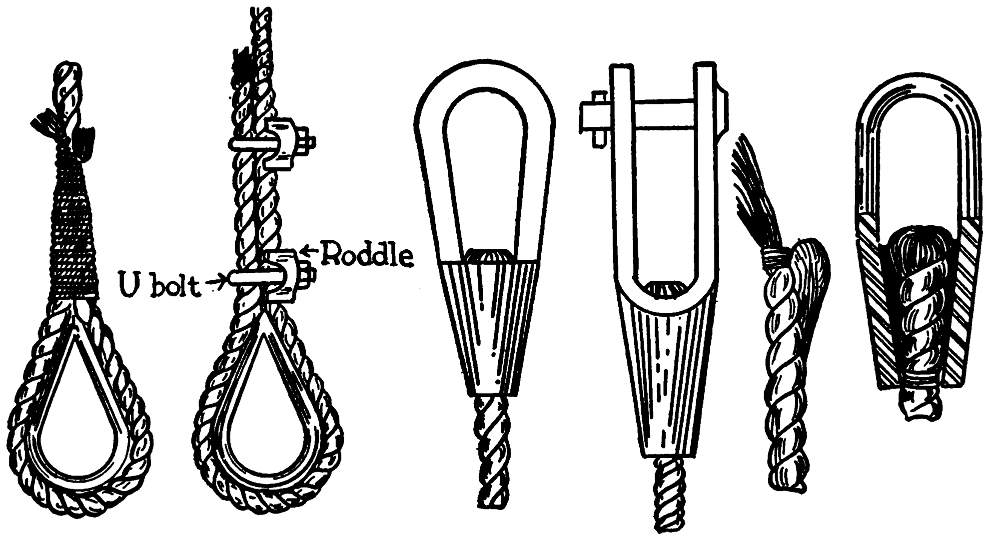



FIGURE 196.—Wire rope fittings.

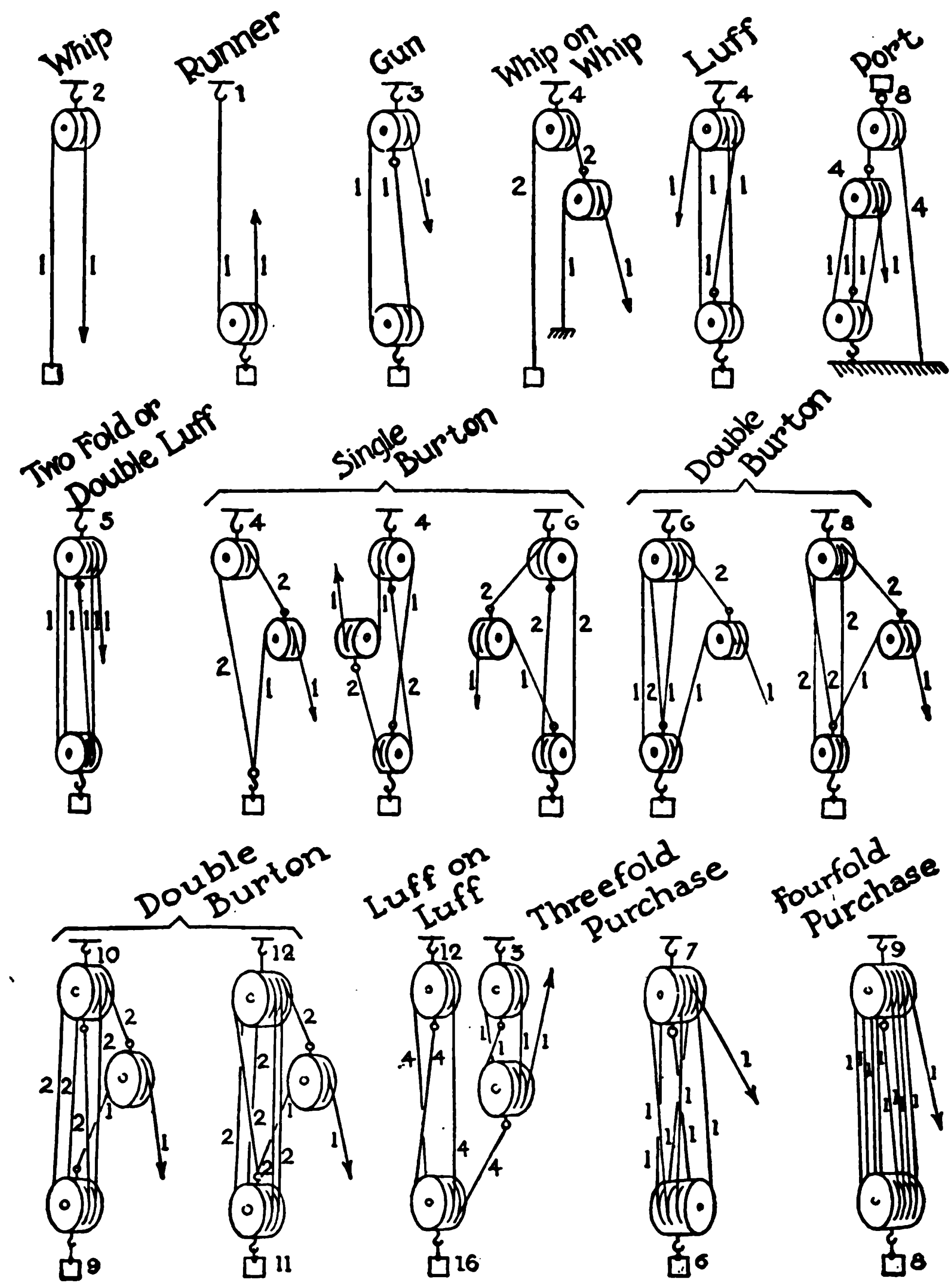



FIGURE 197.—Block and tackle combinations.

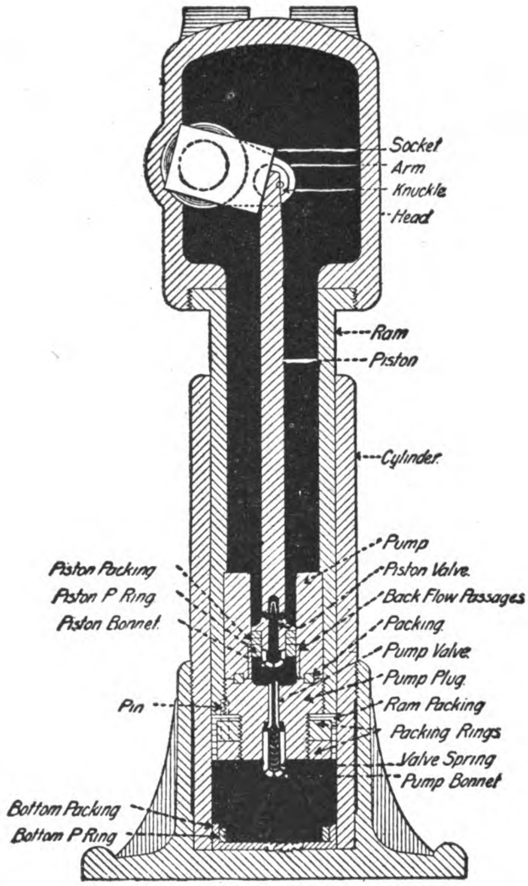



FIGURE 198.—Base jack.

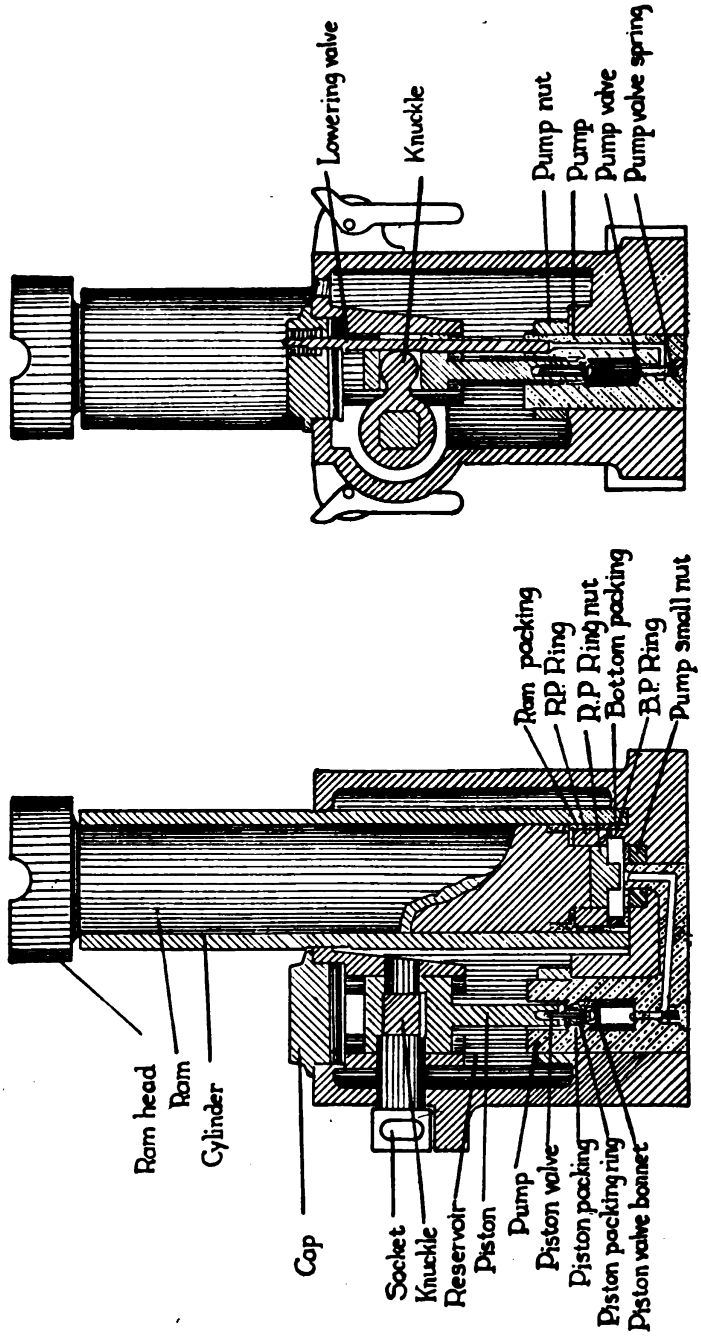



FIGURE 199.—Horizontal hydraulic jack.

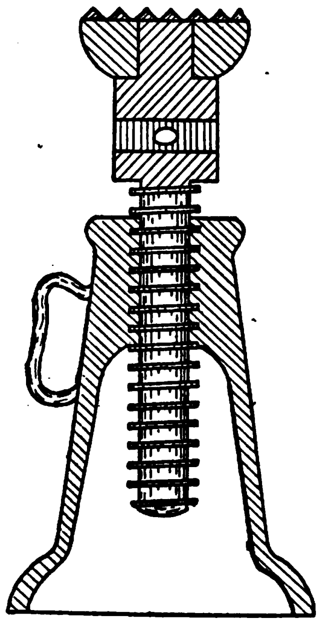


FIGURE 200.—Screw jack.

SECTION V

## NOMENCLATURE OF RAILROAD TRACK MATÉRIEL; PACKING JOURNAL BOXES; BRAKE MECHANISMS; BUFFERS AND COUPLINGS



**118. Nomenclature of railroad track matériel.**—*Q.* What are the main parts of a railroad track? *A.* Steel rails, cross ties, splice bars, bolts, ballast, and roadbed.

*Q.* What is ballast? *A.* Crushed rock, slag, gravel, cinders, etc.

*Q.* Why is ballast used? *A.* Mainly to keep water drained away from the ties and prevent their rotting.

*Q.* What are cuts and fills in railroad work? *A.* A cut is an excavation, made to lower the roadbed below the ground surface. A fill is an embankment, made to raise the roadbed above the ground surface.

*Q.* Point out and state the use of the following common track tools:
*Track gage.*—To measure the distance between rails.
*Track level.*—To check the level of the track.
*Track jack.*—To raise the track.
*Clawbar.*—To pull spikes.
*Crowbar.*—To lift and pry rails and ties.

*Track wrench.*—To tighten bolts.
*Rail tongs.*—To lift and carry rails.
*Tamping bar.*—To tamp ballast under ties.
*Spike hammer or maul.*—To drive spikes.
*Cold chisel.*—To cut bolts, rails, and other parts.

*Q.* What is a switch? *A.* A device of fixed and movable rails used to turn out rolling equipment from one track to another.

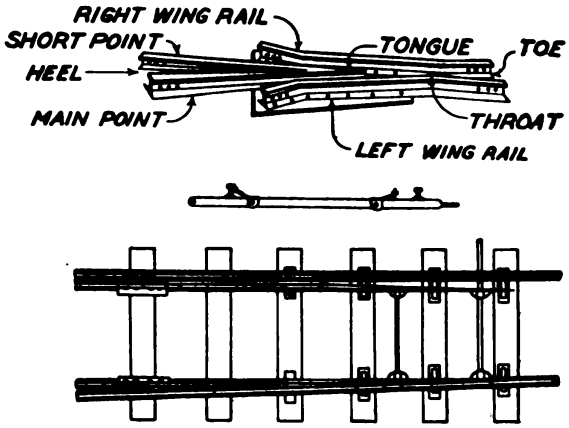



FIGURE 201.—Split switch and frog.

*Q.* What are the main parts of a switch? *A.* One pair of switch points or leads; slide plates for the switch points to move on; connecting rods or switch rods to hold the switch points together and at gage; ground throw or switch stand to throw the switch.

*Q.* What is a railway frog? *A.* A device used where two running rails intersect and providing flangeways to permit wheels and wheel flanges on either rail to cross the other.

*Q.* What is a turnout? *A.* A track arrangement consisting of switch and frog with connecting and operating parts, and extending from the point of the switch to the heel of the frog, by means of which engines and cars may pass from one track to another.

*Q.* What is a guard rail? *A.* It is a section of rail placed beside a track rail to keep the wheel flanges on the proper rail. The ends of the guard rail bend away from the track rail. When used in a turnout, guard rails are placed opposite the frog on the inside of the rails opposite to those in which the frog is placed.

*Q.* What are splice bars? *A.* Splice bars are fastenings used to connect two rails together to form a continuous rail.

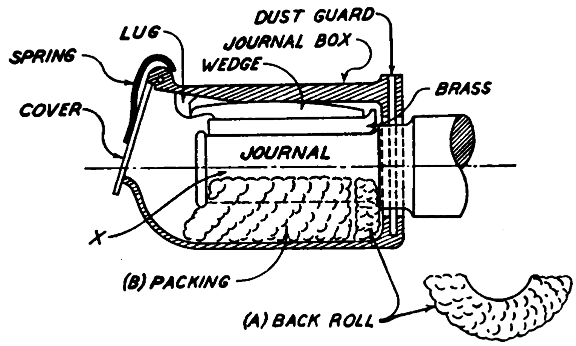
*Q.* What is the gage of a railroad track? *A.* The distance from the inside of one rail to the inside of the other rail.

*Q.* What is standard gage? *A.* 4 feet 8½ inches.

**119. Packing journal boxes.**—*Q.* What is a journal? *A.* The end of the axle where it is machined for the bearing.

*Q*. What is the journal box? *A*. The iron box which covers the journal, bearing, and stop wedge and holds the oily waste which lubricates the bearing.

*Q*. What packing is used for lubrication of journal bearings? *A*. Wool waste for locomotives, tenders, gun cars, and ammunition cars. Cotton waste is used for other cars.




A. Back roll.
B. Body of packing.
X. Top of packing not less than ½ inch nor more than 1 inch below center line of journal.

FIGURE 202.—Packing a journal box.

*Q*. Explain how packing is prepared for use in journal boxes. *A*. The waste is loosened thoroughly, placed in a saturating vat, and kept completely submerged in new car oil at a temperature of not less than 70° F. for a period of at least 48 hours to insure thorough saturation. It is then drained, for the purpose of removing the excess oil, until the packing is in a resilient or elastic condition. Oil should not drip from drained packing when lifted from the drain rack, but oil should flow from it when squeezed by hand.

*Q*. What should be done to a journal box before packing it? *A*. The oil cellar should be thoroughly cleaned of all dirt, sand, scale and grit, and if water is present it should be removed. Boxes should also be inspected for cracks which might cause oil leakage.

*Q*. Describe how to pack a journal box. *A*.

(1) *Back roll.*—Insert a back roll and work it back under the journal to the extreme back part of the box, as shown at *A*, figure 202. Make sure that the roll is well up against the journal, so as properly to lubricate the fillet at the end of the journal and keep out the dust. Rolls about 3 inches in diameter insure good contact. To form the roll, the necessary amount of dry packing is laid on a flat surface and then rolled to the length for a given journal, properly twisted and then wound with twine and tied to hold its shape. The roll is to be soaked in oil and drained the same as other packing.

(2) *Body of packing.*—Apply sufficient packing, preferably in one piece, to fill firmly the space *B*, figure 202, under the journal so as to prevent settling away, care being taken to have packing bear evenly along the full length of the lower half of the journal. This is best accomplished by placing the packing across the full width of the mouth of the journal box, and allowing the strands to hang down outside, always adding more packing before placing the hanging strands inside the box. The top of the packing should not be less than ½ inch nor more than 1 inch below the center line of the journal, along the sides, to insure against waste rolling under the bearing. By placing the packing under the journal until the front or outer edge of the collar is reached, the front end of the packing then presents an inclined surface toward the front of the box. No loose ends or threads should protrude at the sides or ends, such ends being carefully tucked under the sides of the packing; nor should any pieces of packing be laid along the side of a journal, as such pieces may become caught under the bearing and cause a hot box.

**120. Brake mechanisms.**—*Q.* Show how a hand brake is set, locked, and released. *A.* Actually perform this, or describe as follows: Turn the handwheel as far as possible in a clockwise direction. Lock by putting the pawl in the ratchet with the foot. Release by turning the handwheel a little tighter and kicking out the pawl. If necessary, turn the handwheel in the opposite direction.

*Q.* What other kind of brake is used? *A.* The automatic air brake operated by compressed air. It is automatic because if the air line is cut, the brake will set.

*Q.* How may the air brake be released? *A.* By pulling the valve release rod at the side of the car and allowing the air to escape.

*Q.* How is the air hose coupling between two cars made? *A.* After the cars have been coupled, bend the ends of the hose up so that the flanges of the fittings will fit together. When the hose is released it bends downward and the cams force the two fittings together, making an airtight joint. Cut in the air *slowly* by opening angle cock on the train line. See that the angle cocks on both cars are open.

*Q.* How is the air hose uncoupled? *A.* Close the angle cocks on both cars. Lift the hose until the cams on both fittings release. *Never uncouple cars without first uncoupling air hose.* It is possible for the train to pull the air hose couplings apart, but this is apt to damage hose or fittings.

**121. Buffers and couplings.**—*Q.* What is a coupler? *A.* A device for connecting railway cars together. The coupler consists of a shank, head, knuckle, horn, and uncoupling lever.

*Q*. What is a draft gear? *A*. A device made up of draft and coupler attachments, used to transmit pushing or pulling force from one car to another, and to absorb excessive shocks that might be destructive to the car.

*Q*. What types of draft gears are used? *A*. Spring and friction draft gears.

*Q*. What type draft gear is used on gun and ammunition cars? *A*. Friction type.

*Q*. What principle is used in the construction of a friction type draft gear? *A*. The excessive shocks of pulling or buffing are absorbed by a combination of steel blocks and wedges which cause a variable friction coefficient according to the amount of displacement of the drawbar.

*Q*. How are cars coupled and uncoupled? *A*. Pull the uncoupling handle as far out as possible, or turn it, depending on type. This is the bar at the end of the car, which is connected with the uncoupling lever. A short pull on the uncoupling lever handle releases the knuckle so that it is free to turn on its pivot in the head. Continuing the pull throws the knuckle about its pivot so that the knuckle of the other coupler can engage it. To uncouple two cars, pull or turn the uncoupling lever handle on one car enough to release the knuckle. As soon as one car has moved away from the other, the knuckle will turn on its pivot, allowing the cars to separate.

## SECTION VI

## MAP READING



**122. Scales, contours, and conventional signs.**—*Q*. What is a map? *A*. A map is a picture of an area of ground, showing certain important features accurately to scale.

*Q*. Do the features shown on a map appear as they do on the ground? *A*. No. They are represented by symbols called conventional signs, which resemble the actual features as nearly as practicable.

*Q*. What it a topographical map? *A*. One which (according to its scale) shows all the natural and artificial features of the terrain, such as hills, valleys, streams, woods, roads, towns, houses, and bridges.

*Q*. What is a military map? *A*. A military map is one which shows particularly those features, and conveys that information, which are important for military purposes.

*Q*. What is meant by map reading? *A*. Map reading is the art of understanding the information given by the map.

*Q*. What is meant by the scale of a map? *A*. The scale of a map is the relation between any distance shown on the map and the corresponding distance on the ground. It is always the same for any one map.

*Q*. How is the scale of a map indicated or expressed? *A*.

(1) As a *representative fraction* (*RF*), such as 1/5000 (or 1:5000), which means that any distance on the map is 1/5000 of the corresponding distance on the ground The RF is always expressed with a numerator of unity. The RF is always the ratio of a map distance to the actual or ground distance it represents. Thus if 2 inches on the map represent 10 miles on the ground, the relation can be expressed thus:

$$\frac{\text{Map distance}}{\text{ground distance}}=\frac{\text{2 inches}}{\text{10 miles}}$$

Reduce the numerator and denominator to the same unit, and then reduce the numerator to *unity* to get the RF, as follows:

$$\frac{\text{2 inches}}{\text{10 miles}}=\frac{\text{2 inches}}{\text{10 miles}\times\text{5280 ft.}\times\text{12 inches}}=\frac{\text{2 inches}}{\text{633,600 inches}}=\frac{1}{316{,}800}=RF.$$

(2) In *words and figures*, such as 6 inches=1 mile, meaning that 6 inches on the map represent 1 mile on the ground. From this the RF can be easily found, thus:

$$\frac{\text{6 inches}}{\text{1 mile}}=\frac{\text{6 inches}}{\text{1 mile}\times\text{5280 ft.}\times\text{12 inches}}=\frac{\text{6 inches}}{\text{63, 360 inches}}=\frac{1}{10{,}560}=RF.$$

(3) By a *graphical scale* drawn on the map, which shows ground distances in their usual units, such as miles, thousands of yards, or hundreds of feet, as they appear on the map. A graphical scale is easily made if RF of the map is known. Thus, suppose the RF is 1:5000 and a graphical scale to read to 1,000 yards is desired. Since any distance on the map is 1/5000 of the same distance on the ground. 1,000 yards on the map will be as follows:

$$\frac{\text{1000 yards}}{5000}=\frac{\text{1 yard}}{5}=\text{0.2 yard}=\text{0.2 yard}\times\text{36 ins.}=\text{7.2 inches}$$

that is, one 1,000-yard division of the scale will be 7.2 inches long. This can be divided into 10 equal parts, each of which will represent 100 yards. (See fig. 205 for examples of graphical scales.)

*Q*. Why do we have maps of different scales? *A*. The scale of a map must be large enough to show the particular features about which we need information. Thus, a map showing the positions of all buildings and streets in a town must be of much larger scale than a map intended only to show the size and positions of the various counties in a State. A small scale map is one which shows a large area in a small space. Thus 1 inch = 100 miles would be a very small scale map on which very little detail could be shown. A map on a scale of 1 inch = 25 feet would be a very large scale map on which individual trees could be shown in their exact positions. The first map could be used by a general planning a large campaign, the second by an architect laying out a plan of a house and grounds.

*Q*. What determines the proper scale of a map? *A*. It should be just large enough to show the detail necessary to serve the purpose for which it is to be used.

*Q*. How do you determine direction on a map? *A*. By referring to an arrow on the map which points due north. It is called the meridian.

*Q*. How is direction measured and indicated on a map? *A*. By azimuth as in gunnery. Azimuth on a map is measured from the north point of the meridian, clockwise around the horizon. It is measured in degrees, minutes, and seconds, or in mils.

*Q*. What are the cardinal points of direction, and what are their azimuths? *A*. North, east, south, and west. Moving clockwise around the horizon: north, the origin, is azimuth 0°; east is azimuth 90°; south is azimuth 180°; west is azimuth 270°.

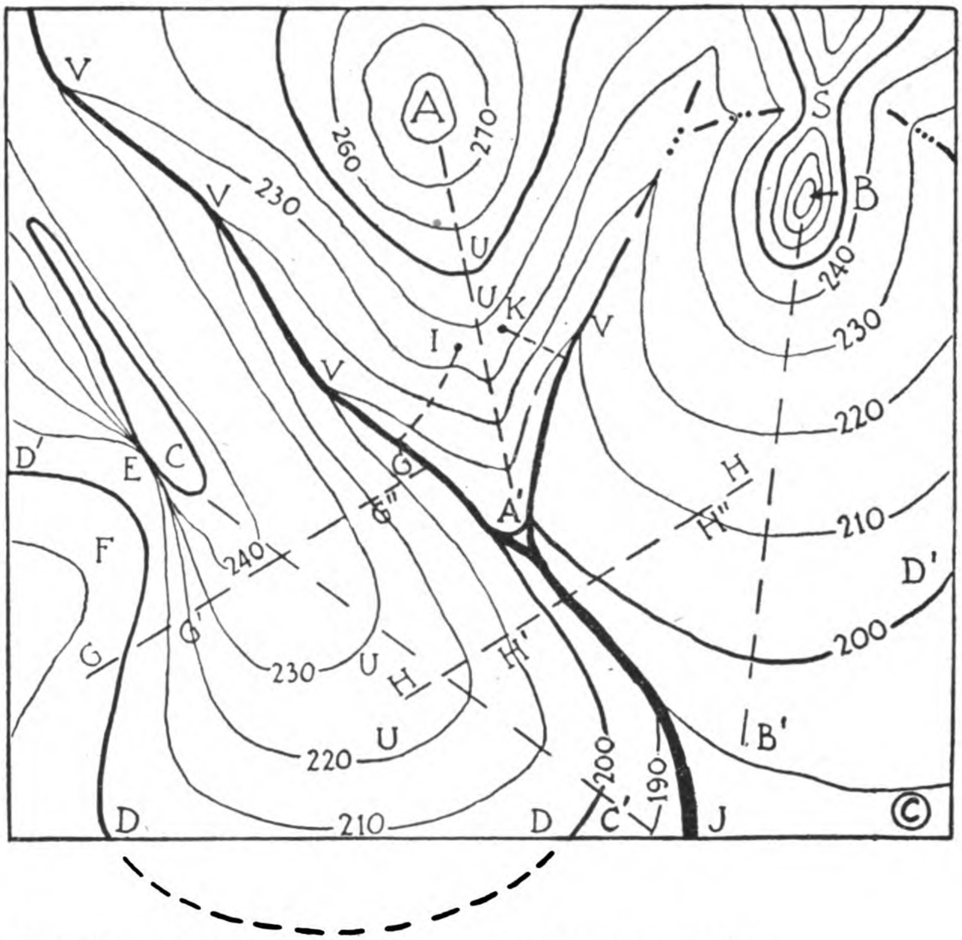
*Q*. What is meant by orienting a map? *A*. Placing the map in such a position that the meridian or arrow on the map points to north on the ground. Every line on the map will then be parallel to the line on the ground which it represents, and all the features on the map will be in the same relative positions as the actual objects on the ground.

*Q*. What is elevation? *A*. The elevation of any point is its vertical height in feet above some level, usually sea level.

*Q*. How is elevation indicated on a map on a flat piece of paper? *A*. By means of contours.

*Q*. What is a contour? *A*. An irregular line joining all points at the same elevation. A contour is thus a level or horizontal line.

*Q*. How are contours separated vertically? *A*. By some definite interval, such as 5, 10, 20, 50, or 100 feet, depending on the scale of the map and the nature of the ground. This constant interval is known as the vertical interval or contour interval of the map. Certain contours are numbered with their height (in feet) above sea level.




| | |
|---|---|
| A, B. Hilltops or peaks. | IG. Line of steepest slope. |
| C. Ridge. | B. Steep slope. |
| DD. Contours close on themselves. | B'. Gentle slope. |
| E. Cliff. | S. Saddle. |
| AA'. Uniform slope. | UU. Hill contours. |
| BB'. Concave slope. | VV. Valley contours. |
| CC'. Convex slope. | A'. Stream junction. |

FIGURE 203.—Typical ground forms as shown by contours.

*Q.* Do contours show the ground forms, such as hills, valleys, and ridges? *A.* Yes. When one has become familiar with them they show accurately all the forms of nature.

*Q.* Mention briefly the principal characteristics of contours. *A.*

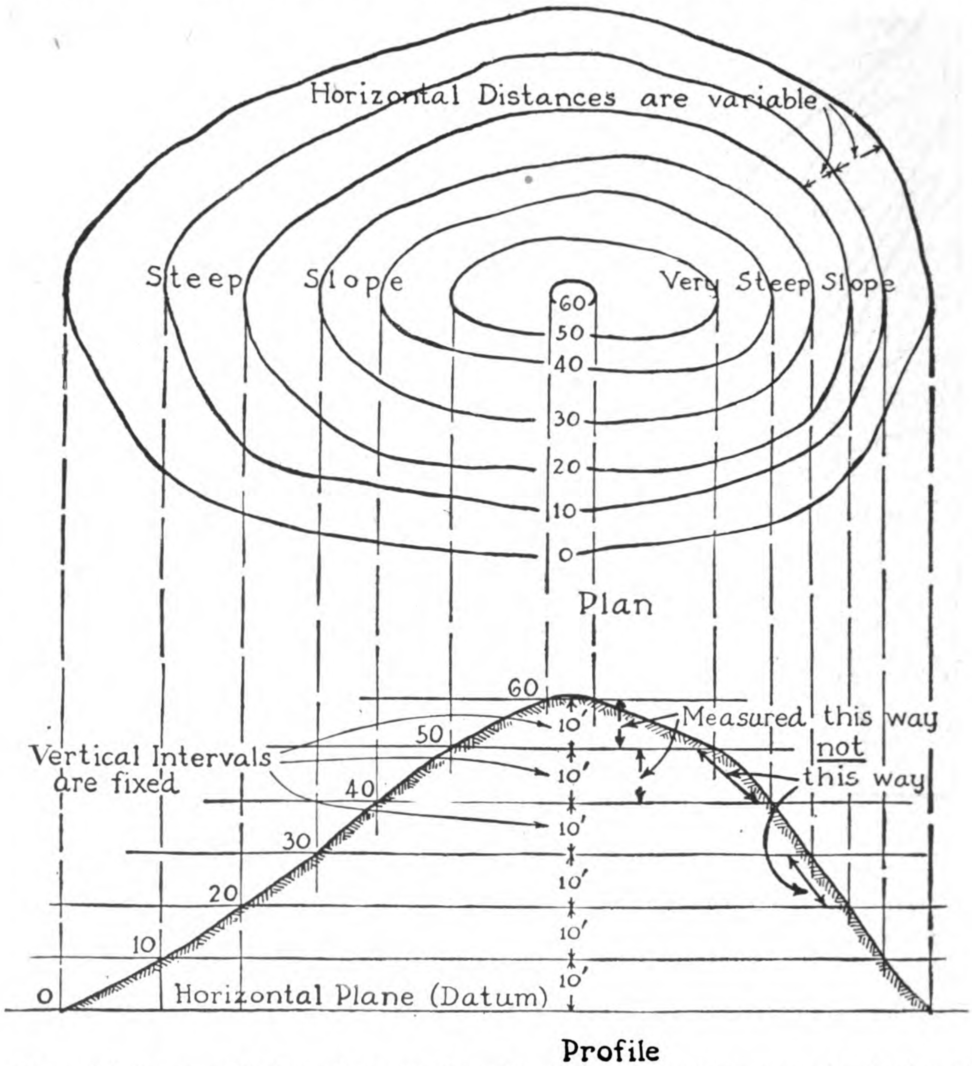
(1) A contour is a horizontal line joining points of equal elevation.

(2) Contours are spread at uniform vertical intervals.

(3) Every contour is a continuous closed curve. (It may not close within the limits of the map.)

(4) There may be any number of separate contours of the same elevation.

(5) A small, closed contour indicates either a hilltop or a depression.




The contours are the lines that would be left on the ground by successive horizontal slices, 10 feet thick.

FIGURE 204.—Plan and profile of a hill.

(6) Contours never touch or cross each other except in the case of a vertical or overhanging cliff.

(7) Contours are at right angles to the lines of steepest slope.

(8) The horizontal spacing of contours indicates the degree of slope, steep if they are close together, gentle if they are far apart. They also indicate the kind of slope, uniform, concave or convex.

(9) Valley contours are usually of V-shape, and hill or ridge contours of U-shape.

(10) Adjacent contours resemble each other.

*Q*. How is the elevation of a point between two contours determined? *A*. By its relative distance from the contours on either side. Thus in figure 205, the elevation of the number "46" is about 527 feet.

*Q*. Point out the characteristic ground forms in figure 203 and explain how they are shown by the contours. *A*. See figure 203.

*Q*. What is a slope? *A*. The inclination of ground to the horizontal. The slope of a road is called its grade.

*Q*. How can you determine the average grade of a length of road from a contoured map? *A*. Measure the horizontal distance along the road in feet, using the scale of the map. Find from the contours the difference in elevation between the two ends. The difference in elevation of the two ends, divided by the length of the road (both in feet), will give the average grade in percent.

*Q*. How is a steep grade indicated on a map? *A*. By contours close together, showing a considerable change of elevation in a short distance.

*Q*. What is a profile? *A*. It is a section of the ground as it would appear if it were sliced vertically with a huge knife.

*Q*. Give a simple method of making a profile. *A*. To make a profile of the hill shown in figure 204, along the line of the words "steep slope, very steep slope," draw a number of parallel lines at uniform intervals, as in the lower figure, numbering them at 10-foot intervals from 0 to 60 feet (the limiting elevations of the hill). Mark each point where a contour cuts the line "steep slope," and project these points vertically down to the correspondingly numbered lines. Join the points thus found by a line. It will be the contour of the hill on the line "steep slope."

*Q*. What are conventional signs? *A*. They are the symbols used by map makers to show the various features of the terrain. As nearly as practicable they resemble or suggest the features they are intended to show.

*Q*. Point out and name the conventional signs shown in figure 205. *A*. See figure 205.

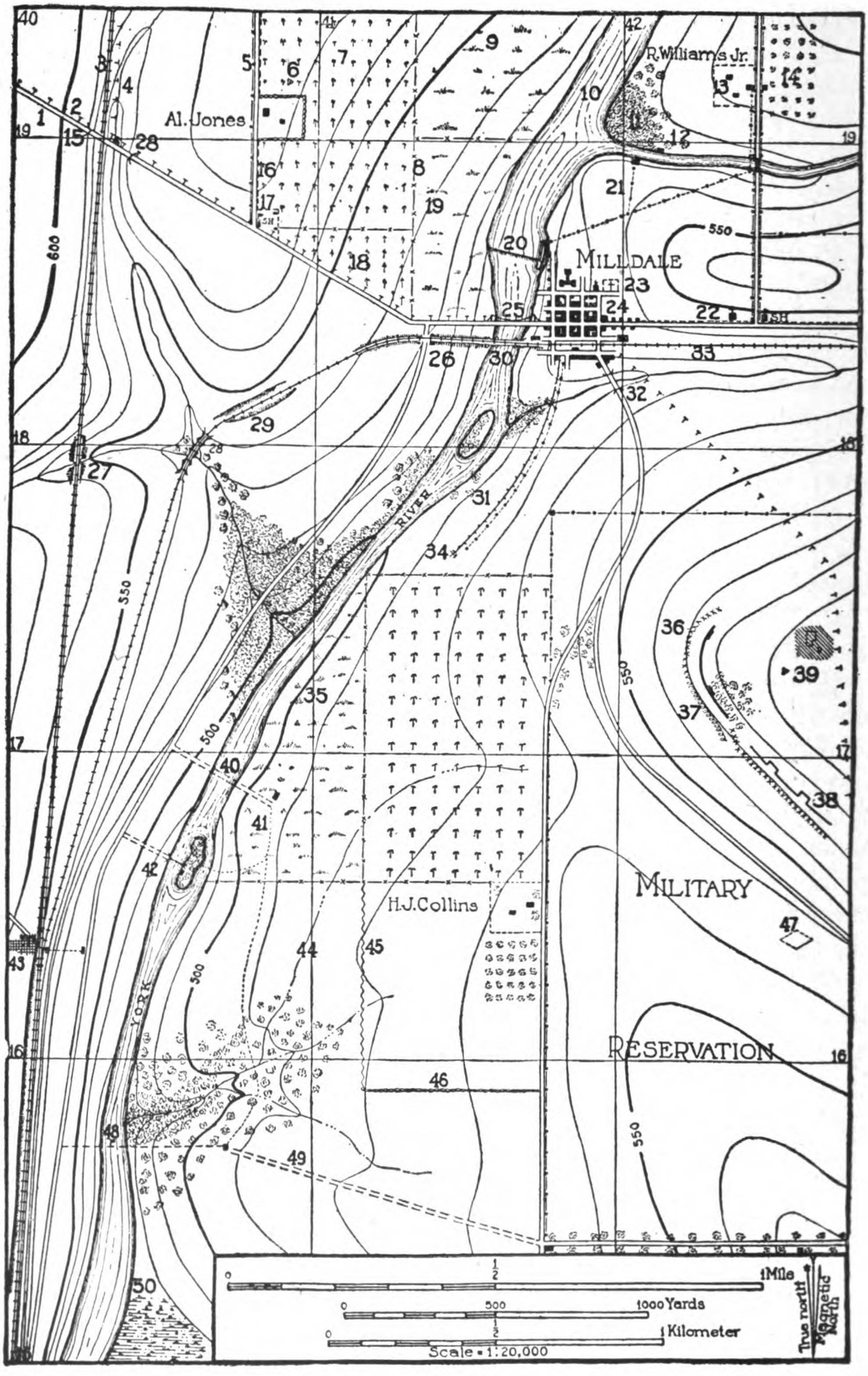
*Q*. What colors are used on standard topographical maps and what do these colors mean? *A*. Colors are used to show certain classes of features. On the standard topographical map they show the following:

*Black.*—All artificial features, such as houses and roads.

*Blue.*—All water, such as streams, ponds, lakes.

*Green.*—Vegetation, such as woods and grassland.

*Brown.*—The ground forms as shown by contours.


Al. Jones
R. Williams Jr.
MILLDALE
RIVER
YORK
H.J. Collins
MILITARY
RESERVATION
600
550
500
1 Mile
1000 Yards
1 Kilometer
Scale • 1:20,000
True north
Magnetic North

*Numerical key*

1. Good motor road.
2. Telephone or telegraph line.
3. Double track standard gage railroad.
4. Stream or creek (blue on a four-color map).
5. Fence, smooth wire.
6. Triangulation point or primary traverse station.
7. Corn field.
8. Fence, barbed wire.
9. Tall tropical grass.
10. River (blue on a four-color map).
11. Woodland (deciduous trees).
12. Lone trees.
13. Buildings in general.
14. Orchard.
15. Railroad crossings, railroad beneath.
16. Fence of any kind (or board fence).
17. Schoolhouse.
18. Cultivated field, sugarcane.
19. Grassland in general.
20. Dam.
21. Electric power transmission line.
22. Church.
23. Cemetery.
24. City, town, or village.
25. Bridge, suspension.
26. Railroad crossing, railroad above.
27. Fill.
28. Bridge, steel.
29. Cut, railroad.
30. Bridge, truss, for standard gage railroad.
31. Narrow gage railroad.
32. Bridge, highway.
33. Railroad, single track, standard gage.
34. Mine or quarry of any kind (or open cut).
35. Pasture or grassland in general.
36. Wire entanglement.
37. Low or concealed entanglement.
38. Trenches (dotted when proposed).
39. Demolitions.
40. Ford, general symbol for vehicle ford.
41. Good pack trail or foot path.
42. Bridge, foot.
43. City, town, or village (generalized).
44. Intermittent stream.
45. Worm fence.
46. Stone fence.
47. Tank trap.
48. Equestrian ford.
49. Road, poor motor or private.
50. Marsh in general.

*Alphabetical key*

| | |
|---|---|
| Bridge, foot | 42 |
| Bridge, highway | 32 |
| Bridge, highway, made of steel | 28 |
| Bridge, suspension | 25 |
| Bridge, truss | 30 |
| Buildings in general | 13 |
| Cemetery | 23 |
| Church | 22 |
| City, town, or village (generalized) | 43 |
| Combination showing city, town, or village | 24 |
| Crossing, railroad (railroad above) | 26 |
| Crossing railroad (railroad beneath) | 15 |
| Cultivated field, corn | 7 |
| Cultivated field, sugarcane | 18 |
| Cut | 29 |
| Dam | 20 |
| Demolitions | 39 |
| Electric power transmission line | 21 |
| Fence of any kind (or board fence) | 16 |
| Fence, barbed wire | 8 |
| Fence, smooth wire | 5 |
| Fence, stone | 46 |
| Fence, worm | 45 |
| Fill | 27 |
| Ford, equestrian | 48 |
| Ford, for vehicles | 40 |
| Grassland in general | 19 |
| Grass, tall tropical | 9 |
| Marsh in general | 50 |
| Mine or quarry of any kind (or open cut) | 34 |
| Orchard | 14 |
| Pasture or grassland in general | 35 |
| Railroads, double-track, standard-gage | 3 |
| Railroad, narrow-gage | 31 |
| Railroad, single-track, standard-gage | 33 |
| River (blue on a four-color map) | 10 |
| Road, good motor | 1 |
| Road, poor motor or private road | 49 |
| Schoolhouse | 17 |
| Stream or creek, intermittent | 44 |
| Stream or creek (blue on a four-color map) | 4 |
| Tank trap | 47 |
| Telephone or telegraph line | 2 |
| Trail or footpath | 41 |
| Trees, lone | 12 |
| Trenches (dotted when proposed) | 38 |
| Triangulation point or primary traverse station | 6 |
| Wire entanglement (low or concealed) | 37 |
| Wire entanglement | 36 |
| Woodland (deciduous trees) | 11 |

FIGURE 205.—Conventional signs.

**123. Location of position by coordinates.**—*Q.* How are military maps divided? *A.* Into squares 1,000 yards on a side by two sets of parallel lines, one of these sets being at right angles to the other. (See fig. 206.)

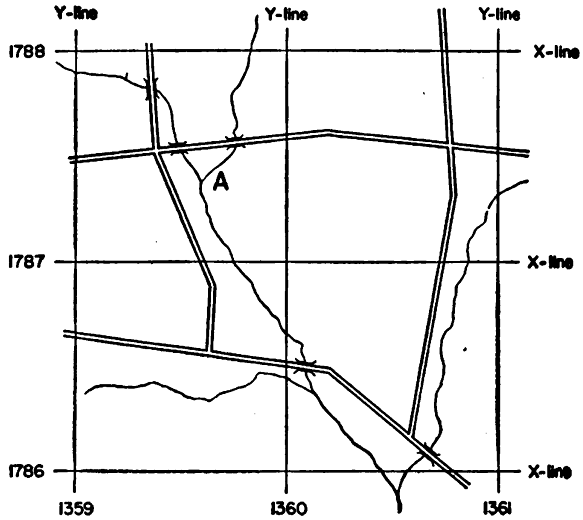



FIGURE 206.—Rectangular coordinates; 1,000-yard grid printed on a terrain map (1:20,000 scale). (Not reproduced to scale.)

*Q.* What is this system of lines or squares called? *A.* A grid system, or system of rectangular coordinates.

*Q.* What is the use of this grid or coordinate system? *A.* It is used to make it possible to describe and locate points on a map by referring their positions to the coordinate lines.

*Q.* What are the coordinate lines running from left to right called? *A.* *X* lines.

*Q.* What are the other coordinate lines called? *A.* *Y* lines.

*Q.* Describe the grid system for the continental United States. *A.* The country is divided into zones running north and south, each covering 9° of latitude. The central true meridian of adjacent zones are 8° apart, hence there is an overlap of 1° at the boundaries, included in both adjacent zones. The west longitudes of the central meridians of the zones are 73°, 81°, 89°, 97°, 105°, 113°, and 121°. In each zone the *Y* lines are all parallel to the central true meridian. The direction of the *Y* line at any point is called grid north; it is the same as true north only at the center of the zone. The *X* lines are perpendicular to the *Y* lines, and so they are true east and west lines only at the center of the zone. In each zone the origin of coordinates, or zero point, is to the west and south of the zone, and hence all coordinates are positive. (See fig. 206.)

*Q.* What is the *X* distance or *X* coordinate of a point on a map?

*A*. The distance of that point to the right of the origin of measurement measured along an *X* line.

*Q*. What is the *Y* distance of *Y* coordinate of a point on a map? *A*. The distance of that point upward from the origin of measurement measured along a *Y* line.

*Q*. What is the origin or point from which measurements are made? *A*. A point off the map to the west and south. The distance from this origin, in thousands of yards, is indicated on each *X* line and each *Y* line.

*Q*. In order to locate a point on a map, what information is useful? *A*. The *X* and *Y* coordinates of that point.

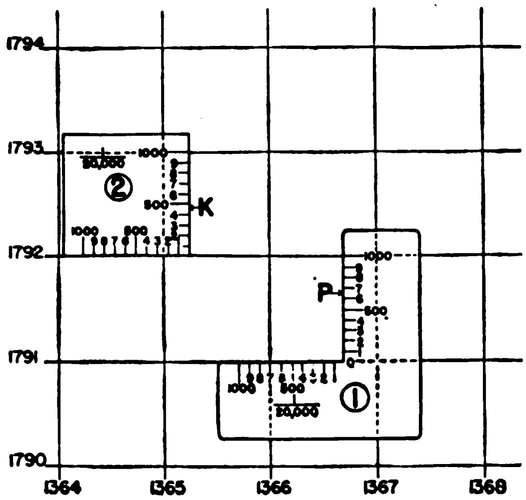



FIGURE 207.—To plot position of point with coordinate scale on terrain map (1 : 20,000 scale) having 1,000-yard grid. (Not reproduced to scale.)

*Q*. In what order are the coordinates of a point always given? *A*. First the *X* coordinate and then the *Y* coordinate.

*Q*. How can their order be remembered easily? *A*. Remember that in the alphabet *X* comes before *Y*, or remember the rule "Read right up."

*Q*. How can one *X* line be distinguished from the other *X* lines or one *Y* line from the other *Y* lines? *A*. Each set of lines is numbered.

*Q*. How are the *X* lines numbered? *A*. In the left- and right-hand margins, increasing upward from the bottom of the map.

*Q*. How are the *Y* lines numbered? *A*. Along the upper and lower margins, increasing from left to right of the map.

*Q*. Is the number of a coordinate line given in the margin of a map the full number of that line? *A*. No. It is only a part of its full number.

*Q*. Are there any coordinate lines on a map that have their full numbers given? *A*. Yes. The first *X* line at the bottom of the map and the first *Y* line at the left of the map.

*Q*. Explain in detail how to read the coordinates of any point on a gridded map. *A*. The coordinates of any square in the grid system are the *X* and *Y* coordinates of the lower left-hand (southwest) corner of the square. The coordinates of the lower left-hand square in figure 207 are (1,364,000–1,790,000) but are usually written (1,364–1,790), it being understood that each number represents thousands of yards. These coordinates also locate to the nearest thousand yards any point in the lower left-hand square of figure 207. To locate a point more closely we can assume that each side of the square in question is divided into 10 equal parts, each of which represent 100 yards. Then the coordinates of the center of the lower left-hand square would be expressed as (1,364.5–1,790.5), which locates the center to the nearest hundred yards in each direction. The method may be further refined to read to the nearest 10 yards.

*Q*. What is a coordinate scale? Explain its use. *A*. A coordinate scale is a right-angled ruler made of thin metal, celluloid, or other material with scales on it equal in length to the grid interval of the map being used (fig. 207). To plot any point on the map, for instance the point *P* of which the coordinates are given as (66.70–91.65), place the coordinate scale on the map in position ① as shown in figure 207. The position of *P* can be marked at once with a pin or sharp pencil. It should be noted here that the first two numbers of the coordinate expression (1366.70–1791.65) have been dropped because they are common to all points in the section of map under consideration. The process of reading the coordinates of a point appearing on the map is the reverse of the method given for plotting a point on the map.

*Q*. How many norths are indicated on an artillery map? *A*. Three: true north, magnetic north, and grid north. (See fig. 206.)

*Q*. Define each. *A*.

(1) True north is geographic north, or the direction of the north pole.

(2) Magnetic north is the direction in which the compass points when used in the area covered by the map. The angular difference between true north and magnetic north is called the magnetic declination.

(3) Grid north is the direction in which the *Y* lines of the coordinate system point.

*Q*. When indicating direction which north is generally used? *A*. Grid north.

*Q*. On what kind of maps is such a system of coordinates usually found? *A*. On topographical maps.

*Q*. What type of maps are often used to cover harbors and water areas? *A*. Coast and Geodetic Survey maps.

*Q*. Do these maps generally have a system of grid coordinates? *A*. No. There is, however, a local system of grid coordinates placed on these maps so points can be located in the same way.

*Q*. What do these maps show? *A*. Coast line, channels, depths of water, location of lights, channel markers, and certain permanent features of the terrain along the shore.

NOTE.—In addition the candidate should be required to give the coordinates of several points on a map.

**124. Following route indicated on map.**—*Q*. How is a route, selected from a map, usually indicated? *A*. It is indicated by naming successive points along the route that can easily be identified locally.

*Q*. How are the best roads identified on the ground? *A*. Usually they will be paved, and will be wider, straighter, and have easier grades than secondary roads. If not paved they will at least be wide and show signs of traffic. They usually have telegraph or telephone lines running parallel to them. Except in very sparsely settled country the principal roads will also be indicated by signposts at intersections and Federal and State numbers, which are shown on commercial route maps.

*Q*. What points along a route are most easily identified? *A*.

(1) Large towns.
(2) Villages.
(3) Important crossroads or junctions.
(4) Crossings of large streams.
(5) Railroad crossings.
(6) Crests of important hills or ridges.
(7) Passes or gaps through lines of hills.

*Q*. How may an indicated route be traced on a map? *A*. By locating in succession the towns, crossroads, and other important points named.

*Q*. How are crossroads and road junctions indicated on a map? *A*. By numbers sometimes followed by a letter, as 423 or 423–A.

*Q*. How would cross road 418–A be written in indicating a route? Road junction 403? *A*. CR 418–A. RJ 403.

*Q*. To what do the numbers in the previous answer refer? *A*. To the elevation of the cross road or road junction.

*Q*. In case a cross road or junction is not plainly marked on the map, how would it be indicated? *A*. By its coordinates, as CR (4365.5-6427.3) or RJ (7295.4-8665.4).

NOTE.—The candidate should be able to trace out on a map a route that has been indicated to him.

**125. Data as to roads, bridges, fords, grades, and swamps.**— *Q*. What information concerning a road can usually be obtained from a good topographical map? *A*.

(1) The distance between any two points.

(2) Whether or not the road is paved, and often the kind of pavement.

(3) The width of the road, that is, whether narrow, wide, or quite wide.

(4) The steepness and length of important grades.

(5) The stream crossings, whether bridges, fords, or ferries, and sometimes the kind and principal dimensions of bridges; width, depth, nature of bottom, and velocity of current in the case of fords; and the kind of ferry.

*Q*. What is usually the most critical question in the selection of a route? *A*. The stream crossings.

*Q*. How would you decide the question as to whether a certain bridge was safe for the transport accompanying your organization? *A*. Reports on the practicability of all bridges should be secured in advance if possible. If not, the following observations will indicate the safety of bridges in most cases.

(1) Bridges on important routes habitually carry heavy commercial trucks and busses, moving at high speed, and are therefore safe for artillery transport moving slowly.

(2) If a bridge is massive, and reasonably new, or apparently in good condition as to flooring, paint, etc., it is probably safe.

(3) Bridges may be compared with similar bridges that have been crossed. If they look too light or appear to be of older design than other bridges, they should be regarded with suspicion.

(4) If there is any chance that the enemy may have tampered with a bridge, its abutments, piers, flooring, and truss members or cables should be examined to make sure they are intact.

(5) If in doubt about any bridge, send across some lighter vehicle and watch the bridge as it crosses. If there is no excessive sway or vibration the bridge is probably safe for the next heavier load. Send loads across one at a time and at very slow speed.

*Q*. How may the practicability of a ford be determined? *A*. Note the swiftness of the current. Send a line of men to wade across, preferably barefoot, to determine the depths, nature of the bottom, and whether the banks are steep or slippery or both. Some of the lighter vehicles may then be sent across, and these can assist the heavier vehicles by pulling them out on the far side if necessary.

*Q*. In case a bridge or ford proves impassable what should be done? *A*. Detour to another crossing.

*Q*. What in general can you say as to the practicability of routes? *A*. In general, important main routes are practicable for artillery transport; in the case of less important routes it is desirable to have a reconnaissance made in advance by competent experts; any route that lacks a bridge at an important crossing is of doubtful practicability.

**Note.—The candidate should be required to examine a route shown on a map, to give all the information concerning it that can be obtained from the map, and his opinion as to the practicability of the route.**

## Section VII

## ORIENTATION AND RECONNAISSANCE



**126. Orientation.**—*Q*. What is meant by orientation? *A*. As here used it means the determination of length and direction of lines and the location of certain points.

*Q*. What equipment is used with a transit to measure distances and elevations? *A*. Level rods, stadia rods, steel tapes, and tally pins (or marking chalk).

*Q*. What is a level rod? *A*. A rod used with a level or transit to determine the vertical distance of the line of sight of the transit above the point on which the rod rests. As elevations are usually measured in feet, the level rod is graduated in feet and tenths.

*Q*. What is a stadia rod? *A*. A rod used in connection with the stadia wires of the transit to measure horizontal distances. The vertical interval (intercept) on the rod seen between the two horizontal stadia wires in the telescope is read and multiplied by 100 to give the distance from the transit to the rod. Thus a rod intercept of 1.2 feet would correspond to a distance of 120 feet from transit to rod.

*Q*. How are steel tapes graduated? *A*. Steel tapes are made in various lengths and are graduated in feet or meters, sometimes both —feet on one side, meters on the other.

*Q*. What care should be taken of steel tapes? *A*. Care should be taken to avoid kinks and the tape should be cleaned and oiled after use.

*Q.* What are the duties of the rodmen? *A.* The front rodman selects the new station and holds the rod at that point until the instrument man occupies that station. He then selects a new station forward. The new station must be clearly visible from the instrument and not more than 500 yards away if distances are measured by stadia. The rear rodman occupies the station vacated by the instrument man, to the rear of the instrument. The rod must be held vertically during sighting.

*Q.* What are the duties of chainmen? *A.* The rear chainman alines the front chainman on the rod ahead. The front chainman carefully marks off each tape length with tally pins or crayon. Each keeps a record and if they disagree must measure again. Stations should be definitely located on even 10-foot marks of the tape for ease in computations. The tape must be kept *horizontal* with no kinks in it. When taping on steep slopes a plumb bob must be used with the tape.

**127. Reconnaissance.**—*Q.* What is meant by reconnaissance? *A.* As here used it means the securing of information pertaining to the selection of battery positions, observation posts, command posts, routes of approach, and routes for communication.

*Q.* What enlisted personnel is included in a reconnaissance party? *A.* Those required and selected to accompany the commander or officer in charge, usually a communication sergeant, an instrument sergeant, and scouts or messengers. Agents of other units may be included in the detail if it is a battalion commander's reconnaissance party.

*Q.* What are the duties of the communication sergeant? *A.* He assists in selecting communication routes and switchboard stations and makes preparation for establishing them.

*Q.* What does the instrument sergeant do? *A.* He assists in selecting fire-control stations or observation posts and assists in installing them.

*Q.* What are the duties of the scouts? *A.* Scouts as members of reconnaissance parties assist in reconnaissance and when spotting OP's are selected they establish them and act as observers and spotters. They may be used also to mark the positions for the guns selected by the battery commander.

*Q.* What is an agent? *A.* A representative of any unit attached to the headquarters of a higher unit or other command. He must possess training similar to that of a scout. He is frequently detailed to assist in the reconnaissance of a superior commander and is either left at a position selected for his organization or sent back to guide his organization to the position.

*Q.* What are the qualifications for an agent? *A.* He should be able to read and follow routes from a map, make a simple sketch, drive a motorcycle or car, write a message, deliver an oral message, and understand the requirements sought after in making a reconnaissance. His duties are such that he should be active and intelligent and should have initiative.

*Q.* What special training should agents and scouts have? *A.* Training in orientation, map reading, identification of targets, and all other duties of an observer or a messenger.

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