C A T E C H I S M

for

C A N D I D A T E S F O R R A T I N G S ,

6 I N C H G U N

compiled

by

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THESIS

P R E F A C E .

This work was originally undertaken for the instruction of the 88th Company, Coast Artillery Corps, during the winter of 1912-1913 at which time the compilers were the officers on duty with that company.

The amount of labor involved in getting the information together and the very general interest taken in the work by the enlisted men suggested the offering of the paper to the Journal of the U.S. Artillery for publication under the same condition as the Gunners' Instruction pamphlets, the sale to be without profit to the compilers.

The inspiration for this work has come from the men who were eager to learn and compete for these specialized positions when the way was opened for them to acquire the mass of details which the Coast Artillery Drill Regulations contemplates the rated man should know.

It is hoped that this undertaking may be an aid toward;

(a) Providing an available text for the advanced gunnery instruction required of qualified gunners during the indoor period.

(b) Establishing a more definite standard of proficiency on the part of rated men in the several companies.

(c) Encouraging the ambitious and studious element among the enlisted men to perfect themselves for their duties and to place themselves in line for advancement early in their military careers.

It is desired to acknowledge the courtesy of Major William Chamberlaine, C.A.C., Director of the Department of Artillery and Land Defense, Coast Artillery School, for authority to quote from his pamphlet on the Coast Artillery War Game and for the large quantity of material supplied, particularly in the way of illustrations. As the originator of our excellent Gunners' Instruction book, he is also entitled to the credit for his conception. Ours has been only an effort to adapt his idea to a special purpose.

Acknowledgement is also due to the Journal of the U.S. Artillery for the cooperation of its personnel and permission to quote from the Journal and Gunners' Instruction books.

We cannot, in justice, fail to acknowledge the earnest efforts of a group of the noncommissioned officers of the 88th Company, each to do his **best** in carrying out his assigned part, particularly the drafting of Corporal Antoniades and the clerical work of the office force, 1st Sergeant Byers, and Corporals Prime and Zerphy.

The first edition of such a work could hardly be expected to be perfect. The criticism and suggestions of our fellow officers will be gratefully received. .

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It would not be unexpected if some should think that too high a standard was set in this book for rated candidates. The compilers would point to the C.A.D.R. as fixing in a general way the scope of the examination and to the fact that no syllabus of these examinations, such as that in G.O.106, W.D.-1908 for the gunners' examinations, has been published. Our aim has been to make the catechism complete, not only for the 6-inch gun, model of 1897 and 6-inch disappearing carriage, model of 1898, but to include, when it seemed feasible, information concerning other materiel in order that the catechism might be used in companies assigned to other models and calibers until such time as the catechism may be adapted by the service to each class of materiel. The real standard of requirements on these examinations will be determined, as before, by each company commander. There is seldom reasonable ground for objection to the candidate being too well informed. The compilers have therefore preferred to follow the example of the Gunners' Instruction pamphlets when they exceeded the scope of the syllabus prescribed for them, and to err in the direction of collecting too much rather than too little information.

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This paper was first submitted to the Michigan Agricultural College as a technical paper, or thesis, for the post graduate degree of mechanical engineer. The conditions of acceptance of the degree require the appending of this statement to show its original publication as a thesis.

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GUN COMMANDER OR GUN POINTER.

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See questions indicated in "GUN COMMANDER OR GUN POINTER" column in appendix A.

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GUN COMMANDER AND GUN POINTER

II GUN AND CARRIAGE

(The answers to the following questions on gun and carriage are for 6 inch rapid fire gun Model 1897 M.and disappearing carriage Model 1898 for 6 inch gun.See Ord.pamplet No.1686 on disappearing carriage for 6 inch gun,and Ord.pamplet No.1765 on 5 inch and 6 inch rapid fire guns.)

(a) Nomenclature,purpose and action of several parts.

1.Q.Of what metal and in how many parts is the base ring made?

A.It is made in one piece of cast iron.

2.Q.What purpose does the base ring serve?

A.It serves as a fixed level base for the carriage; its upper surface provides the lower path for the conical rollers; and an annular projection from it serves as the female part of the pintle. It also serves to hold the traversing rack in place.

3.Q.How is the base ring leveled before setting it in the cement of the foundation?

A.By means of 12 bronze leveling screws in the base ring. Steel plates are provided in the concrete beneath the screws for the screws to bear against in the process of leveling.

4.Q.How is the base ring secured to the foundation?

A.By 12 1.75 inch foundation bolts set in the concrete.

5.Q.Of what metal is the azimuth circle made?

A.Brass.

6.Q.How is it held in place?

A.It is attached to the top of the pintle of the base ring by counter sunk screws.

7.Q.How is it graduated?

A.In degrees. The numbers are added after the carriage is mounted in its emplacement.

8.Q.How is the azimuth circle read?

A.By means of the azimuth pointer and subscale fastened to the racer on the left side where the top of the racer has an opening exposing the circle.

9.Q.Of what metal and in how many pieces is the racer made?

A.It is made of cast steel in one piece.

10.Q.What purpose does the racer serve?

A.It supports the two chassis. On its underside is formed the upper roller path. A cylindrical projection 1 1/4 inch thick from its underside forms the male part of the pintle. It supports the sight standard,dust guard and traversing mechanism.

11.Q.Describe the traversing rollers and distance ring? How many rollers are there?

A.There are 20 rollers. They are made of forged steel with a trunnion at each end. On the inner end of each is a flange to guide the roller on its path. The diameter of the inner end is less than that of the outer end. The distance rings are united and stiffened by 10 separators. The roller trunnions fit into the rings at equal spaces In this way the rings keep the rollers at equal distances and prevent their jamming together.

12.Q.Explain why the traversing rollers are cone-shaped.

A.The circumference of the outer edge of the roller path is larger than that of the inner edge. Therefore where the gun is traversed the inner end of the roller has a smaller distance to travel over than the outer end has. Hence the circumference of the inner end of the roller is made smaller than that of the outer end to correspond to the smaller distance it traverses. So,for any point between the inner and outer ends of the roller,the circumference of the roller at that point corresponds to the distance that point has to traverse. The center of the base ring is the only point in it which does not have any rotary motion when the carriage ia traversed. It is therefore the apex or point of the cone-shaped surface of each roller,if the surface were extended sufficiently.

13.Q.Describe the dust guard?

A.The dust guard is composed of four sections. The sections are made of steel and are bolted at the top to the racer. The row of bolts at the bottom secures the steel and felt cloth strips which prevent dust from entering at the bottom and accumulating on the roller and paths.

14.Q.What are the chassis?

A.The two chassis,united near their middle by a transom,form the structure which rests upon the racer and supports the top carriage.

15.Q.Of what metal are they made?

A.The chassis are made of cast iron and the transom of cast steel.

16.Q.Give all the purposes for which the chassis serve

A.1.To support the top carriage.
2.Top surfaces form recoil roller path,also called the chassis rail sometimes.
3.Crosshead~~s~~guides are cast on them.
4.Support ends of piston rods.
5.Support elevating pinion shaft,elevating worm wheel bracket elevating rack guides.
6.Support retracting mechanism.
7.Support tripping gear.
8.Support recoil buffers.

17.Q.What is the slope of the recoil roller paths and what is the reason for this slope?

A.The recoil roller paths slope one degree to the front,making it easier for the counter-weight to force the gun into battery.

18.Q.Of what does the top carriage consist?

A.Two sides frames and two recoil cylinders united by a transom.

19.Q.How is the top carriage made and of what metal?

A.The top carriage is cast in one piece,the metal being gun iron.

20.Q.Describe the purpose of the top carriage?

A.The side frames contain the recoil cylinders and the beds for the gun lever axle. The recoil cylinders hold the oil and the piston heads,the main parts in the control of the energy of recoil after discharge.

21.Q.Describe the action of the top carriage,gun levers and counter-weight during counter recoil and recoil?

A.During counter recoil,as the counter-weight hung on suspension rods to the cross head,descends it draws downward the front ends of the gun levers. This movement causes the gun lever axles to be drawn to the front,bringing the top carriage with it. The top carriage moves forward over the live roller train on the roller path of each chassis,the top carriage moving twice as fast and twice as far in a forward direction as do the centers of the rollers.The gun lever axles being the pivot,as the cross head pins at the front end of the levers go downward the rear ends must move upward. The upward and forward motions of the rear ends of the levers carry the gun into the firing position.
During recoil the motion of the different parts is opposite to that in counter recoil. The force which produces recoil is powder pressure which not only moves the projectile forward but also causes the gun to kick backward,or recoil,when fired.

The force which produces counter recoil is that due to the weight of the counter weight being greater than that of the parts which have to be moved when the gun goes into battery.

22.Q.Describe the recoil roller frames,the rec il rollers and their action?

A.Each frame consists of two side pieces and two end pieces forming a rectangle. The side pieces have bronze-bushed holes for the roller trunnions to fit into. The frame serves to hold the rollers in place and cause them to act together.
Each frame contains 14 rollers,The rollers are of forged steel and have a flange on each end to guide them on the path.

23.Q.What devices insure the movement of the top carriage being straight to the front or rear?

A.The cylinder guides which project downward from the cylinders on both sides of the chassis rails and the flanges on the rollers.

24.Q.When is the gun fully in battery?

A.When the forward projections on the top carriage are against the stops on the chassis crosshead guide frames.

25.Q.Of what metal are the gun levers made?

A.Cast steel.

26.Q.At what point and by what are they connected?

A.A little below their middle by the forged steel gun lever axle.

27.Q.How is the axle secured to the levers?

A.Keyed to them.

28.Q.For what do the projecting ends of the axle serve?

A.They serve as trunnions for the gun levers. They rest in bronze bushed axle beds in the side frames of the top carriage,and are secured therein by bronze bushed axle caps.

29.Q.What is the crosshead ?

A.That mass of metal which forms the connection between the gun levers and the counter-weight.

30,Q.Why is the connection between crosshead and gun levers made by cylindrical pins passing through cylindrical holes in the ends of the levers.

A.Because when the counter-weight rises or descends the levers must be free to rotate about their lower ends.

31.Q.Why do the crosshead and counter weight move in a vertical direction?

A.Because the cross head clips on the cross head fit around the cross head guides on the inside of the chassis and the guides being vertical compel the cross head to move vertically.

32.Q.In what direction would the counter weight move if there were no guides (a) during recoil (b) during counter recoil.

A.(a) upward and toward the front (b) downward and toward the rear.

33.Q.Describe the action of the tripping gear giving the names of the different parts?

A.In order to trip the gun one or both of the tripping levers must be raised until they are latched. The tripping gear on the two sides are identical. Lifting the tripping lever upward about its fulcrum draws the tripping rod toward the rear. This movement pulls the upper end of the tripping shaft lever to the rear,this rotates the tripping shaft which throws both the right and left tripping arms against their respective pawls tripping the latter. The pawls having been withdrawn from the crosshead racks,the excess in weight of the counter weight over the weights of the other moving parts causes the counter weight to fall and the gun to rise into the firing or "in battery"position.

34.Q.Describe the action of the tripping safety mechanism.

A.It consists of the following parts duplicated for each side :a tripping safety latch and spring;a dog on the side of the crosshead near the upper end of the rack;cone-shaped catch on the tripping rod having the large end forward. The tripping safety latch spring holds the latch with the upper end projecting outward thru a slit in the chassis close to the tripping rod and the lower end projecting inward in the path of the dog. When the tripping lever is raised the tripping rod carries the catch past the upper end of the latch forcing the latter in against its spring. As soon as the catch passes to the rear the spring throws the safety latch in front of the catch thus holding the rod back with the pawls disengaged until the cross head descends and the rack teeth are clear of the pawls by about a foot. The dog then forces the lower end of the safety latch outward which draws the upper end inward and allows the rod and catch to move forward returning the pawls to the position from which they are ready to engage the crosshead when it rises.
For precautions to be observed in tripping,see Duties of No.9 under Service of the Piece,Page____.

35.Q.How is the counter-weight supported?

A.The layers of counter-weight rest upon the bottom plate. Two suspension rods extend from the bottom plate to the crosshead and support the entire counter-weight.

36.Q.How many hand weights are furnished with each carriage and what is their total weight?

A.16 handweights weighing in all about 1,000 lbs.

37.Q.What is the purpose of the handweights?

A.By adding handweights the gun can be made to go into battery more quickly;or if it fails to go fully into battery,usually enough hand weights may be added to force it fully into battery. If the gun goes into battery too quickly,causing the top carriage to bump against the stops,enough handweights may be removed to cause the gun to go into battery properly.

38.Q.What is the total amount of counter-weight furnished with the carriage?

A.About 19,000 lbs.of lead. The bottom plate,crosshead and suspension rods weigh about 3000 pounds more.

39.Q.Name and locate all the parts of the recoil system and describe the purpose and action of each part?

A.1.Two recoil cylinders,formed in the top carriage casting. The cylinders contain the hydroline oil. Each has on the inside two throttling bars. As the top carriage moves toward the rear during recoil,and toward the front during counter recoil,the oil is compressed in that part of the cylinders between the piston heads and the ends of the cylinders approaching the piston heads and is forced thru the various openings to the opposite side of the piston heads. Most of the force of recoil and of counter recoil are spent in forcing the oil thru some of these openings.

2.Two piston rods with a piston head forged solid with each. The rods are secured and held stationary by the chassis in front and the piston rodbrackets in rear. Each piston head has two slots in which the throttling bars work.

3.4 throttling bars,2 bolted to opposite sides of each cylinder . The bars have the same width throughout the length but have a varing thickness, The reason for which is as follows: The amount of pressure on the oil in the cylinders depends upon two things,namely,the velocity of recoil of the cylinders and the size of the opening for the passage of the oil. The greater the velocity of recoil the graater the pressure. The smaller the size of the opening for the passage of the oil the greater the pressure. If the throttling bars are given a varying thickness bearing a certain relation to the velocities with which the different points of the bar move over the piston it is evident that the oil pressure may be kept constant and the metal of the cylinder will not be stressed too much. To obtain the constant pressure,when the velocity of recoil is the greatest the thickness of the throttling bar is the least giving the greatest opening for the oil.As the velocity of recoil decreases the thickness of the bar increases causing the opening to decrease. Therefore the bars are so made that the rear ends are the thinnest parts and the thickness increases toward the front.

If this were not done the cylinders would have to be built strong enough to stand the maximum pressure, in spite of the fact that for the greater portion of the time of recoil, the oil pressure would be but a small fraction of this maximum pressure.

4. Equalizing pipes. They connect the front end of the cylinders, allowing the oil to flow from one cylinder to the other, and thereby equalizing the pressure in the cylinders.

5. Connecting pipe. It connects the equalizing pipes with the throttling pipes, allowing the oil to flow from one end of the cylinders to the other by way of the equalizing pipes, connecting pipes and throttling pipes during recoil or in opposite direction during counter recoil.

6. Throttling pipes. They connect the rear ends of the cylinders for the same purpose that the equalizing pipes connect the front ends.

7. Throttling valve. It regulates the recoil of the gun by varying the opening for the oil to pass thru in going from the connecting pipe to the throttling pipes. The valve can be adjusted to give openings varying by 0.0066 square inch from 0 to 0.2 square inch. The graduations of the valve are stamped on top. There are eleven divisions numbered 0, .02, .04 etc up to 0.2 one half turn of the valve changes the opening 0.0066 square inch; a whole turn changes it twice 0.0066 or .0133 square inch: hence it takes 3 half turns to move from one numbered division to the next.

The purpose of the throttling valve is to control the length of recoil. Read in this connection the discussion as to why it is <u>safe</u> but poor artillery practice to fire the gun when the top carriage is as much as 2 inches out of the "in battery" position under Duties of No. 9 Service of the Piece, page .

If the strength of the cylinder walls were without limit it is evident that the recoilof the piece could be taken up in a very short length of recoil by forcing the full quantity of oil thru say only one small slot in the piston. So also, if the one slot were made very large the oil would meet with little resistance in passing thru the piston and the cylinder would have to be very long and move a long distance to absorb all of the energy of recoil. Mechanical considerations make it advisable to have two cylinders and two slots in each piston.

Now having decided upon a reasonable length of recoil permitted by the size of his carriage, the designer computes the exact sizes of slot openings, or orifices, which are required at several points along the bar to absorb the designed force of recoil of the gun. This force may however be exceeded hence the designer allows for this by making his orifices a little smaller. This final set of sizes would be satisfactory if there was some way of letting the oil get past the piston easier when light pressure shots were fired, that is, the recoil system still needs a regulator to make the length of recoil stay the same or nearly the same. This is exactly the part the throttling valve plays. It is a by-pass so that the battery commander can, by adding a variable amount to the size of the orifices made by the designer to take care of the heaviest pressure, make the length of recoil stay at the amount the designer intended within close limits. For convenience the length of recoil is indicated by the number notch of the notch in the cross head racks at which the pawls come to rest. The proper notch for the 6 inch disappearing carriage model 1898 is the 19th. One whole turn of the throttling valve changes the length of recoil by about <u>two</u> notches.

(In printing omit underlined word and leave a blank)

8. Recoil buffers. They are made of alternate layers of balata and steel and are supported on the chassis. Their purpose is to take up the shock of recoil in case the oil fails to check the recoil properly.

40. Q. Why are the filling plugs about 30° from the top of the cylinders?

A. So that it is impossible to fill the cylinders without leaving an air space/in the top of each one to make room for the oil when it expands due to hot weather, or to the heat of friction inside the cylinders during firing, and also to make up for the space occupied by the male part of the counter recoil buffers as explained under counter recoil system below.

41. Q. Would any damage to the carriage occur if it were fired when say 2 inches out of battery? Explain.

A. No. The filling plugs of the cylinders are purposely so located that it is impossible to completely fill them with oil. When in battery the piston head is in the rear (higher) end of the cylinder. All of the air in the cylinder is now over the piston head. At the instant that recoil begins that portion of the air in front of the piston head rushes to the rear. The recoiling parts, including the counterweight, being very heavy it requires about 3 to 5 inches of movement to "build up" the speed of the moving parts. The throttling bar orifices (openings between the throttling bar curved surface and the bottom of the piston head slot) are so large that throttling effect is negligible for small to moderate velocities but increases to great proportions as the velocity of recoil increases. Therefore little or no checking of the recoil occurs in the first two inches of the movement away from the stopping surfaces on the chassis cross head guide frames.

The shortening of the length of recoil by firing when the top carriage is not fully in battery lessens of course the space in which the energy of recoil can be absorbed by the throttling process. Fully counteracting this, within the limit of 2 inches under discussion, is the fact that the point of maximum velocity of recoil falls farther to the rear measured on the roller path, farther forward as measured by the position of the piston head on the throttling bar, hence for each successive position the velocity will be relatively greater for the same size of orifice, hence a more than proportionately greater throttling or energy absorbing effect. It is this principle which enables the designed length of recoil to take care of all usual variations in powder pressures in successive charges with a given throttling valve setting.

42. Q. Is there any objection to firing with the top carriage not over 2 inches out of battery?

A. From the standpoint of the ordnance engineer, No. See page 14, O.P.1686, 1911. From the standpoint of the artilleryman, yes. See C.A.D.R.378, and Duties of No.9 under Service of the Piece, page .

43.Q.Describe the counter-recoil buffers and their action?

A.Each buffer consists of a male part on the piston rod against the rear face of the piston head and the female part,a corresponding recess in the rear cylinder head. The male part is a cylinder in appearance but really has three tapers of varying steepness on its surface. When the top carriage is within about 4 inches of the stops of the chassis the female part on the rear cylinder head is just beginning to move over the male part. The oil pocketed in the female part can escape only thru the clearance space between the male and female parts. In carriages having a buffer valve some oil escapes from the pocket thru the buffer valve. The clearance at this stage between male and female part is large but as the female part moves over the male part toward the piston head the lighter tapers come into play and make the clearance smaller hence the oil pressure inside of the pocket higher. Thus the pressure on the pocketed oil is small when the velocity of the top carriage is high and as this pressure stops the top carriage it increases thus bringing the top carriage,counter weight and gun to a "cushion" stop without any hard blow against the metal stops of the chassis.

When the gun is fired,the recoiling parts gain their maximum velocity in the first few inches of movement of the top carriage. The female parts of the counter recoil buffer is therefore quickly drawn off of the male part,too quickly to allow the oil on the low pressure side (rear) of the piston head to fill the female part until it is wholly clear of the male part. During this instant there is probably less than ordinary atmospheric pressure (a partial vacuum) in the pocket while the effect in the rear part of the main cylinder is that of suddenly adding the full volume of the metal of the male part. If the cylinder were entirely filled with oil,an almost incompressible substance,an enormous pressure would be created. If several cubic inches of air are always left in the cylinder due to the position of the filling plugs,this air will stand the compression due to expansion of oil from heat or to the above action of the recoil buffer without any high pressure developing.

44.Q.Name all the parts of the elevating system giving the purpose of each part?

A.1.Elevating hand wheel,by which a member of the gun section elevates and depresses the gun.

2.Elevating hand wheel shaft,which supports the elevating hand wheel.

3.Two elevating bevel gears,one on the end of the elevating hand wheel shaft and the other on the front end of the elevating worm shaft,meshing together.

4.Elevating worm shaft,connecting elevating hand wheel shaft with elevating pinion shaft.

5.Elevating worm,on rear end of worm shaft,and elevating worm wheel near left end of elevating pinion shaft connecting worm shaft with pinion shaft.

6.Elevating pinion shaft,passing thru chassis and supporting the elevating pinions.

7. Two elevating pinions whose teeth engage in the teeth of the elevating racks and raise and lower the racks.
8. Two bronze elevating rack guides bolted to the chassis, supporting and guiding the racks.
9. Two elevating racks which raise and lower the lower end of the elevating arm.
10. Elevating arm, connecting elevating band with racks.
11. Elevation disk (range drum) around its circumference is a white metal band graduated in yards for service and sub-caliber ranges. It is also graduated every 1° to enable the battery commander to check the correctness of the location of the range pointer. The reading of the range scale is indicated by the elevation pointer on the worm wheel bracket. The pointer is held in adjustment by two dowel pins.
12. Elevating maneuver hand wheel, by means of which the gun pointer may elevate and depress the gun.
13. The motion of the elevating maneuver hand wheel is transmitted thru the several parts in the following order: elevating maneuver hand wheel shaft, elevating maneuver bevel pinion shaft and elevating maneuver shaft. The bevel gear on the elevating hand wheel shaft which meshes with the bevel gear on the lower end of the elevating maneuver shaft can be locked to the elevating hand wheel shaft by a clutch operated by a clutch handle, thereby throwing in the elevating maneuver gear for action. This gearing is seldom or never used because the gun will seldom or never be fired by Case I from the sighting platform.

45.Q. What is the shape of the elevating racks and guides? What is the reason for this shape?

A. Each is an arc having the elevating arm as a radius and the center of the arc at the axes of the elevating band trunnions. This arrangement permits the gun being set to the proper range (elevation) while in the loading position without changing the height of the breech above the loading platform, since the raising or lowering of the elevating racks to give the proper range setting does not move the elevating band trunnions. In gun batteries larger than 6 inch where the projectile is too heavy to be thrown into the gun by hand by one man any great change in height of breech results in delay until the height of the shot pan of the ammunition truck shot pan can be adjusted to the new height. In the later carriages however the curved racks have been abandoned because of the expense of making them and because it has been found that the change in height of breech is not so large as to be important.

46.Q. What is the maximum elevation and depression of the gun? How is the maximum depression assured?

A. Maximum elevation is 15° above horizontal, maximum depression is 5° below horizontal.
A lug is cast on the rear part of each rack and two holes for stop bolts against which the lugs strike are drilled in each chassis near the upper end of the path of the elevating racks, since the racks are moving upward when the gun is being depressed. Stop bolts are inserted in the upper set of holes when the concrete parapet is constructed to allow firing at 5° depression and in the lower set of holes when the parapet is constructed to allow firing in positions not lower than horizontal.

Batteries near sealevel do not need to fire in depression hence are built with higher parapets to give greater protection to gun, carriage, and personnel.

Note: The battery commander will cause the one of the two next paragraphs which does not apply to his battery to be cancelled in all books before issue.

The parapets for this battery are constructed to allow a maximum depression of 5 degrees to permit firing at targets on the inner edge of deep water areas. The stops should therefore always be kept in the upper set of holes.

The parapets for this battery are constructed to allow firing not lower than horizontal since that is low enough to cover all important deep water at short ranges. The stops must never be left in the upper set of holes since if this were done and the gun were tripped while set in depression the muzzle would strike the concrete parapet and seriously damage the carriage.

A spring buffer is attached to each chassis near the bottom of the elevating rack guides to prevent any shock, if by chance the racks run down of their own weight, and also to serve as an elastic stop for elevation.

47.Q. What is the purpose of the helical (coiled) spring at the rear of the elevating worm?

A, The part of the worm shaft on which the worm is mounted is square. Except for the helical spring nothing prevents the worm from slipping to the rear on the worm shaft when it is turned. The spring holds the worm forward in place. If any force greater than the resistance of the spring turns the pinion shaft the worm will move to the raar on the worm shaft compressing the spring. When the force is removed the spring will expand and force the worm forward in place. In this way the spring protects the elevating mechanism from any dangerous strains due to a strong downward force exerted on the elevating rack during recoil.

48.Q. Describe the sight standard and platform?

A. The sight standard is made in one piece and is bolted to the racer. The sighting gear and traversing and elevating maneuver gears are attached to it. The platform is supported in front by the standard and in rear by the platform ladder.

49.Q. What is the purpose of the trunnion sight bracket?

A. It is intended primarily for emergency firing after the sight standard has become unserviceable. It also affords an excellent place for testing the sight as outlined under VIII Pointing, (c) Emergency System, page 47.

51.Q.What is the purpose of the sight bracket and sighting mechanism?

A.The sight bracket secures the sight in its proper position. The sighting mechanism connecting the bracket with the front end of the elevating worm shaft causes the sight to be elevated or depressed with the gun.

52.Q.Is this used now? What case do you fire in when you use it,

A.No, Case I.

53.Q.Describe the traversing gear?

A.The traversing gear is operated by turning the traversing crank. The connections from the crank to the traversing rack consist of the traversing crank shaft,a vertical shaft inside the traversing gear standard,and another vertical shaft supported in the racer,and the bevel gears and pinions connecting these shafts.On the lower end of the vertical shaft supported in the racer is a pinion whose teeth mesh with the teeth of the traversing rack. The rack,being fastened to the base ring,is stationary,so that when the pinion rotates it travels around on the rack forcing the carraige to move with it.

The traversing maneuver hand wheel and the gears connecting it with vertical shaft inside the gear standard on the racer, permit the gun pointer to traverse the carriage. The maneuver gears are engaged and disengaged by a clutch attached to the gear standard.

One revolution of the traversing crank turns the gun and carriage thru 4.09 degrees of azimuth. The traversing maneuver hand wheel makes 6 1/15 turns for every turn of the traversing crank hence one revolution turns the carriage thru 0.66 degrees of azimuth only. The traversing crank is intended for the use of a man on the gun platform who can traverse the carriage rapidly to the approximate azimuth,especially when changing target. The C.A.D.R.-1909 provide no traversing detail for the 6 inch disappearing carriage but authorizes the battery commander to make such modifications of the Service of the Piece as he deems necessary. The traversing maneuver hand wheel affords the gun pointer a slow motion means of traversing the carriage under his own control.

54.Q.Describe the action of all the parts of the retracting mechanism.

A.The retracting handle on the right side of the carriage operates through 2 small and 2 large spur gears the retracting shaft supported in the lower rear part of the chassis. On the shaft are two drums for winding in the two wire retracting ropes. The ropes pass from the drums under and over the retracting rope sheaves on the upper rear ends of the chassis rails to the hooks provided on the upper ends of the gun levers over which the eye socket on the end of each rope is hooked. Two cannoneers can easily retract the gun to the loading position by operating the handle. The retraction ratchet-wheel pawl and retraction ratchet are mounted on the retraction pinion shaft outside the right chassis and serve as a safety device to prevent the handle from spinning if it escapes from the control of the cannoneers.

Until the pawls engage in at least the first notch of the crosshead rack the loss of control of the retraction crank would allow the gun to return to the "in battery" position

55.Q.What precautions must betaken during retraction?

A.1.See that the ratchet is engaged. 2.Guide the ropes on to the drums without kinks or slack,3.See that the ropes wind on smoothly without lapping over themselves or the ridges between the grooves of the drum. 4.See that the ropes are under equal tension,so that each will do its share of the work. Adjustment should be made at the rope clamps on the drums to secure equal tension.

56.Q.What is the purpose of the safety lanyard attachment and how is it accomplished?

A.To prevent firing the piece by a pull on the lanyard until the piece is in battery. The branch of the lanyard from the primer to the ring cannot be pulled taut unless the cord in the housing mounted on the rear of face of the elevating band of the gun on the right side will unwind and come to the rear. This cord will not unwind until the pawl which holds the reel on which it is wound is released by the cam on the end of the elevating arm. The cam should not release the pawl until the top carriage is within the distance equal to the caliber of the gun from "in battery" position,therefore the piece cannot befired by lanyard until the muzzle is well above the parapet. For effect of firing the gun before it is fully in battery,see V Service of the Piece,Duties of No.9,page .

57.Q.How do the electrical wires reach the carriage?

A.They pass thru a cable in a duct in the concrete to the counter weight well. In the well they enter a terminal box.From this they pass thru a flexible metallic conduit to the vertical pipe conduit at the center of rotation of the carriage. The flexible conduit in the form of a loop is necessary to allow the carriage to be traversed without breaking the wires. The different wires pass from the vertical pipe conduit to their respective lamps.

58.Q.How many lamps are on the carriage and for what is each used?

A.4 16-candle power lamps and 3 8-candle power 3 of the 16-candle power lamps are for the general illumination of the carriage. These lamps are controlled by one switch located under the sighting platform. The fourth is a portable lamp. One 8 candle power lamp is used to illuminate the elevation pointer,1 for the azimuth pointer and 1 for the throttling valve. A switch at the range drum controls the first two. The throttling valve switch is at the throttling valve.

59.Q.What supplies the current for the firing circuit?

A.A battery of dry cells.

60.Q.Trace the firing circuit?

A.From the positive side of the battery along the wire to the firing pistol,thru the firing pistol,from the pistol along the wire to the safety switch,from the safety switch along the wire to the circuit breaker on the breech mechanism,from the circuit breaker along the firing cable to the contact clip on the firing mechanism,from the contact clip to the primer button,from the primer button along the primer stem to theplatinum wire in the priming charge of gun cotton,along the wire to the primer body,thru the breech block and gun to the end of the wire near the breech,along this wire to the firing switch,from the firing switch along the wire to the negative side of the battery.

61.Q.In what are the wires of the firing circuit enclosed?

A.In flexible metallic conduits entirely separate from all other wires.

62.Q.How is the firing circuit tested?

A.With the safety switch closed push in the contact piece protruding from the rear of the pistol. If the circuit is all right the buzzer in the pistol will be heard. This current that actuates the buzzer is too small to fire a primer,so it is safe to test the circuit with a primer seated.

63.Q.In case the buzzer does not work during the test how is the trouble located?

A.Connect the terminals of the pistol directly with the terminals of the battery and try the buzzer. If it works,the trouble lies in the connections of the firing circuit. If the buzzer does not work,try another battery that you know to be good. If still the buzzer does not work the trouble lies in the pistol. But if in the second case the buzzer does work the fault is in the first battery.

64.Q.How many degrees in the field of fire of the gun ?

A.170°

65.Q.Why cannot the gun fire thru out the circle of 360°

A.Because of the shape of the parapet which is necessary to afford protection for the gun,carriage,and the gun section.

66.Q.What is the type and model of guns to which your company is assigned?

A.6-inch rapid fire guns model of 1897 M I.

67.Q.How is the gun constructed?

A.It is a built up gun made of steel sections by shrinking one over the other.

68.Q.In what part is the bore and powder chamber formed?

A.In the tube.

69.Q.In what part is the breech recess formed?

A.In the jacket,the rear end of which projects beyond the rear end of the tube.

70.Q.How are the tube and jacket strengthened?

A.By steel hoops shrunk on them.

71.Q.Of what are the trunnions a part?

A.One of the outside hoops.

72.Q.Describe the breech recess?

A.It is the cylindrical opening into which the breech block fits. On its surface are 4 threaded sectors and 4 slotted sectors. The slotted sectors allow the threaded sectors on the breech block to enter the breech recess. The threaded sectors receive the corresponding threaded sectors on the breech blockwhen the block is rotated in the breech recess.

73.Q.Locate,describe,and give the purpose of each of the following parts:

1.Powder chamber. It is between the breech recess and centering slope. It is cylindrical in shape,33 inches long and 7 inches in diameter. The powder charge is placed in the powder chamber where it burns when the gun is fired.

2. Gas check seat. It is formed on rear end of powder chamber. It is cone shaped,increasing in diameter toward the rear. The gas check pad and split rings fit inside of it.

3. Centering slope. It is between the powder chamber and forcing cone. It is cone shaped,forming a gradual change from the 7 inches diameter of the powder chamber to the 6.04 inches diameter of the rear end of the forcing cone. The centering slope guides the projectile into its seat in the bore. It is about 10 inches long.

4. Forcing cone. It is between the centering slope and the main bore. It is about 26 inches long. It is cone shaped. The diameter of the rear end measured between diametrically opposite lands is 6.04 inches, and the diameter decreases uniformly to 6 inches (caliber of the bore) at the front end where the main bore begins. The grooves at the beginning of the forcing cone are .02 inch deep,and their depth increases to .04 inch (depth they have thru out the main bore) at the beginning of the main bore. At the instant the projectile starts on its path thru the bore,the lands at the rear end of the forcing cone cut into the copper rotating band .02 inch (the depth of the grooves at that point). Thus forcing the soft metal of the band to flow into the adjacent grooves.While the band itself travels from the rear end to the front end of the forcing cone the depth of the cuts in the band made by the lands increases from .02 inch to .04 inch. The result of the lands gradually cutting into the copper rotating band is to ease the strain of forcing the band to follow the twist of the rifling.

5.Main bore. It is the part of the bore between the forcing cone and the muzzle. It contains the rifling which consists of the lands and grooves.

There are 36 lands and 36 grooves. The lands are 0.15 inch in width. The width of the grooves is 0.3736 inch and the depth of the grooves is .04 inch. The diameter of the bore is 6 inches, measured between diametrically opposite lands.

74.Q. What is meant by caliber?

A. The caliber of a gun is the length expressed in inches of the diameter of the bore measured between diametrically opposite lands. In speaking of 5,10, 15, or any other number of calibers one means 5,10,15, etc times the length of one caliber. For a 6 inch gun 50 calibers equals 6 times 50 or 300 inches.

75.Q. What is meant by the twist of the rifling?

A. Twist of rifling is expressed as one turn in a certain number of calibers, meaning that while the projectile travels over a distance in the bore equal to a certain number times the diameter of the bore between lands, the rifling causes the projectile to make one complete rotation about its longer axis.

76.Q. What two kinds of twist may a rifling have?

A. Uniform twist or an increasing twist. A uniform twist is one that remains the same thru out the bore. An increasing twist does not remain the same but increases from the rear toward the muzzle.

77.Q. What kind of twist has this gun?

A, An increasing twist. It begins with one turn in 50 calibers and increases until at a point 23.25 inches from the muzzle it is one turn in 25 calibers. It is uniform from this point to the muzzle, that is, it remains 1 turn in 25 calibers.

78.Q. At what rate is the projectile rotating when it leaves the muzzle?

A, 208 turns per second. This is determined as follows:
Muzzle vel. times twist ÷ caliber in feet=

$$\frac{2600}{1/2} \text{ times } \frac{1}{25} = \frac{5200}{25} = 208.$$

79.Q. What is the purpose of rifling?

A. To produce this rotation of projectiles about their longer axis in order to keep them from wobbling and finally tumbling in the air like a dart thrown from the hand.

80.Q. What is the weight and total length of the 6 inch gun model 1897 M I ?

A. Weight 16,216 lbs. Length, 23.15 feet.

81.Q. What is the normal muzzle velocity ?

A. 2600 f,s,

82.Q.How many inches of Krupp cemented steel will the projectile penetrate at the muzzle,at 1000 yds and at 5000 yds?

A.At the muzzle using a capped armor piercing shot it will penetrate 9.5 inches; at 1000 yds,8. inches; at 5000 yds,3.75 inches.

83.Q.The penetrating power of the projectile fired from this gun places the gun in which class of armament and for what use?

A.($ee par.8 C.A.D.R.1909)
In the intermediate class of armament which is used primarily to attack unarmored vessels,but which may be used effectively to supplement the primary armament in the attack of armored vessels,or the secondary armament in the defense of the mine fields.

84.Q.What data is marked upon the muzzle?

A.The number of the rifle,place and data of manufacture,weight,initials of the inspector and the model of the piece.

85.Q.Is any cause for alarm if after firing the first few rounds the tube is found to project 0.02 or 0.03 of an inch beyond the chase hoop on the muzzle face?

A.No. It is not uncommon for this to occur after the first few rounds. The hoop and tube are faced off at the muzzle before the gun has been fired. Firing a few rounds relieves some of the internal strains due to shrinkage allowing thetube to project at the face. The parts are locked together internally. If there is no marked increase in this projection from firings after the first few rounds it is no cause for alarm.

BREECH MECHANISM.

1.Q.What is the name of the breech mechanism and firing attachment on the 6 inch R.F.gun model 1897 M I ?

A.Stockett Breech Mechanism fitted with the combination electric-friction firing attachment.

2.Q.What are the principal parts of the breech mechanism?

A.Breechblock,gear segment,block carrier,lever,pinion,latch,and obturator.

3.Q.Name and describe the different parts of the breech block,and give the purpose of each part?

A.1.Threaded and slotted sectors. These sectors are formed by cutting a V shaped screw thread around the outer surface, then dividing the circumference into eight equal parts,and cutting away the threads of alternate parts. The parts from which the thread is cut are the slotted sectors. The threaded sectors on the block mesh with the threaded sectors in the breech recess when the block is closed and rotated,thereby preventing the block from being blown to the rear when the gun is fired. The slotted sectors in the breech recess receive the threaded sectors of the block,and the slotted sectors of the block fit over the threaded sectors of the breech recess when the block is closed prior to rotation.

2.Guide cylinder. This is the rear part of the block,smaller in diameter than the block. It fits in the cylindrical hole in the block carrier. It supports the block in the block carrier and guides the block in its motions of translation and rotation. The gear segment is attached to its rear face. It contains the locking recess into which the latch bolt fits.

3.Guide groove. This is the groove in the rear end of the block around the guide cylinder. The guide flange on the block carrier fits into it and assists in supporting and guiding the block.

4.Stop flange. It is that portion of the rear face of the block which is outside the guide groove. When the block is drawn toward the rear by the by the rack on the gear segment and the pinion on the operating lever,the stop flange strikes the bottom of the stop groove in the block carrier and prevents the block from being translated farther to the rear.

5.Axial hole thru the block. This hole is for the spindle and the spindle ball washer.

6.Locking recess. It is cut in the guide cylinder.When theblock is translated rearward,the latch lever and spring force the inner end of the latch bolt into the locking recess. Thus the latch bolt locks the block to the block carrier.

7.Four oil holes are drilled radially from the exterior of the block to the bottom of the guide groove to facilitate oiling the bearing surfaces.

4.Q.Why is the front part of the block reduced in diameter for a short distance back?

A.This reduced part of the block leaves a space in the breech recess of the gun in which fowling may collect without interrupting the working of the block.

5.Q.Describe and give the purpose and action of the gear segment and pinion?

A.The gear segment is fastened to the rear end of the guide cylinder by a spline (two strips on the rear face of the guide cylinder which fit into two slots in the gear segment) and two screws. On it is formed a segment of a bevel gear and one tooth of a rack. On the pinion, which is secured to the operating lever, is a segment of a bevel gear and two teeth of a pinion. The bevel gears cause the breech block to rotate, and the short rack and pinion part translates the block (moves it along the axis of the gun). When the breech is opened the action is as follows: one continuous motion of the operating lever rotates, translates, and swings the block clear of the breech. During the first part of the motion the bevel gear on the pinion meshing with the bevel gear on the gear segment, rotates the gear segment and breech block 45° in a counter clock wise direction around the axis of the gun thereby disengaging the threaded sectors on the breech block from those in the breech recess. When the rotation is completed, the rack tooth on the gear segment comes into place between the two pinion teeth, and further rotation of the pinion by the operating lever translates the block back against the block carrier withdrawing the obturator from the gas check seat. The remainder of the movement of the operating lever serves to withdraw the block from the breech by swinging it to the right around the hinge pin as an axis. In closing the breech the action of the different parts is the reverse of the above.

6.Q.How is the block carrier supported?

A.By the hinge. A hinge pin secures the block carrier to the hinge lug on the rearmost hoop.

7.Q.Name the different parts of the block carrier?

A.Stop groove, guide flange, cylindrical boring for guide cylinder, pinion seat, recess for latch, recess for spindle key.

8.Q.How is the pinion and operating lever secured to the block carrier?

A.The pinion pivot passes down thru the pinion and lever and screws into the lug which forms the pinion seat. The pivot is prevented from unscrewing by the pivot nut secured to the pivot by a thru pin underneath the lug.

9.Q.Where is the latch mounted, of what does it consist, and what is its object?

A.The latch is mounted in the block carrier. It consists of the latch bolt, latch lever, latch spring and latch lever pivot and the latch bolt seat and tripping stud secured to the face of the breech by screws. When the breech is closed the latch locks the carrier to the face of the breech, and when the breech is opened it locks the breech block to the block carrier.

10.Q.Describe the [illegible] action of the latch?

10.Q.Describe the complete action of the latch?

A.The complete action of the latch is as follows: With the breech closed, the outer end of the latch bolt rests in the latch bolt seat,locking the block carrier to the breech of the gun; the inner end of the latch bolt bears against the guide cylinder of the block,and,at the end of the motion of rotation of the block in opening the breech,rests in line with the end of the latch groove. When the block is withdrawn against the carrier,the bolt rides down the inclined bottom of the latch groove and its outer end is withdrawn from the latch bolt seat,freeing the block carrier from the breech of the gun. At the end of the motion of withdrawal the inner end of the latch bolt enters the locking recess in the breech block. As the block carrier is swung away from the gun the end of the latch lever clears the tripping stud so that the full force of the latch spring comes into play and the latch bolt is forced to the bottom of the locking recess,securely locking the block to the carrier. In closing the breech the action of the latch is the reverse of that just given. With breech open the block is locked to the carrier. As the latter is swung against the breech face of the gun the tripping stud,by means of the lever,raises the latch bolt far enough from the bottom of the latch groove locking recess for the end of the bolt to ride on the inclined bottom of the groove as the block is moved forward thru the block carrier. As the bolt rides up the inclined bottom of the latch groove its outer end enters the latch bolt seat and locks the block carrier to the breech face of the gun.

11.Q.Of what does the obturator consist?

A.Mushroom head,spindle,gas check pad,front and rear exterior split rings, interior split ring,filling in disc,spindle nut,spindle ball washer.

12.Q.What is the object of the obturator?

A.To prevent the escape of gas from the powder chamber to the rear during firing.

13.Q.Describe the spindle and mushroom head?

A.The front end of the spindle is enlarged into a mushroom shaped head which plays the part of a piston head at the rear end of the powder chamber under the action of the powder pressure. The stem of the spindle passes thru the axial hole in the breech block,the rear end being threaded for the spindle nut. The axis of the vent is the axis of the spindle. The rear end of the vent is enlarged to form the primer seat. In the mushroom head is a copper bushing around the vent to protect it from erosion and to enable repairs to be easily made.

The spindle nut screwson the rear end of the spindle and secures in place the spindle,gas check pad,split rings,and filling in disc.

14.Q.What is the object of the ball bearing washer?

A.It is interposed between the spindle nut and the breech block to reduce the friction between them when the block is rotated.

15.Q.Describe the gas check pad,split rings,and their action?

A.The split rings are made of steel and are split diagonally thru at one place to permit them to be expanded and contracted. The exterior ones are made of slightly greater diameter thanthe gas check seat so that when forced to place by closing the block the resulting compression will press them hard against the gas check seat at every point of the circumference. In order that the interior one might fit tightly around the spindle its diameter is slightly smaller than that of the spindle at its seat. A slight shoulder on the rear face of the mushroom head and the front face of the filling in disc support and center the exterior rings. The gas check pads were formerly made of asbestos and tallow but are now made of 3 parts asbestos and 1 part nonfluid oil. The later ones are marked N.F.O.to distinguish them. Asbestos is used to resist combustion under the high temperature of the exploding powder. A fluid oil would run out of the pad and leave it dry so that it would no longer be plastic. It is compressed under heavy pressure and covered with canvas. Under the high pressure of the powder gas on the mushroom head it moves to the rear compressing the yielding pad which expands outward and inward. The pad in expanding outward by virtue of the shape of its shoulder under the exterior split rings,forces them tight against the gas check seat,and,in expanding inward,it compresses the interior ring tight around the spindle. The gas from the chamber cannot escape to the rear between the gas check seat and the exterior split rings,nor between the spindle and the interior split ring. The gas check is then metal against metal and not canvas against metal.

The movement of the mushroom head to the rear under the pressure of the powder gases may at first seem to produce a tendency toward cushioning effect similiar to that exerted by the counter recoil buffers when the carriage goes into battery. It is essentially different however in these important respects:

(a) No provision is made for the escape of any of the imprisioned mass of the gas check pad.
(b) The maximum pressure is not encountered at the beginning of the compression of the pad hence the full movement is undoubtedly taken up before,or by the time,maximum powder pressure occurs,otherwise the system would fail as an obturator (gas check),and the maximum pressure is exerted on a solid mass and therefore transmitted in full intensity to the breech recess threads.
(c) The movement of the mushroom head is too slight to be important.
(d) The material of the gas check pad is too nearly of the nature of a solid.

16.Q.What is the object of the filling in disc?

A.It acts as a steel washer between the pad and the front face of the breech block. The projection on its front face assists in centering and supporting the rear split ring.

17.Q.Describe the purpose of the spindle key?

A.The spindle key extends downward thru the block carrier and the block. Its lower end fits in a slot in the spindle stem, and prevents the spindle from rotating. The spindle must not rotate because the firing mechanism attached to its rear end must be kept in an upright position. The key allows the block to rotate the proper amount by means of a slot in the guide cylinder in which the key fits.

FIRING ATTACHMENT

18.Q.Name the principal parts of the firing attachment?

A.Slide, slide housing, ejector, firing leaf, contact clip, firing cable, circuit breaker, and safety bar.

19.Q.Where and how is the housing attached?

A.To the rear end of the spindle by means of an interrupted screw thread. A spline screw secures it in place.

20.Q.Where and how is the slide attached?

A.The slide is securedin the housing and has a vertical motion in guides which project from the rear portion of the housing.

21.Q.What is the action of the slide stop?

A.The slide stop has a horizontal movement against a spring in a hole in the housing. The inner end projects into a groove in the side of the slide and limits the vertical motion of the slide. The spring pressure keeps it in the groove of the slide.

22.Q.Describe the position of the firing leaf and the action of the firing leaf and slide when a primer is fired.

A.The firing leaf is pivoted at its upper end to the slide against which it lies flat except when pulled outward. A notch is cut through both the slide and the firing leaf so that, when in its lowered position, the slide supports the head of the primer against the pressure of the powder gases while the primer stem is allowed to project through both pieces, leaving a clearance between the firing leaf and the button of the primer of about 0.06 inch. When the firing leaf is pulled to the rear its rear face, pressing against the button, draws the stem to the rear, exploding the primer and firing the gun.

23.Q.Describe the position and purpose of the contact clip.

A.The contact clip is held in a housing which is secured to the firing leaf by the housing nut and is insulated from the leaf by the housing insulation. The contact clip fits around the button on the primer stem, connecting electrically the contact clip housing and the primer stem, two parts of the firing circuit.

24.Q.What parts of the firing circuit does the firing cable connect?

A.Circuit breaker contact piece with the clip housing .

25.Q.Describe the circuit breaker,its purpose and action?

A.It consists of two parts,namely,the circuit breaker contact piece secured to the gear segment and insulated from it,and the circuit breaker housing secured to the block carrier and insulated from it, and containing the circuit breaker contact pin. The purpose of the circuit breaker is to prevent the firing circuit from being closed until the breech block is closed and completely rotated. When the block is rotated in closing the breech the contact piece comes in contact with the contact pin. The end of one of the firing cables is secured to the circuit breaker housing by a fork.

26.Q.Describe the ejector and its action?

A.The ejector consists of a horizontal and a vertical branch with a pair of trunnions near the angle. It is supported in the housing by these trunnions,and in its normal position the lower branch,which is in the form of a fork,hangs vertically over the mouth of the primer seat, engaging the rim of the primer on two sides. The horizontal branch projects to the rear into a recess cut in the front face of the slide. The lower end of this recess is a cam surface. When the slide is raised,this cam surface forces the horizontal branch upward,ejecting the primer. When the slide is lowered,the ejector drops into position against the mouth of the primer seat.

27.Q.Describe the safety bar and its action?

A.The safety bar is a lever pivoted in the slide housing and actuated by a stud on the gear segment working in a slot cut thru the outer end of the safety bar. At the beginning of rotation of the block in opening the breech the inner end of the safety bar rotates inward,entering a slot in the right side of the firing leaf,thus preventing any movement of the firing leaf,and therefore an accidental discharge of the gun,except when the breech is fully closed.

28.Q.Describe the process of dismounting and mounting the firing attachment and breech mechanism?

A.Open the breech. Unscrew safety bar pivot and remove safety bar. Detach firing cable from circuit breaker contact piece. To remove slide,pull outward on slide top and lift slide from housing. Un-screw housing spline screw and revolve housing 90° to the right,when the housing may be drawn to the rear from the spindle. Unscrew the spindle nut and the spindle key screw,and remove the spindle key. Be careful not to remove spindle nut and spindle key before opening the breech,as in that case the split rings are liable to drop down and prevent the withdrawl of the block. The spindle,split rings,pad,etc.,are then free to be removed from the block. Take out the two gear segment screws and drive off the gear segment,using a copper drift to prevent injury to the metal. Take out the latch lever pivot and remove the latch lever,spring,and bolt. The block is then free to be removed from the carrier.

Drive out the pivot pin and remove the pivot nut,unscrew the pivot, and the pinion and lever are then free to be removed fromthe carrier. Drive out the hinge pin,being careful to support the carrier while doing so,and the carrier is then free from the gun.

The process of mounting the mechanism is the reverse of that of dismounting it.

II GUNS AND CARRAGES.

(b) Packing stuffing boxes and cleaning recoil cylinders.

1.Q.How is the old packing removed from the stuffing box?

A.First draw all the oil from the cylinders,then with spanner wrench remove the follower and the gland. Remove the old rings of the packing,using the extractor. Examine the old packing and throw away that which is not fit for use. If any of the old packing is to be used,it should be put in after the new packing. If it is difficult to remove the old packing,use the packing extractor as follows: Force the extractor down on the packing and turn in a counter clockwise direction until the hooks have engaged in the packing and are turning it. Then continue to turn in a counter clockwise direction and pull the extractor out gently at the same time. The packing will conform to the threads of the stuffing box and may be brought out easily and without injury to threads or packing.(C.A.D.R.1909.Par. 870 and Ordnance pamphlet No.1686.)

2.Q.How is a stuffing box repacked?

A.Put on the piston rod one ring of Garlock's Waterproof Hydraulic packing and force it well to the bottom of the stuffing box with a wooden stick or mallet. Treat each layer the same until six rings of new packing have been inserted,or an equal amount of old and new packing,if any of the latter has been used. Place the halves of the gland on the follower,being careful that the halves of the gland do not bind on the screw threads. No more force should be used on the spanner wrench than that of two men;generally that of one man is sufficient. The addition of a pipe to the end of the spanner wrench should not be permitted.

3.Q.How can you tell if the stuffing box is properly tightened?

A.There should be about one inch between the flange of the follower and the part into which it is screwed.

4.Q.What should be done to keep the stuffing box properly tightened?

A.The follower should be tightened from time to time. If the follower is screwed into the stuffing box too tightly an unnecessary amount of friction will be produced on the piston rod. If when the follower is screwed in the flange strikes the box,another ring of packing should be added.(Ordnance pamphlet No.1686).

5.Q.For what are drip pans used?

A.To catch the small amount of oil that is likely to soak through and drip from the stuffing boxes when the carriage is not in use.

6.Q.How often should recoil cylinders be emptied and how often cleaned?

A.They should be emptied at least once every three months and cleaned once every six months (Ordnance pamphlet 1686). They should be cleaned a short time prior to each firing (C.A.D.R. 869).

7.Q.Describe in detail the method of cleaning recoil cylanders on disappearing carriage using a plumber's hand force pump with about ten feet of suction hose and fifteen feet of discharge tube?

A.(a)Trip the gun.
(b)Remove the oil from the hydraulic system as follows:
Obtain a length of hose sufficiently long to reach from from the emptying coupling to the gun platform,make one end fast to the equalizing pipe under the emptying coupling,and place a funnel in the end so that when the coupling is opened oil will flow into the funnel and through the hose. Provide a reserve tank for hydrolene oil and place it on the gun platform near the chassis. Pass the end of the hose through the opening in the chassis just in front of the traversing shaft,place a sieve above the opening in the top of the reserve tank and hold the end of the hose just above the sieve. Unscrew the open ing coupling and the oil will flow from the cylinders (both filling plugs having been taken out) into the reserve tank. This avoids spilling oil on the carriage and the platform and saves the labor of handling it in buckets.
(c)Retact the gun until the pistons are in the middle of the cylinders,then slack away until the pawls engage in the ratchet teeth on the crosshead; observe that the pawls are engaged properly in the ratchet teeth,and that the pistons are not under the filling holes.
(d)Remove the piston rod brackets from the rear ends of the chassis rails. Take off the two nuts on the front end of each piston rod,remove the rear cylinder head from each cylinder, and pull the rods carefully to the rear out of the cylinders. Before removing any part it should be marked so as to insure its being assembled in its correct position.
(e)Clean thoroughly each cylinedr from both ends with kerosene oil forced in with a hand pump,then wipe dry with clean cotton waste and clean the piston rods. The equalizing and connecting pipes should be dismounted and cleaned by forcing kerosene oil into them with the pump.
(f)Assemble the equalizing and connecting pipes,leaving the throttling valve wide open. Insert each piston rod in its cylinder,exercising care to prevent binding of the piston, burring of the walls,or other damage. Assemble the two nuts on the front of the rod; move each rear cylinder head foward into its seat in the cylinder. Assemble the piston-rod brackets to the chassis,and then secure firmly the rear cylinder heads to the cylinders and fill the recoil cylinders with hydrolene oil. This will require some time,as the oil can enter the parts of the cylinders in the rear of the pistons

only through the equalizing pipes and the throttling bar orifices. Insert the filling plugs when apparently filled, close the throttling valve, and retract the gun to the loading position. Complete the filling of the cylinders and close the throttling valve to its proper setting. For this method a plumber's forcepump is supplied to each coast artillery post, also suction-hose discharge tube. Inspect carefully all parts dismounted and note that they have been assembled properly. Then the piston-rod nuts should be loosened to insure the rod being located centrally in the cylinder and the nuts tightened. The gun should be retracted and tripped several times to insure that all parts are in proper working order. (C.A.D.R. 1909, Par. 869).

8.Q. Describe the method of cleaning recoil cylinders on disappearing carriage when plumbers hand pump, hose and tube are not used?

A. (a) Trip the gun.
(b) Remove the oil.
(c) Close the emptying coupling and put ten gallons of kerosene oil in each cylinder and replace filling plugs. With the use of retraction cables bring the gun from battery and allow it to go in battery slowly with the cables on, controlling the motion by the retraction cranks. Repeat this operation several times. In this way the kerosene will be forced through every portion of the recoil cylinders and pipes and will clean all parts. With the gun in battery the emptying coupling is unscrewed and the kerosene allowed to drain out. After kerosene has drained out place about 20 gallons of hydrolene in the cylinders and work the gun in and from battery with cables on, in the same manner as before. Drain this hydrolene out and throw it away or save it to flush out pintle bearings. After cylinders have drained refill with hydrolene.
When batteries are equipped with electric power for retracting, the foregoing method is an easy one. Guns are drawn from battery by power and allowed to go back with four men on the retracting cranks (for 12-inch guns). If retracting is to be done by hand, labor will be saved by removing all hand counterweights before starting.
(d) If cylinders have not been cleaned for so long that female portions of counter-recoil buffers have become packed with hardened oil sediment, the gun will either go in battery by creeping the last inch or may not go entirely in. If the above method does not serve to remove the obstruction, the cylinder head must be taken out and the buffers cleaned by hand.
(e) In employing this method a careful examination should be made to see that the cables are in good condition, and the gun must be allowed to go into battery slowly and evenly. (C.A.D.R. 1909 Par. 869).

GUN COMMANDER and GUN POINTER.

VII Fire-control system.

(a) General knowledge of that in use at the battery.

For this subject, see the same subject under Plotter II(A).

GUN COMMANDER & GUN POINTER.

II Gun and carriage.

(c) ADJUSTMENTS.

Sight Standard.

1.Q.Can the sight standard of the disappearing carriage model 1898 for 6-inch gun be adjusted so that the line of sight and axis of the bore can be converged upon a desired point? Why?

A.No. The sight standard and the axis of the bore and the line of sight, having once been adjusted to parallelism, cannot easily get out of adjustment. Should this adjustment be not properly made during the shop test, there is no way of correcting it.(See Bore Sighting, Page 48 .

2.Q.What adjustment is made on the sight standard of this carriage, and how is it made?

A.The sight parallel mechanism may be adjusted if it is desired to use Case I with the sight on the sight standard. The sight bracket must be placed in parallelism with the gun in the firing position. To do this bring the gun in battery and by means of a quadrant or machinist's level lay it in a horizontal position. Put the sight in the sight bracket and loosen the coupling that connects the sight operating worm with the elevating worm shaft. Turn the sight operating worm using a wrench on the square part projecting to the front of the sight standard, until the level on the sight indicates that the sight is in a horizontal position. Then tighten up the coupling. The line of sight and axis of the bore will be parallel when the sight is set for zero elevation and deflection and the telescope longitudinal level is centered.

3.Q.On the disappearing carriages models of 1903, 1905 and 1905 M I 6-inch gun what adjustment is made to bring the line of sight parallel to the axis of the bore?

A.On Models of 1905 and 1905 M.I., a lug at the base of the sight arm bracket is engaged by two set screws secured on the sight standard. By means of this lug and the set screws the sight arm bracket, sight arm and sight may be moved in azimuth and the line of sight made parallel to the axis of the bore. To make the adjustment, point the gun at a distant object (about 6000 yards away, if practicable) by means of a bore sight, set the deflection scale of the sight at zero, then bring the line of sight on the target by means of the set screws. Four tap bolts are screwed into the sight standard through holes in the flange at the base of the sight arm bracket. These holes are 0.188 inch in diameter larger than the bolts, which allows sufficient adjustment. The screws should be loosened, the adjustment made, then the screws tightened and the adjustment verified. (See O.P 1703-08 and 1774-08).

The 6-inch disappearing carriage, model of 1903 has a similar

adjustment. In fact practically all disappearing carriages have provisions for this adjustment, differing from the above in mechanical details only.

Throttling valves.

4.Q. How are proper settings of throttling valves determined?

A. The setting of the valves best suited to different conditions of loading, full or practice charges, can be determined only by experience in actual firings on each particular carriage. Different carriages may require different settings, and the same carriagesmay at different times require different settings for the same conditions of loading if it is in a materally different condition as to cleanliness and lubrication of parts. (Ord. Pamphlet No.1686).

5.Q. What records should be kept in connection with throttling valve settings?

A. It is necessary that careful records be kept of the setting of the valve, the conditions of loading and recoil, the elevation of the piece and any abnormal condition of the carriage which might effect the freedom of its operation. These records should be studied in the light of all these circumstances to obtain perfect working. (Ord. Pamphlet No.1686).

6.Q. In lack of experience how much should the valve be opened for full charges?

A. To about 0.05 Sq.inch but not more (Ord. Pamphlet No.1686).

7.Q. What is the purpose of the padlock for locking the valve yoke?

A. To guard against accidental or unauthorized changes in the valve setting. The valve should habitually be kept locked but this should not be understood as discouraging examination and handling of the valve, as it is highly desireable that the personnel understand the construction and operation of the valve, (Ord. Pamphlet No.1686).

Gas Check Pad.

8.Q. Describe the method of adjusting the gas check pad on the 6-inch gun, model 1897 M.I.?

A. Close the breech with the spindle nut loose, but not loose enough to permit slipping of the pad or split rings, rotate the block one-half. With the mechanism in this position screw up the spindle nut as tight as it can be screwed with the wrenches provided. It is necessary to insert the end of a screw-driver in the opening of the nut in order to spread it sufficiently to allow its rotation without rotating the spindle. Clamp the spindle nut and rotate the breechblock until the breech is closed completely. This last operation presses the pad into its seat, due to the forward motion of the block. Then the pad should be in proper adjustment for firing; this may be tested by turning the mushroom head by hand. It should turn easily, but without play.

The breech mechanism of the 6-inch guns, models 1897 M.I. 1903 and 1905 have a spindle key which prevents the spindle and mushroom head from turning. The parts of the above method involving the turning of the mushroom head does not apply to these guns. (C.A.D.R. Par. 873).

9.Q. ELEVATING GEAR.

9.Q. What adjustment is made on the elevation gear of the 6-inch disappearing carriage, model 1898?

A. The elevation pointer must be adjusted to indicate correct elevation.

10.Q. How is the adjustment made?

A. Using a clinometer, bring the gun successively to the elevations 0 degree 5 degrees and 10 degrees. Adjust the pointer so that it will coocincide with the corresponding gegree marks on the range drum. After this has once been done _____ ___ 1909 requires that it be dowelled in place.

11.Q. How is the resistance of the elevating worm spring tested?

A. With the gun at zero degrees elevation, a weight of not to exceed 5000 lbs is applied on the elevating arm G.O.3, W.D. 1912 and Cir.13, W.D.-10. This requires considerable ingenuity on the part of gun commanders and battery commanders, especially in a 6-inch battery, to obtain the maximum test prescribed. It is not material to the results of the test whether the gun be in battery or not. The in-battery position affords much more room in which to work. The conditions which do affect the severity of the test are the point of application tion of the maximum weight and its line of direction relative to to the motion of lower end of elevating arm along racks. The mo most severe conditions are produced by applying the weight at the rack end of the arm in a direction parallel to the motion of the racks. The method of securing the maximum weight of pull prescribed depends upon the means available. It is usually accomplished by

12.Q. GREASE CUPS.

Note: There are no grease cups provided for 6-inch disappearing carriages, model of 1898, but all of the later 6-inch disappearing carriages are provided with them.

12.Q. How should grease cups filled and adjusted?

A. Fill them with lubricant $4\frac{1}{2}$ to the bottom of the bevel at the top of the cup being very careful that no grit or dirt gets into them. Put on the cap, taking care that the leather packed follower enters the cup properly and is not caught nor bent. Screw the cap down until the spring rod projects about $4\frac{1}{2}$ inches above the head of the cap.

VIII POINTING.

(a) Methods of pointing and pointing tests.

1.Q.Name the three methods of pointing?

A.Case I,Case II,Case III.

2.Q.Describe the method of Case I?

A.This method of pointing is used only with rapid-fire guns where means for laying in elevation by quadrant have not been provided. Direction and elevation are given by the sight. The gun pointer adjusts the sight in its seat and sets the elevation and deflection scales for the indicated range and deflection,respectively. He keeps the line of sight as nearly as possible on the designated point of the target and the piece is fired as soon after the command READY as it is aimed accurately.
In firing a series of shots he observes the splashes if possible and, when necessary,changes the setting of his sight to correct for the deflections. He changes the elevation to correspond to the changing range of the target or on orders from the battery commander. With two gun pointers,one controls the elevation and the other the direction. (C.A.D.R.531 1909)

3.Q.Describe the method of Case II?

A.This is the normal method of pointing all guns except those of 6 inch or smaller caliber on barbette mounts. Direction is given by the sight and elevation by the range scale attached to the carriage. The range setter lays the gun for elevation in the manner described in the Duties of the Range Setter under the "Service of the Piece",page . The gun pointer sets his sight,causes the piece to be fired,and corrects for error in deflection as described in Duties of Gun Pointer under "Service of the Piece",page .(C.A.D.R.532 1909)

4.Q.What is Case III and when is it used for guns?

A.Direction is given by the azimuth circle and elevation by the elevation scale or by quadrant. The use of this method for guns is limited to batteries where fogs or other local conditions make it necessary in the opinion of the Coast Defense Commander to prepare to fire at a target obscured from the guns.(C.A.D.R.533 1909)

5.Q.State the advantage in firing by Case II rather than by Case I?

A.1.The gun pointer,having to lay the gun for direction only,can watch his target more closely,set his deflection and lay his gun in azimuth more carefully. He has a better opportunity for spotting his splash and is less apt to make his corrections in the wrong direction.
2.The range setter,by observing his time range relation can keep his gun laid in elevation at all times.
3.Practically all range setting and elevating mechanism is under cover.
4.With Case I accuracy of fire is dependent upon the gun pointers accuracy of bisection of the desired point of impact with both the horizontal and vertical wire,while in Case II accuracy of fire is dependent upon his bisection with the vertical wire only.

11.Q.Are there any advantages in firing by Case I instead of Case II with the sight on the trunnion bracket?

A.Firing by Case I instead of Case II eliminates errors due to:
1.Base ring being out of level
2.Range pointer not properly adjusted
3.Errors in range graduations
4.Back lash in elevating mechanism. This includes the "sticking" of the elevating racks with the resulting change in elevation of the gun by jumps while elevating. This is some times found in carriages over certain parts of the path of the elevating racks. This difficulty should be remedied by the ordnance machinist,when found.

12.Q.Which Case should be employed when practicable? Why?

A.Case II. Because all of the disadvantages and errors under Case II have minimized or eliminated by methods and apparatus now in use. While only the first two objections to Case I are capable of being eliminated by design of parts or expert workmanship. The last two objections are inherent in Case I.

13.Q.In how many ways may Case II be employed with the sight on the trunnion bracket?

A.In one way only. Direction is given by the sight and elevation by the range scale.

14.Q.If the range disc becomes unservicable which method of firing Case I should be employed? Why?

A.The second method where sight elevation instead of quadrant elevation is set on the sight,becahse it permits the gun pointer to water line his target.

15.Q.When is the longitudinal bubble on the sight used?

A.Only when using quadrant elevation in sighting by Case I and when testing the sight against the clinometer mounted on the bore rest.

16.Q.How often are pointing tests held?

A.At least once each week a pointing test shall be made at the gun batteries of the primary armament.C.A.D.R.534.

17.Q.Is any record made of the results? How? What is done with it?

A.For each trial,records are kept on Ordnance Dept.form No.817 of the time from LOAD to FIRE,the range to the target,the time from READY to FIRE, and the deflection error; one copy is forwarded to the post commander and one copy posted on the bulletin board of the company.C.A.D.R.536-1909.

18.Q.Describe the method of making this test in a gun battery of the primary armament andgive an example?

19.Q.How is the excellence of the gun pointer's work gaged?

A,The excellence of the gun pointer's work is determined,first,by the accuracy of his pointing; second,by the promptness with which he is able to give the command FIRE after the piece is ready.C.A.D.R.535.

20.Q.In what way is the gun pointer on disappearing guns limited in the time available for getting on the target?

A.With disappearing guns it is important that the gun pointer betrained to get on the target in the time necessary to close the breech plus the tripping interval,so that in practice or action he can fire as soon as the gun is in battery. When the gun is not tripped,the command READY should not be given until the end of the tripping interval. C.A.D.R.537.

21.Q.Describe in detail the drill in pointing and simulating fire held at rapid fire batteries?

A.Rapid fire gun batteries shall have frequent drills at pointing and simulating fire at moving objects. Immediately before the simulated firing begins the gun pointer makes a deflection correction for the movement of the target during the time of flight. To do this he sets the index of deflection scale at normal,traverses the gun until the line of sight is a little in front of some point of the target and stops traversing; when the selected point comes on the line of sight he keeps it there during the time of flight by turning the deflection screw. Then he observes the reading of the deflection scale and sets the vertical wire an equal distance on the opposite side of the normal. The time of filght to the nearest second is given by the gun commander,andthe gun pointer measures time by counting. The gun pointer sets the sight for elevation and follows the target, keeping the gun pointed continuously as far as practicable. C.A.D.R.540.

22.Q.When would a 6 inch gun battery use the pointing test prescribed for the primary armament?

A.When equipped with the standard fire control system for primary armament.

23.Q.When would a 6 inch gun battery use the pointing test prescribed for rapid fire batteries?

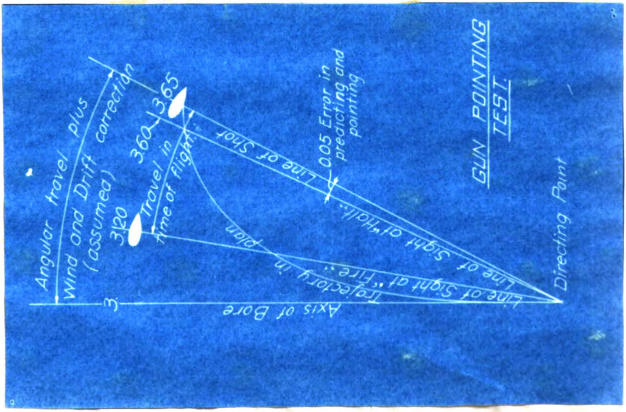
A.(a) When not equipped with the standard fire control system for primary armament.
(b) When equipped with the standard fire control system for primary armamentand
1.Drilling under emergency conditions.
2.Firing under emergency conditions.

Note: See Plotter,II(b) Indication and identification of targets page 85, ~~for~~ discussion on selection of aiming points pages 123 and 128, Also see Plotter II (d), page 116.

A. See Fig.   . In order to simplify the keeping of records, an assumed deflection for wind and drift may be used during the test. This deflection should be changed frequently during the drill so that gun pointers may not know the reading that should be obtained at the end of the time of flight. To accomplish this the platen of the deflection board is set for the assumed deflection, and the setting is not changed so long as the same assumed deflection is used. A noncommissioned officer uses a stop watch and a time-of-flight table. The gun pointer sets his sight at the deflection received from the plotting room, which is that obtained from the deflection board by combining the correction for angular travel during the time of flight with the assumed deflection for wind and drift. With guns on nondisappearing carriages he directs the traversing so as to follow the target continuously, keeping the vertical wire on the designated point; with guns on disappearing carriages he waits until the truck has been withdrawn from the breech before the piece is traversed. In each case he gives the command FIRE as soon after the command READY as he is on the target; traversing is stopped and then he follows the target with the vertical wire. The noncommissioned officer with the stop watch starts it at the command FIRE; commands HALT and stops the watch at the expiration of the time of flight. The gun pointer stops following with the vertical wire at the command HALT, when the reading of the deflection scale should be the same as the assumed deflection for wind and drift. If not, the difference is the error in predicting and pointing.

Example. Assumed deflection, 3.65; deflection sent to gun pointer, 3.20; reading of the deflection scale at the end of time of flight, 3.60. 3.65-3.60=0.05, the error. C.A.D.R.534.

Note: The curvature of the trajectory in plan ~~under~~ in the figure is very much exaggerated in order to make the figure clear.



VIII POINTING

(b) The Telescopic Sight.
(See Handbook of Sights for Cannon, O.P.1952-1903)

1.Q.What Model of Telescopic Sight is in use at the battery to which assigned?

A.Model 1898 M I

2.Q.Of what two principle parts does the sight consist?

A.The trunnion casting and the telescope.

3.Q.What parts does the trunnion casting comprise?

A.The trunnions,the leveling lug,the bearing for the horizontal axis of the telescope drilled thru the casting near the forward trunnion,and the elevation arc with the bearing for the elevating worm spindle.

4.Q.How is the telescope attached to the trunnion casting?

A.By its horizontal axis and the worm rack.

5.Q.Describe the bearing for the elevating worm spindle and the elevation arc?

A.They are made in one piece.The bearing is practically dust proof to protect the worm and worm rack. The center of the elevation arc is on the horizontal axis of the telescope. The arc is graduated from-7 degrees to +23 degrees. The least reading of the arc is 30 minutes. Using the vernier the arc can be read only to 16°56'

6.Q.How is back lash in the worm rack overcome?

A.Within the bearing for the horizontal axis or pivot of the telescope is an annular groove which holds a spiral spring,one end of which bears against the trunnion casting and the other against the telescope. The spring,being placed under considerable strain in fitting it in its groove,exerts practically uniform pressure against the telescope in every position.

7.Q.By what means is the telescope elevated and depressed?

A.The telescope,being pivoted on its horizontal axis,is moved in elevation and depression by means of the worm and worm rack,which are so made that one complete turn of the worm spindle moves the telescope about its horizontal axis thru one degree.

8.Q.How is the micrometer screw graduated? How is it adjusted?

A.It is graduated to read minutes from 0 to 60 minutes. It is provided on top with two small screws which secure the collar on which the graduations are made. After unscrewing them the collar can be turned independently of the spindle and adjusted to make the micrometer reading agree with the vernier reading.

9.Q.How is the vernier graduated? How is it adjusted?

A.The least reading of the vernier is 2 minutes. By means of the vernier each two minutes of the half degrees on the elevation arc may be accurately set. The vernier is attached to a vernier piece on the left side of the telescope and is adjusted by means of two screws working into the vernier piece,and against two shoulder pieces bearing against the vernier.

10.Q.Describe the parts used in setting deflection?

A.For giving deflection a set of platinum cross wires,one vertical and one horizontal,and two scales,one inside and one outside are provided. The vertical cross wire is attached to a sliding diaphragm actuated by the deflection screw on the right side of the telescope. In giving deflection this vertical wire moves along the interior horn scale and indicates the reading. In addition,this diaphragm has a pointer which at the same time moves along the outside scale,giving the reading without looking into the tel scope. The telescope is cut away at this place to make room for the outside scale,and to reveal the pointer. The screw actuating the sliding diaphragm is accuratel, cut to give correct reading,and the back lash is overcome by two spiral springs working against this diaphragm.

The horizontal cross wire is attached to a fixed diaphragm placed behind the sliding one. For the purpose of adjustment this diaphragm can be given a slight motion in a vertical direction and secured in the correct position.

11.Q.How are the inside and outside deflection scales and the deflection screw graduated?

A.The inside scale is graduated from .75 degree to 5.25 degrees,the least reading being .05 degree. 3 degrees is the normal of the scale. The outside scale is graduated from .50 degree to 5.50 degrees,the least reading being .50 degree. Three degrees is the normal of the scale.

The deflection screw is graduated from 0 to .50 degree. The least reading is .05 degree. One turn of the screw moves the outside pointer and the vertical wire thru .50 degrees of their scales. By means of the deflection screw the outside scale can be read accurately to .05 degree and can be estimated closely to .01 degree.

12.Q.Describe the two levels and give the use of each?

A.The telescope level,fastened to the right side of the telescope,is used only in Case I when quadrant elevation is set on the elevation scale,and in making adjustments when it is desired to level the telescope. The cross level is attached to the underside of the telescope and is provided with an opening at the top for direct laying,and one at the bottom for reverse laying (when the objective is pointed to the rear).

To obtain a correct angle of elev tion the elevation arc must be vertical. The purpose of the cross level is to make the horizontal axis of the telescope truly horizontal so that the elevation arc will be vertical.

13.Q.Name the lenses in the telescope in order from front to rear?

A.1.Objective 2.Two erecting prisms which cause the image to be seen right side up 3.Field lense,at the front end of the eye piece 4.Eye lense at the aperture in the eye piece.

14.Q.For what qualities is this telescope especially designed?

A.Large field of view,an erect image,and the maximum amount of light the eye will receive under the most unfavorable conditions.

15.Q.What is the power and field of view?

A.Power is 4. The field of view is 6°75'

16.Q.How are the objective and eye piece focused?

A.Objective,by a focusing collar back of the sunshade.
Eye piece,by screwing or unscrewing it in its bearing.

INSTRUCTION FOR USING THE SIGHT.

17.Q.When should the sight be removed from its case?

A.Not until the gun pointer has reached the sighting platform. This will avoid any accident which might injure the sight before it is placed in its bracket.

18.Q.What other precautions must be taken in handling the sight?

A.While the sight is in the case,the cover should be kept fastened. In removing the sight from its case,take hold of the strap; otherwise it is liable to slip from the hands.

19.Q.Why is it important to see that the objective is screwed home before focusing the telescope .
(The cell and ring containing the objective screw into the front end of the telescope),

A.The optical center of the objective may not coincide with the axis of the screw at all psoitions. A change in the position of the optical center involves at once a change in the line of sight. This may cause a large error.

20.Q.Describe the process of focusing the telescope?

A.First with the telescope pointed to the sky,focus the eye piece by screwing or unscrewing till the cross wires,with every roughness on them, are distinctly visible. Next focus the objective by directing the telescope on a distant object and turning the focusing collar until, on shifting the eye over the eye piece,the intersection of the cross wires remains on the same point of the object (there is then no parallax)

21.Q.What is parallax?

A.For definition,method of removing,and importance See Observer III (a) A detailed knowledge of adjustment and use of all observing instruments and range finders,questions 38 to 40 inclusive,page 148 .

22.Q.What is the trouble when the target cannot be seen as distinctly when parallax is removed as when some of it remains?

A.The distant object selected for this purpose should possess a sharp outline when the objective is focused. Should the image not be clearly defined,then the eye piece is not correctly focused,and must be again adjusted until the image is clear.

23.Q.Do the objective and eye piece require focusing for each individual?

A.The eye piece does,but the objective once focused is correct for all observers. Unless disturbed,an objective once focused will remain so indefinitely.

24.Q.In what manner should the sight be placed on its bracket?

A.The sight trunnions should be carefully placed in the V'$ to avoid scratching or denting them. Any change in their shape will throw the sight out of adjustment. The leveling lug should be brought to bear gently against the leveling screw.

25.Q.Why should the cross level bubble be centered when aiming?

A.The cross level must be centered so that the elevation arc will be vertical in using Case I,otherwise the angle of elevation set on the arc will not be a vertical angle and the elevation given to the gun will be less than intended. In using the vertical wire in Case II, unless the wire is vertical (it should be vertical when the cross level is centered) there is apt to be a sight error in deflection due to the inclination of the wire.

CARE AND PRESERVATION OF TELESCOPIC SIGHT.

26.Q.Can a telescopic sight stand rough usage?

A.No. It is a delicate instrument and must not be subjected to any rough usage, jars,or strains.

27.Q.Why should the V bearings and trunnions be kept free from rust and dirt?

A.Because a small amount of rust or dirt on either of them will be sufficient to throw the sight out of adjustment.

28.Q.In what kind of a place should the sight be kept?

A.The sights must,when not in use,be kept in their leather cases in a dry place.

29.Q.In what condition should the glasses be kept?

A.To obtain satisfactory vision,the glasses should be kept perfectly clean and dry. Either a piece of chamois skin or a clean linen handkerchief will answer for cleaning purpose,care being taken that the cleaning materiel does not contain any dirt or grit which will scratch the glass. The glass will seldom require cleaning on the inside; but, when necessary they should be unscrewed and cleaned by a competent person only. The object glass (objective) should be kept screwed home.

30.Q.What is prescribed by C.A.D.R.1909,par 887 with regard to taking apart telescopes?

A.The prisms and lenses in the telescopes of position finders,azimuth instruments,and sights are not arranged for adjustmentby those using them; the taking apart of telescopes for any purpose,and the making of any adjustments other than those provided for in their construction and described in the pamplets issued by the Ordnance Department, except under the supervision of district armament officers,are forbidden.

When telescopes or any instruments of the range finding and fire control system for coast artillery issued by the Ordnance Department require repair,a report describing the character and extent of the injuries or defects is made to the armament officer of the district. In case the repairs or adjustments required by telescopes and other delicate instruments of precision are of such a nature that they can not be made at the post the instruments are shipped by express to such arsenal as may be designated by the district armament officer.

31.Q.How are the trunnions cared for?

A.The trunnions are purposely left bright. Sand paper or emery paper should on no account be used on these trunnions. A slight rubbing with crocus paper will remove rust from them. The trunnions of the model of 1898 and 1898 M sights are made of phosphor-bronze which possesses great hardness,elasticity and resistance to corrosion. These trunnions are not as liable to rust as those on other models of sight. A little vaseline should be kept on trunnions as a preventative of rust.

32.Q.How are the worm and worm rack cared for?

A.They should be kept oiled with a little machine oil

33.Q.How should dust be removed fromthe cross wire?

A.BY a competent person only,using a fine camel's hair brush.

34.Q.Should any of the adjusting screws be touched?

A.No,unless by a competent person authorized by the Chief of Ordnance to make adjustments. This applies particularly to the screws holding the cross level,the deflection scale,the micrometer screws,and the vernier,but does not apply to the screws for making the graduation on the milled heads of the elevating screw and deflection screw agree respectively with the vernier and with the interior deflection scale.

35.Q.What care is taken of the bearings on the bracket?

A.They should be kept slightly greased to prevent rust,and all dust removed from them before the sight is seated.

36.Q.What should be the condition of the sight when put in its case?

A.It should be free from dust and moisture and have a little vaseline on the trunnions.

37.Q.Why should sights be inspected occasionally while stored in cases?

A.Because the tannic acid in the leather case may affect the bright parts of the sight and cause corrosion.

38.Q.What must be the condition of the optical parts before any sight is tested?

A.The objective and eye piece lenses must be clean and the objective screwed home to the point where its optical axis coincides with the axis of the screw thread.

39.Q.Who ordinarily replaces broken cross wires? Will it ever have to be done by gun pointers? What is the method?

A.The resident ordnance machinist usually replaces broken wires. Under service conditions it may easily happen that this will have to be done by gun pointers.

The method follows:

In the models of 1898 and 1898 M sights,after removing the cap containing the eye piece,unscrew the three screws which fasten the horizontal cross wire frame and remove this frame. Then unscrew the two screws which secure the horn deflection scale and remove it. Now unhook the two spiral springs which are attached to the end of the micrometer box and unscrew the knob fromthe deflection screw,when the slide can be removed. After renewing the cross wires,replace the parts in the reverse order in which they were removed.

The models of 1898 and 1898 M sights will require in addition an adjustment of the frame carrying the horizontal cross wire, and perhaps an adjustment of the graduated ring of deflection knob,as explained in the directions for adjusting these sights.

Care should be had that the platinum wires lie in the bottom of the small grooves which are cut in the micrometer slide and frame to receive them; otherwise they will not be vertical and horizontal, respectively,when placed in the sight.

40.Q.How may a sight be tested with the facilities at a fortification? Who makes such tests?

A.These tests are always conducted by an officer or specially trained ordnance machinist. For tests and methods of conducting them for all models of sights,see Appendix H, page 178.

GUN COMMANDER and GUN POINTER.

VIII Pointing.

(c) Emergency system and salvo points.

For this subject, see the same subject under Plotter II (d), page 116.

VIII

(d) Bore sighting and orientation.

1.Q.Describe the process of bore sighting? Why should guns be bore sighted frequently?

A.Guns should be bore sighted frequently in order to check the adjustment of the sight standard and to correct it if necessary. The process is as follows: Place a bore sight in the breech and a thread in the vertical diameter of the muzzle. Sight thru the bore sight and bring the muzzle thread on a well defined point of an object at or beyond the mean range for the piece. If a bore sight is not available the vent or a thread in the vertical diameter of the breech may be used. With the sight in adjustment on the sight bracket and the vertical wire set at normal, adjust the sight standard until the vertical wire of the sight is brought on the point. C.A.D.R.526.

An improvement in this method which has been practiced by persons acquainted with it for several years and which was published in a circular letter from Headquarters, Eastern Division, Jan.18, 1913, is as follows: Place one of the objectives of a field glass against the vent when the breech is closed, the vertical wire being inthe usual place on the muzzle of the gun. The effect is to cause the wire to appear like the vertical hair in a telescope, and the accuracy in sighting is practically the same as if a telescope centered in the gun were used. A material increase in the accuracy and certainty of adjustment is thereby secured.

See adjustment of Sight Standard under II Gun and carriage, page 33.

2.Q.On the disappearing carriage model 1898 for 6 inch gun, can the line of sight be made to converge with the axis of the bore by adjustment of sight standard?

A.No. (See Adjustment of Sight Standard, page 33.

3.Q.On this carriage, what can be accomplished by bore sighting?

A.It may be determined whether or not the line of sight is parallel to the axis of the bore. If not parallel the error may be determined by measuring the error with the vertical wire and the deflection scale. In making this test for parallelism, converge the line of sight and the axis of the bore on a point at least 3 miles distant. Theoretically the two lines converging on such a point would not be parallel, but practically they may be considered parallel since they are sides of a triangle 3 miles long having a base of only a few feet.

4.Q.How may an error determined as above be corrected on this carriage?

A.It cannot be corrected by adjustment of sight standard. It would not be advisable to have the ordnance Dept.move the inside deflection scale to correct the error because the sight would then be out of adjustment for use on any other carriage. The gun pointer or deflection recorder must be trained to apply the correction to each deflection before it is set on the scale. If the vertical wire reads less than 3 (normal) when the gun is bore sighted the proper deflection for the gun pointer to set will be less than that sent from the deflection board by the difference between the reading when boresighted and 3.

In a similar manner, if the vertical wire reads more than 3 when the gun is boresighted the proper deflection setting will be greater than that sent by the difference between the readings when boresighted and 3.

5.Q. In bore sighting why is a point at or beyond mean range of the piece selected? Draw a figure and explain?

A. Because a point at mid range causes the line of sight and the axis of the bore prolonged to draw nearer each other till they cross at mid range, after which they gradually draw apart until at extreme range the distance between them is not greater than the distance between them at the gun. This gives a zero deflection error at mid range and a minimum error at short and long ranges. Even at these ranges this error is so small that it may be neglected. If any point between the battery and mid range is taken, the error at long ranges will be increased for two reasons:

1. The line of sight and the axis of the bore make a larger angle with each other than before.
2. The error due to the divergence of the lines is equal and opposite to that at the muzzle, when a range is reached that is double the range of the point of intersection, and is proportionately greater as the distance from the point of intersection increases.

It may at first appear that the advantage lies with a point of intersection at about 3/4 of the effective range, since this unavoidable error would then be a minimum where the effect of an error in deflection setting would be approaching the maximum. This error is too small to affect the probability of hitting the general target at long ranges, while at short ranges it might interfere with hitting selected vital parts of the target. For this reason the mid range point of intersection is undoubtedly best.

6.Q. What is meant by orientation in connection with a gun battery?

A. (C.A.D.R. 1909 par.527) The proper setting of the azimuth indices on the azimuth circles of the guns so that, when the guns are aimed at a point near the main channel about mid range from the battery, the azimuth reading is the same for each; this reading to be the correct azimuth of the distant point from the directing point or gun.

7.Q. Why is a point at mid range of the battery and near the main channel selected?

A. Because if such point is used the azimuth differences due to gun displacement may be disregarded.

8.Q. If there are two channels of equal importance what point should be taken?

A. A point at mid range and mid way between the channels.

9.Q.What is the purpose of having the guns of a~~b~~ battery orientated?

A.So that, when Case III is used, the azimuth of the target from the directing point, or gun, may be set on the azimuth circles of both guns.

10.Q.Explain why range differences are stenciled on the base ring or on the step of the loading platform?

A.See Fig. , ~~page~~ marked GUN DIFFERENCES below ~~under Plotter, III Fire Control apparatus~~. Due to the displacement of the guns from the directing point, the range from either of the guns to the target will be different from the range from the directing point to the target, except when the target is on a line midway between the directing point and one of the guns and perpendicular to the line joining them. In this case the range from this gun to the target is the same as from the directing point to the target. The fire control system determines the range from the directing point to the target. To get the range from a gun to the target, the range setter must add the number of yards nearest the indicator if marked + and subtract if marked - . Usually each five yards of range difference is stenciled and marked + or - . A line called the indicator is stenciled at a convenient place on the carriage and indicates the range difference of the gun at any particular azimuth. The numbers may be stenciled on the parapet wall and the muzzle used as an indicator. If one gun is taken as the directing gun, there will be no range difference for it, and only the range setter of the other gun will have to apply range differences.

Paste here blue print marked Gun Differences.

GUN COMMANDER AND GUN POINTER.

XI Channels leading to harbor.
(Note: This is in Part V of the examination for Observer).

1.Q.What is the meaning of the word,"harbor",in the sense that it is used here?

A.All of the navigable water area within or behind the zone of protection of the fortifications. It does not mean the harbor of any particular seaport when more than one are located within or behind the defended area. For instance the Coast Defense of Long Island Sound defends the whole Sound and the many ports which are dependent upon it.

2.Q.What are the names of the bodies of land on which the forts of this coast defense are located?

A.Fort H.G.Wright,N.Y.,on Fisher's Island;Fort Terry,N.Y.,on Plum Island;Fort Michie,N.Y.,on Great Gull Island;Fort Mansfield,R.I.,on Napatree Point;Fort Tyler,N.Y.,on Gardiner's Point Shoal.

(Note:Underlined parts of answers to be left blank in printing under this and the following questions).

3.Q.What is the name of the main channel leading to this harbor?

A.The Race, so called because of the very swift currents found in it on each change of tide

4.Q.Where is it located?

A.In general, between Fort Michie and Fort H.G.Wright. Strictly speaking, between Little Gull Island near Fort Michie and Race Rock near Fort H.G.Wright.

5.Q.What are the names of the lighthouses covering this channel?

A.Little Gull Island light and Race Rock light.

6.Q.What is the least depth of water in this channel?

A.35 fathoms or 210 feet between Race Rock and Valiant Rock.
28 fathoms or 168 feet between Little Gull Island and Valiant Rock.

7.Q.What classes of warships can navigate it with safety?

A.All classes.

8.Q.Are there any natural obstacles in or near it which would make its navigation at night, or in a fog, with aids to navigation removed, dangerous to navigators unacquainted with it.

A. Yes. The Valiant Rock which is submerged under 18 feet of water at mean low tide and which is situated about midway between Little Gull Island and Race Rock. The cross currents and eddies would also be dangerous.

9.Q. What is the name of the second best channel leading to this harbor?

A. Plum Gut.

10.Q. Where is it located?

A. Between Plum Island and Orient Point, the nearest point of Long Island. It is located just beyond what is known as the New Harbor at Fort Terry.

11.Q. What are the names of the light houses covering it?

A. Orient Point Light in the Gut near Orient Point and Plum Island Light on Plum Island.

12.Q. What is the least depth of water in this channel?

A. 9 fathoms or 54 feet either side of the middle ground.

13.Q. What classes of ships can navigate it with safety?

A. All classes.

14.Q. Are there any natural obstacles in or near it which would make its navigation, dangerous to navigators unacquainted with it.

A. Yes. The middle ground on the line between the light houses has but 19 feet of water upon it. Midway Shoal with the same depth of water over it runs from Orient Point light toward Pine Point, the southern point of Plum Island.

15.Q. What is the name of the channel between Great Gull Island and Plum Island?

A. Gull Island Channel.

16.Q. In what part of the water area between Plum Island and Great Gull Island is the channel located?

A. About 1000 yards closer to Great Gull Island than Old Silas Rock; i.e. 2700 yards from F'6 and 1900 yards from Fort Michie dock.

17.Q. Are there any light houses covering it.

A. No, not directly. Little Gull Island light would be of assistance in navigating it.

18.Q.What is the least depth of water in this channel?

A.25 feet.

19.Q.What classes of warships can navigate it with safety?

A.All classes at high tides with skilled pilots,who have an intimate knowledge of the channel and currents. Under other conditions only light draft ships could afford to attempt it.

20.Q.What are the natural obstacles in or near it which would make its navigation at night, or in a fog, with aids to navigation removed, dangerous to navigators unacquainted with it.

A.Old Silas Rock, usually quite well exposed, is 1000 yards nearer Plum Island. Half way between the channel and Old Silas Rock is a submerged rock having but three feet of water over it. On the N.E.side of this channel, 1500 yards from Old Silas Rock and in prolongation of the line, East End of Plum Island-Old Silas Rock is a small shoal under 18 feet of water. Toward Great Gull Island is rapidly shoaling water. The area immediately S.E.of Old Silas Rock is occupied by Middle Shoal under 19 feet of water. 1500 yards South of Old Silas Rock is Bedford Shoal under 15 feet of water. The greatest depth between East End of Plum Island and Old Silas Rock is 17 feet. No channel exists here.

21.Q.What is the name of the channel between Plum Island and Gardiners Point?

A. No name is given on the charts but it is customary to refer to it as Gardiners Bay Entrance.

22.Q.What are the names of the light houses covering this channel?

A.There are none. Distant lights furnish range lights to aid navigation.

23.Q.What is the least depth of water in this channel?

A.About 12 fathoms or 72 feet.

24.Q.What class of warships can navigate it with safety?

A.All classes.

25.Q.Are there any natural obstacles in or near it which would make its navigation at night, or in a fog, with aids to navigation removed, dangerous to navigators unacquainted with it.

A.Not in the immediate vicinity of the channel but Constellation Rock,under 17 feet of water and situated about 4500 yards E.N.E.of the channel and Plum Island Rock opposite the bath houses at Fort Terry are a menace to navigation.

26.Q.What is the name of the channel between Fisher's Island and Napatree Point?

A.The charts give no general name but each passage between the reef joining Fisher's Island and Watch Hill is named: Watch Hill Passage,Sugar Reef Passage,Catumb Passage, Lords Reef Passage and Wicopesset Passage.

27.Q.What is the width of this channel?

A.From Napatree Point Ledge to Wicopesset Rock is 1800 yards. Sugar Reef Passage is about 500 yards wide.

28.Q.What are the names of the lighthouses covering this channel?

A.Watch Hill Light and Latimer Reef Light.

29.Q.What is the least depth of water in this channel?

A.21 feet in Watch Hill Passage; 35 feet in Sugar Reef Passage; 22 feet in Catumb Passage; 39 feet in Lord's Passage; 19 feet in Wicopesset Passage.

30.Q.What class of warships can navigate it with safety?

A.Lord's Passage and Sugar Reef Passage can be navigated by all classes. The others are confined and full of short turns.

31.Q.Are there any natural obstacles in or near it which would make its navigation at night, or in a fog, with aids to navigation removed, dangerous to navigators unacquainted with it?

A.Yes there are many submerged rocks and shoals in the immediate vicinity of the passages and in Fisher's Island Sound.

32.Q.What is the name of the body of water northwest of Plum Island and west of Fisher's Island?

A.Long Island Sound.

33.Q.What is the name of the body of water southeast of Fisher's Island and east of Plum Island?

A.Block Island Sound.

34.Q.What is the name of the body of water south of Plum Island?

A.Gardiner's Bay.

35.Q.What is the name of the body of water north of Fisher's Island?

A.Fisher's Island Sound.

36.Q.What headlands or points are visible from Fort Terry?

LONG ISLANDS HEADLANDS.

A.Montauk Point at the extreme end of Long Island;
Shagwong Point just leaves Montauk Point exposed;
Culloden Point with a prominent group of three buildings upon it, is on the east side of Fort Pond Bay;
Rocky Point is separated from Culloden Point by Fort Pond Bay and marked by a low conical hill standing in front of higher ground to the south and southwest;

GARDINER'S ISLAND HEADLANDS.

Eastern Plain Point marks the east end of Gardiner's Island;
Gardiner's Point on which Fort Tyler is located;
Crow Head the high tan colored bluff, which marks the west end of Gardiner's Island;

LONG ISLAND HEADLANDS.

Hog Creek Point, with three prominent buildings regularly spaced upon it, on Long Island, just west of Crow Head;
Cedar Point on the east side of Sag Harbor entrance;

SHELTER ISLAND HEADLANDS.

Mashomack Point on the west side of Sag Harbor entrance and beyond Cedar Point;
Nicholls Point on the west side of Sag Harbor entrance and closer than Cedar Point;

RAM ISLAND HEADLAND.

Ram Head, north of Cedar Point and in front of Shelter Island;

LONG ISLAND HEADLAND.

Long Beach Point, south of the town of Orient and on the north side of the channel leading to Greenport;

PLUM ISLAND HEADLAND.

Pine Point, the southern end of Plum Island;

LONG ISLAND HEADLAND.

Orient Point, opposite the New Harbor;

CONNECTICUT HEADLANDS.

Hatchett Point, west of Black Point;

Black Point, on the west side of Niantic Bay;

Mill Stone Point, between Niantic Bay and White Stone Creek and directly north of East End of Plum Island;

Eastern Point on the eastern side of New London Harbor;

FISHER'S ISLAND HEADLANDS.

Race Point, the western extremity of Fisher's Island;

Wilderness Point just to the east of Race Point.

37.Q.What light houses and light ships can be seen from Fort Terry?

A. See table below.

LIGHTHOUSES.

NAME	CHARACTER Flash'g	INTERVAL Bet.Flash. Min.Sec.		COLOR OF Structure	HEIGHT Above Sea Ft.	VISIBILITY Nautical Miles	FROM EAST DISTANCE.	END AZIMUTH.
Cedar Island	**Fixed White**			**Granite**	**45**	**11**	**10**	**26°**
Long Beach Bar	Fixed Red			White	54	8 1/2	8	53°
Orient Point	Fixed Red			Brown	64	11 1/4	3	60°
Plum Island	Flash'g White	0	7 1/2	White	76	14	2.5	67°
New London Harbor	Fixed Red			White	90	15	8.3	204°
North Dumpling	Fixed White			White	70 1/2	11	8.9	228°
Race Rock	Flash'g Red and White	0	10	Granite	68 1/2	14	6.1	238°
Little Gull I.	Fixed White			Granite	92	17	2.8	248°
Montauk Point	Flash'g White	0	10	White with Brown band	169 1/2	19 1/4	15 1/2	297°

LIGHT VESSELS.

NAME	COLOR OF HULL	HULL MARKS	FOREMAST	MAINMAST	LIGHTS
Bartlett Reef Light Vessel	Black with White Streak	Words "Bartlett Reef"	Black cage	Black cage	2 Fixed White.

GENERAL FEATURES OF WARSHIPS

BATTLESHIPS

1.Q.What is the purpose of a battleship?

A.To fight the heaviest ships of the enemy in line of battle.

2.Q.What is meant by pre-Draednoughts,Dreadnoughts,and super-Dreadnoughts?

A.The Dreadnought was a British battleship built in 1906 which made a great change in the size and construction of warships because it was built on the "all-big-gun principle." Battleships built before the Dreadnought are called pre-Dreadnoughts and are rated as having but moderate power in battle. Dreadnoughts are warships having about the same qualities as the Dreadnought. Super-Dreadnoughts are ships having greater power than the Dreadnought. American examples of each type are as follows:

Pre-Dreadnought	Vermont and Louisana classes
Dreadnought	Michigan and South Carolina
Super-Dreadnought	Arkansas and Oklahoma classes

3.Q.What is the usual length of battleships?

A.Pre-Dreadnoughts	360 to 425 feet.
Dreadnoughts	490 to 520 feet.
Super-Dreadnoughts	520 to nearly 700 feet.

4.Q.What is the beam and draft?

	Beam	Draft.
A.Pre-Dreadnoughts	About 76 feet	24 to 28 feet
Dreadnoughts	" 80 "	24 to 31 "
Super-Dreadnoughts	80 to 97.5	26 to 29 "

5.Q.What is the usual displacement?

A.Pre-Dreadnoughts	10000 to 16000 tons.
Dreadnoughts	16000 to 18000 "
Super-Dreadnoughts	18000 to 32000 "

6.Q.What is the usual speed?

A.Pre-Dreadnoughts	15 to 19 knots.
Dreadnoughts	19 to 21 "
Super-Dreadnoughts	20 to 25 "

7.Q.How much motive power does a battleship usually have?

A.Pre-Dreadnoughts	9000 to 17000 horse power.
Dreadnoughts	16500 to 23000 " "
Super-Dreadnoughts	20000 to 40000 " "

8.Q.What guns does a battleship carry?

A.Pre-Dreadnoughts 4-12 inch,about 8-8 inch and a number of smaller guns.
Dreadnoughts 8 to 10-12 inch,and 20 or more 3 inch guns.
Super-Dreadnoughts 10 to 14-12 to 14 inch guns and 20 or more 5 to 6 inch guns.

9.Q.How many turrets does a battleship carry?

A.Pre-Dreadnoughts	2 large 2 to 8 small
Dreadnoughts	4 to 5 large
Super-Dreadnoughts	4 to 6 large

10.Q.What armor does a battleship carry?

	Belt	Casemate	F. S. Turrets	Barbettes	Conning T.
A.Pre-Dreadnoughts	8 to 9	5 to 8	8 to 12	5 to 17	7 to 14
Dreadnoughts	9 " 12	8 " 12	8 " 12	10 " 11	12
Super-Dreadnoughts	9 " 12	8 " 12	16 " 10	9 " 14	12

11.Q.How many funnels does a battleship usually carry?

A.Pre-Dreadnoughts	2 to 3	funnels
Dreadnoughts	2	"
Super-Dreadnoughts	1 to 2	"

See table of Battleships on page .

BATTLE CRUISERS

12.Q.What is a battle cruiser?

A.It is a type of ship designed immediately after the British Dreadnought of 1906. It so improved the armored cruiser type by increasing gun power,armor protection,and speed that they were capable of overtaking and destroying the fastest armor cruisers. Battle cruisers are almost the equals of Dreadnought and super-Dreadnought battleships in gun power and armor protection,and are much superior in speed. The battle cruiser is longer,narrower,has more displacement usually,a much greater motive power and one less big gun turret than a battleship of the same date.

The U.S.Navy has no ships of this type. The British Lion,and Invincible and the German Moltke and Von der Tann are examples of this type.

13.Q.What is the usual length of battle cruisers?

A.Moltke 590 feet,Invincible 560 feet,Lion 556 feet.

14.Q.What is the beam and draft?

A.Moltke beam 76 draft 26 feet,Invincible beam 78 draft 27/ feet.
Lion beam 86 draft 27 feet.

15.Q.What is the usual displacement?

A.Moltke,22500 tons,Invincible,17250 tons,Lion,25000 tons.

16.Q.What is the usual speed?

A.Moltke,28 knots,Invincible,28 knots,Lion 29.5 knots.

17.Q.How much motive power does a battle cruiser usually have?

A,The Moltke 80000 horse power,Invincible 41000 horse power,Lion 70000 horse power.

18.Q.What guns does a battle cruiser usually carry?

A.See table of Armored and Battle cruisers, pages 68 to 71

19.Q.How many turrets does a battle cruiser carry?

A.About four. Usually one turret less than the battle ships built at the same date.

20.Q.What armor does a battle cruiser carry?

A.See table of Armored and Battle cruisers

21.Q.How many funnels does a battle cruiser usually carry?

A.Moltke,	2	funnels
Invincible	3	"
Lion	3	"

ARMORED CRUISERS

22.Q.What is an armored cruiser?

A.It is a type of ship designed and built from about 1895 to 1906 as a destroyer of the enemy's protected cruisers,for the protection of the merchant marine of the nation to which they belonged,and for "flying squadron" duty;i,e,,for making sudden dashes upon the enemy.

23.Q.What are its characteristics?

A.Great length,narrow beam,high freeboard,three or four funnels,large motive power plant,great coal capacity,moderate armor protection and medium guns.

24.Q.What is the usual length of an armored cruiser?

A.From 400 to 600 feet.

25.Q.What is the beam and draft?

A.The beam from 40 to 70; draft from 23 to 28 feet.

26.Q.What is the usual displacement?

A.From 9000 to 16000 tons.

27.Q.What is the usual speed?

A.From 19 to 24 knots.

28.Q.How much motive power does an armored cruiser usually have?

A.From 12000 to 32000 horse power.

29.Q.What guns does an armored cruiser carry?

A.They usually carry 4-8 to 10 inch and a variable number of smaller guns.

30.Q.What armor does an armored cruiser usually carry?

A.Belt 4 inches,barbettes 4 to 7 inches,and conning tower 5 to 12 inches.

31.Q.How many funnels does an armored cruiser usually carry?

A.From 2 to 4 funnels.

32.Q.Are any nations building armored cruisers to-day?

A.No. Some authorities refer to the battle cruiser as a modern armored cruiser,others make the distinction that an armored cruiser is one having particularly guns smaller in caliber than battleships of the same date as well as the usual differences of lighter armor and greater speed. The latter authorities define the battle cruiser as an improved armored cruiser having guns of the same caliber as battleships of the same date but usually about one turret or two guns less in the main battery.

All nations building the cruiser type are building this latter type.

See table of Armored and Battle cruisers on pages 68 to 7?

BATTLESHIPS.

SHIP	NATIONALITY	LAUNCHED	DIMENSIONS. WATERLINE LENGTH	BEAM	DRAFT
Massachusetts	U.S.	1893	358	69.33 ft.	28 ft.
Royal Soverign	British	1891	380	75	30
Heimdall	German	1892	267	48.75	18.25
Tango	Japanese	1894	367	69	28
Georgia	U.S.	1904	435	76.17	26
Louisana	U.S.	1904	450	76.83	23.75
King Edward	British	1903	439	78	26.75
Braunschweig	German	1902	410	72	25.75
Kashima	Japanese	1905	455	78.17	26.6
Michigan	U.S.	1908	450	80.25	24.5
Dreadnought	British	1906	520	82	31
Westfalen	German	1908	470	89	27.5
Satsuma	Japanese	1906	479	83.5	28.75
Delaware	U.S.	1909	510	85.25	27.25
Neptune	British	1909	540	86	
Helgoland	German	1909	490	97	25.5
Aki	Japanese	1907	492	84	28.75
Arkansas	U.S.	1911	562	93.17	28.5
Orion	British	1910	528	85	27.75
Kawachi	Japanese	1910	479	86	28.25
Texas	U.S.	1912	573	95	24

BATTLESHIPS.

SHIP	NORMAL DISPLACEMENT	SPEED DESIGNED	SPEED BEST	HORSE POWER	FUEL CAPACITY NORMAL	FUEL CAPACITY MAX.	FUNNELS.
Massachusetts	10288 tons	17-knots		9000	400	1800-tons	2
Royal Soverign	14100	15	15.1	9000	900	1400	2
Heimdall	4100	15	16.1	5000		580 100-oil	2
Tango	11000	16	17	9000	700	1050	2
Georgia	14948	19	19.54	19000	900	1700	3
Louisana	16000	18	19.02	16500	900	2200	3
King Edward	16350	18.9	19.1	18000	950	2150 400-oil	2
Braunsehweig	13200	18	18.6	16000	700	1600 200-oil	3
Kashima	16400	18.5	20.22	17000	750	2000	2
Michigan	16250	19	20.01	16500	900	2200	2
Dreadnought	17900	21	21.3	23000	900	2000	2
Westfalen	18500	19.5	20.4	20000	950	2700 200-oil	2
Satsuma	19250	20		18500	1000	2500	2
Delaware	20300	21	22.25	25000	1016	2340 600-oil	2
Neptune	20600	21		25000	900	2700	2
Helgoland	21000	20.5			950	2700 200-oil	2
Aki	19750	20.5		25000	1000	2500	2
Arkansas	26400	20.5	21.3	33000	1933	3000 600-oil	2
Orion	23000	24		27000	900	2700 1000-oil	2
Kawachi	20750	20		26500		2500	3
Texas	27000	21					2

BATTLESHIPS.

ARMAMENT ---Number of each Caliber.

SHIP	16	15	14	13.5	12	11	10	9.2	8	7.5	7	6	5	4.7	4	3
Massachusetts				13" 4					8							12
Royal Soverign				4								10				
Heimdall								9.4" 3								10
Tango					4							12				1
Georgia					4				8			12				12
Louisana					4				8		12					20
King Edward					4			4				10				12
Braunschweig						4						6.7" 14				20
Kashima					4		4					12				12
Michigan					8											22
Dreadnought					10											27
Westfalen						12						12				16
Satsuma					4		12					12				4
Delaware					10								14			
Neptune					10										20	
Helgoland					12							12				16
Aki					4		12					12				4
Arkansas					12								22			
Orion				10											20	
Kawachi					14							10		12		
Texas			10										21			

BATTLESHIPS.

ARMOR THICKNESS IN INCHES.

SHIP	BELT	CASEMATE LOWER	CASEMATE UPPER	BARBETTES OR TURRETBASES	TURRETS LARGE FACE	TURRETS LARGE SIDE	TURRETS SMALL FACE	CONNING TOWER
Massachusetts	18-16"	5"		17"	8.5	5"	6"	10"
Royal Soverign	18-16	6	5"	17				14
Heimdall	9.5-6			8				7
Tango	15	5		5	10	5		12
Georgia	11-4	6	6	10 to 7	12	8	6	9
Louisana	11-4	7	2	12	12	10	6	9
King Edward	9-2	8	7	12	8		7	12
Braunschweig	9-4	4	9	11	11		6.75	12
Kashima	9-6.5	6		9 to 5	9		8-6	9
Michigan	12-1.5	12-8		10-8	12	8		12
Dreadnought	11-6	11		11	8			12
Westfalen	9.75-4	10	4	11	12			12
Satsuma	9-4	8		12	8		8	
Delaware	11	8	5	9-8	12	8		
Neptune	12	12-4	12-4	12	12	12		12
Helgoland	9.75			11				12
Aki	9-4	8		12	8		7	
Arkansas	11				11	10		12
Orion	12							12
Kawachi	12-5							
Texas	12-10	11-9	6.5	14	14	8		12

LATEST BATTLESHIPS.

SHIP	NATIONALITY	LAUNCHED	DIMENSIONS LENGTH	BEAM	DRAFT	NORMAL DISPLACEMENT
King George V	British	1911	564	89	27.75	25000
Oklahoma	U.S.	1913	570	95	28.5	27500
Iron Duke	British	1913	580	90		25400
Warspite	British	1913				
Konig Albert	German	1913	564.3	95.3	27.3	24500
Pennsylvania	U.S.	1914	600	97	28.6	31000

SHIP	SPEED DESIGNED knots.	BEST	HORSE-POWER	FUEL CAPACITY NORMAL	MAX.	FUNNELS.
King George V			31000	900	2700 1000-oil	2
Oklahoma	20 1/2					1
Iron Duke	21		33000			2
Warspite	25					
Konig Albert	21		2500	1000	3600	
Pennsylvania	21					

LATEST BATTLESHIPS.

A R M A M E N T -Number of ecah Caliber

SHIP	16"	15"	14"	13.5"	12"	11"	10"	9.2"	8"	7.5"	7"	6"	5"	4.7"	4"	3"
King George V				10											16	
Oklahoma			10													
Iron Duke				10								14				
Warspite		8										16			4	
Konig Albert					12							5.9" 14				
Pennsylvania			12										22			

A R M O R -Thickness in inches.

SHIP	BELT	CASEMATE LOWER	CASEMATE UPPER	BARBETTS	T U R R E T S FACE	T U R R E T S SIDE	T U R R E T S S.FACE	Conning TOWER
King George V	12"	9"			12"			12"
Oklahoma	13.5"			13"	16"	10"		
Iron Duke	12"				12"			12"
Warspite								
Konig Albert								
Pennsylvania	16"							

ARMORED AND BATTLE CRUISERS

SHIP	NATIONALITY	LAUNCHED	DEMENSIONS. LENGTH	BEAM	DRAFT	NORMAL DISPLACEMENT
Saratoga	U.S.	1891	380	64	28	8200
Edgar	British	1890	360	60	26	7350
Kaiserin-Augusta	German	1892	388	49	25.5	6300
Chiyoda	Japanese	1890	308	43	17	2450
St Louis	U.S.	1905	423	65	23.25	9700
Diadem	British	1896	450	69	27.25	11000
Roon	German	1903	403.25	65.5	25.75	9050
Kasuga	Japanese	1903	357	61.5	25.25	7750
California	U.S.	1904	502	70	26.5	13400
Duke of-Edinburgh	British	1904	480	73.5	27.5	13550
Scharnhorst	German	1906	449.75	71	25	11600
Tsukuba	Japanese	1905	440	75	26	13750
Washington	U.S.	1905	502	73	26.5	14500
Warrior	British	1905	480	73.5	27.5	13550
Bluecher	German	1908	489	80.33	27	15500
Kurama	Japanese	1907	450	75.5	26	14620
Invincible	British	1907	560	78.5		17250
Lion	British	1910	656	86.5	27.5	25000
Moltke	German	1910	590.5	88	28	21800
+Takao	Japanese	1911	541	80	26.5	18650

ARMORED AND BATTLE CRUISERS

SHIP	SPEED DESIGNED	BEST	DESIGNED HORES-POWER	FUEL CAPACITY NORMAL	MAX.	FUNNELS.
Saratoga	21 kts.	21 kts.	16500	750	1150	3
Edgar	18.5	19.5	12000	850	1250	2
Kaiserin-Augusta	20.7	22.5	12000	900		3
Chiyoda	19		5500	330	420	1
St Louis	21.5	22.4	21000	650	1500	4
Diadem	20.25	18.	16500	1000	2000 400-oil	4
Roon	21	21.4	19000	750	1600 200-oil	4
Kasuga	20	19.8	13500	650	1100	2
Calfornia	22	22.5	23000	900	2000	4
Duke of-Edinburgh	22.33	22.5	23500	1000	2000 400-oil	4
Scharnhorst	22.5	24.8	26000	800	2000 200-oil	4
Tsukuba	20.5	21	20500	600	2000	2
Washington	22	22.48	23000	900	2000	4
Warrior	22.33	23.1	23500	1000	2000 400-oil	4
Bluecher	24.5	26.4	32000	900	2300 200-oil	2
Kurama	21.25	22.17	25000	600	2000	3
Invincible	25	28.4	41000	1000	3000-oil	3
Lion	28		70000	1000	2500-oil	4
Moltke	28		80000	1000	2500-oil	2
Takao	25		44000			

ARMORED AND BATTLE CRUISERS

SHIP	16"	15"	14"	13.5"	12"	11"	10"	9.2"	8"	7.5"	7"	6"	5"	4.7"	4"	3"
Saratoga									4				10			8
Edgar								2				10				
Kaiserin-Augusta												12				8
Chiyoda														10		
St Louis												14				18
Diadem												16				14
Roon									8.2" 4			10				14
Kasuga									4			14				10
California									4			14				18
Duke of - Edinburgh								6				10				
Scharnhorst									8.2" 8			6				20
Tsukuba					4							12	12			4
Washington							4					16				23
Warrior								6		4						
Bluecher									8.2" 12			8				16
Kurama					4				8			12				4
Invincible					8										16	
Lion				8											20	
Moltke					12.2" 8							6.7" 12				16
Takao					10							8		10		

Table heading: A R M A M E N T - Number of each Caliber.

ARMORED AND BATTLE CRUISERS

SHIP	16"	15"	14"	13.5"	12"	11"	10"	9.2"	8"	7.5"	7"	6"	5"	4.7"	4"	3"
	A R M A M E N T -Number of each Caliber.															
Saratoga									4				10			8
Edgar								2				10				
Kaiserin-Augusta												12				8
Chiyoda														10		
St Louis												14				18
Diadem												16				14
Roon									8.2" 4			10				14
Kasuga									4			14				10
California									4			14				18
Duke of -Edinburgh								6				10				
Scharnhorst									8.2" 8			6				20
Tsukuba					4							12		12		4
Washington							4					16				23
Warrior								6		4						
Bluecher									8.2" 12			8				16
Kurama					4				8			12			16	4
Invincible					8										20	
Lion				8												
Moltke					12.2" 8							6.7" 12				16
Takao					10							8		10		

ARMORED AND BATTLE CRUISERS

SHIP	BELT	CASEMATE LOWER	CASEMATE UPPER	TURRETBASE BARBETTS	TURRETS FACE	TURRETS SIDE	TURRETS S.FACE	CONNING TOWER
Saratoga	4"			10"	7"			7"
Edgar	5-3	6"		7				12
Kaiserin Augusta								
Chiyoda	4.5"			Guns in sponsons.				
St Louis	4"	4	4	Guns behind shields				5"
Diadem		6						12
Roon	4-3"	4	4	4	6		4	6
Kasuga	6-1.5	6	6	5.5	5.5			4.75
California	6-3.5	6	5	4	6.5	6		9
Duke of Edinburgh	6-3		6	7	6			
Scharnhorst	6-4	6	6	6	6			8
Tsukuba	7-4	5	5	7	7			8
Washington	5-3	5		7	9	5		9-5
Warrior	6-3	6	6	7	8	6	8	12
Bluecher	6-4				6			
Kurama	7-4	5	5	7	7		6	8
Invincible	7-4	8			10	10		
Lion	6.25-4							
Moltke	7.5-4				8			
Takao								

U. S. ARMY CABLE SHIPS.

Q. What is a cable ship? By whom is it manned and operated?

A. A ship designed for the laying and repair of submarine cable. The ship is supplied and the civilian officers and crew are employed by the Quartermaster Corps. Each ship is under the command of an officer of the Signal Corps, U.S. Army. All work is performed by the ship's crew under the direction of the commanding officer.

Q. What are the distinguishing features of cable ships?

A. The distinguishing feature of a cable ship is marked projection at the bow or stem in which is mounted a large cable sheave over which the cable is paid out or wound in. Otherwise the smaller ships look much like mine planters. All cable ships are now equipped with wireless.

Q. What are the names, size, and stations of the Army cable ships.

A. Names	Tonnage Gross	Net.	Where employed
Burnside	2194	1405	Pacific and Alaskan Coast.
Cyrus W. Field	235	146	Atlantic Coast.
Joseph Henry	601	409	Atlantic and Gulf Coast.

The Burnside is an Army transport employed solely on cable work in the harbor of the Pacific Coast of the United States and more particularly on the Alaskan submarine cable.

U. S. ARMY MINE PLANTERS.

Q. What are the distinctive characteristics of a mine planter?

A. It is painted with the government standard colors like navy tugs and tenders, coast and geodetic survey ships, fish commission ships, army transports, harbor boats of the Quartermaster Corps, boats of the Engineer Dept., U.S. Army, etc.

It has one funnel and two masts, the formast being used as the post of a derrick with three booms. Some have now discarded two of the booms. When the booms are not in use they are usually secured in a horizontal position. During the mine planting season there are also three davits, carrying differential blocks, along the rail on each side just forward of the foremast. An extension bridge at the pilot house over hangs the sides of the ship.

The upper cabins are perhaps the most distinctive feature of all. Abaft the pilot house are cabins for the ships officers. Abaft the main mast is the commanding officer's cabin.

There is considerable deck space abaft this cabin and still more abaft the lower cabin. This latter space and the large deck space forward are designed to afford plenty of space for handling mine material while planting.

Q. By whom is a mine planter manned and operated?

A. The ship is supplied and the civilian ship's officers and crew are employed by the Quartermaster Corps. Each ship is under the command of an officer of the Coast Artillery Corps. The ship's officers and crew are the navigating force. The commanding officer, assisted by a detachment of about 20 enlisted men from some mine company, is charged with the planting and taking up of mines and the maintenance of mine fields.

Q. What are the names, sizes, and places of employment of the Army mine planters?

	Gross--Tonnage	--Net	Where Employed.
A. Col. George Armistead	447	304	San Francisco, Cal. San Diego Cal.
Major Samuel Ringgold	447	304	Puget Sound, and Columbia River.
Gen. Henry J. Hunt	447	304	Manila, P.I.
Gen. Henry Knox	447	304	Manila, P.I.
Gen. Samuel M. Mills	590	401	Fort Monroe, Va.
Gen. John M. Schofield	590	401	Atlantic and Gulf.
Gen. Edward O. C. Ord	590	401	Atlantic and Gulf.
Gen. Royal T. Frank	590	401	Atlantic and Gulf.

QUARTERMASTER HARBOR BOATS..

Q.How many Quartermaster boats are assigned to this Coast Defense? What are their names?

A.Four. The General Nathanael Greene,the General J.M.Brannan,the General Robt.B.Ayres,and the Capt.Charles W.Rowell.

Q.What are the features by which these ships can be distinguished from each other?

A.Ship	Length	Speed	Tonnage Gross	Tonnage Net	Distinguishing Features.
Greene	130	12	340	210	2 masts. Deck house flush with rail in the waist. No deck space abaft the cabin. 4 life boats.
Brannan	98	9 1/2	153	104	1 mast. Tug boat type of deck house. Moderate deck space abaft the cabins. 2 life boats. Flag staff at stern on rail. Boom shorter than on Ayres. 3 windows and 1 door on starboard side of officers' cabin,4 windows on port side. No railing around top of pilot house and officers' cabin. Glass in pilot house door. Aluminum paint on whistle. Wood cover on port life boat painted buff. Unpainted canvas cover on starboard life boat. Ships' rail painted red. Cowls vermilion inside.
Ayres	98	9 1/2	153	104	1 mast. Tug boat type of deck house. Moderate deck space abaft the cabin. 2 life boats covered with unpainted canvas. Flag staff at stern of cabin. After stays on mast removed. Pilot house doors and cabin windows the same as on the Brannan. Pipe railing all around top of pilot house and officers' cabin. Shining brass whistle. Ships' rail varnished. Cowls vermilion inside.Boom longer than on Brannan.
Rowell	86	9 1/4	128	75	1 mast. Tug boat type of deck house. Comparatively large deck space abaft the cabin. 1 life boat. Flag staff at stern on rail. After stays on mast removed.Jackstaff and flagstaff painted white. Cowls light green inside. No glass in pilot house door. Two windows only on either side of cabin.

Q.How can these ships be distinguished from commercial ships of the same size?

A.All Quartermaster boats are required to be painted the standard government color and when under way in day light to fly the Union Jack at the jack staff, the National Flag at the flag staff and the Quartermaster Corps flag at the main,except that when an officer entitled to a flag is aboard,his flag is

PLOTTER.

I. Definitions C.A.D.R.

See questions indicated in "PLOTTER" column in appendix A.

Elementry gunnery definitions are illustrated on Elementry Gunnery and Warships diagram under Plotter IV Elementry Gunnery (a) Explanation of the several corrections to be applied to the observed range to obtain the corrected range, facing page 123.

PLOTTER

II FIRE CONTROL SYSTEM

(b) Indication and Identification of Targets.

This is subject II (b) in the examination for Observers, alsoCandidates for Gun Commander and Gun Pointer ratings must be proficient in so much of this subject as pertains to their own duties and should be required to have a sufficiently general knowledge of the duties of the plotter and observers under this heading as will permit them to act intelligently in conjunction with the others. To avoid unnecessary separation of like material or repetition, some matter is placed here which could be placed under V Service of the Piece (a) Duties of Gun Pointer or XI Characteristic features of the several classes of warships, etc.

1.Q.What is meant by "indication of a target"?

A.Any method employed to designate a target. C.A.D.R.137

2.Q.What is meant by "identification of a target"?

A.The act or process of recognizing a target which has been designated. C.A.D.R.133

3.Q.What methods may a battle commander use in the day time to indicate targets to his fire and mine commanders?

A.During the day the battle commander need indicate the target in a general way only, no attempt being made to give the exact location of the ship or ships by range and azimuth. If two or more squadrons enter the battle area, a particular one may be indicated to the fire commander by its relative position. When the squadrons are in different well known channels they may be indicated as the squadron or vessels in ______ channel. When the attacking ships are in well defined column they may be indicated by their position in the column. C.A.D.R. 576.

4.Q.What methods does he use at night?

A.Targets may be indicated at night by means of the search lights, a battle commander indicating a target to the fire commander by covering it with a searchlight. The battle commander may cause a target to be illuminated and followed by some light, and direct any particular fire commander or all of the fire commanders to open fire on such a target. C.A.D.R. 577.

5.Q.When a fire commander desires to indicate a target to his observer at F", what methods does he use?

A.The same as those prescribed for the use of a battery commander. See question 9 below.

6.Q.How does a fire commander indicate a target to his battery commanders?

A.A target is indicated to a battery commander by its description and general location. In addition,it may be tracked for two or three observations and its predicted position for a convenient interval ahead located. This predicted position is relocated for the battery by means of the pantograph attachment of the F' plotting board,when provided,and the relocated range and azimuth sent to the battery commander's station. The fire commander's instrument is set to the predicted azimuth and "now" called over the telephone as the target crosses the vertical wire. C.A.D.R.554.

7.Q.How may a fire commander concentrate the fire of two or more batteries of his command on a target already under fire of one of them?

A.By the command,"BATTERY------(or BATTERIES-------and ------) TARGET UNDER FIRE,COMMENCE FIRING".

8.Q.Under what conditions is it not permissable to use this command?

A.This method should not be followed if more than one fire command is in action,since a battery commander might mistake the target.C.A.D.R.555

9.Q.What is the ordinary method of indicating a target prescribed for the use of a battery commander?

A.The battery commander having identified a target indicated to him from the fire commander's station by description,place in line,or otherwise,it must be indicated to and identified by the observers at B' and B" and the gun pointers. The battery commander,using the observer's line, commands TARGET. The observers reply B' and B", respectively. The battery commander adds a description of the target and at night gives the designation of the searchlight covering it,makes sure that it is correctly identified by the observers,designates the point for observation,and then commands TRACK. C.A.D.R.540

10.Q.Do the methods of indicating and identifying targets differ in a battery of the intermediate armament (4.7,5,and 6 inch guns) from that employed for the primary armament (guns of 8 inches and larger caliber and 12 inch mortars) ?

A.No.

11.Q.When the fire commander relocates the target for the battery commander's station,what action does the battery commander take?

A.He transmits the azimuth to the guns,range and azimuth to the plotter, and a description of the target to the observer. C.A.D.R.481.

12.Q.Under the above circumstances what do the gun pointers do?

A.They set their sights to normal,3 on the deflection scale,and cause the gun to be laid at the azimuth given. The battery commander or his assistant calls,"now" when the target crosses the vertical wire of the B.C.instrument.

The gun pointer calls "on target" or "lost". If the gun pointer fails to identify the target at the first trial, the operation is repeated with more detailed description. Identification may be confirmed in the same manner as for observers. C.A.D.R.485

13.Q.Under the above circumstances, what do the plotter and plotting detail do?

A.See Duties of Plotter ~~of~~ and Duties of Nos 1 to 7 under heading, Indication and Identification of Targets, pages 93 to 115.

14.Q.Under the above circumstances, what do the observers and readers do?

A.The battery commander's observer sets his instrument to the predicted azimuth received from the fire commander. The fire commander's observer calls, "NOW" when the target crosses the vertical wire of his instrument; this message is transmitted to the battery commander, who repeats, "NOW" to the observers. Both observers having reported to the battery commander, "ON TARGET", he designates the point of observation and commands, "TRACK". C.A.D.R.481
The readers set the observing instruments to the azimuths received from their respective armsetters.

15.Q.What change is made when the vertical base system is to be used?

A.None in method except that the description, azimuth, and range are sent only to the station (B' or B") at which the D.P.F. is to be used.

16.Q.What action is taken when, after the command, "TRACK", one or more stations do not appear to be on the proper target?

A.If, after the command TRACK, the battery commander has reason to believe that there is a possibility of confusion of targets on account of the number in the field or other reason, he commands B' (or B") DESCRIBE. The B' (or B") observer, without ceasing to track, describes the target giving details in addition to those furnished him by the battery commander in indicating it. When B' (or B") has confirmed the identification of the target to the satisfaction of the battery commander, the latter repeats back "on target B'" (or B"), and then commands B" (or B') DESCRIBE, until the identification is confirmed. C.A.D.R.483

17.Q.Is there any other method in general use?

A.Yes. It is as follows: Suppose B" is on the wrong target. The battery commander commands, "B', RELOCATE FOR SECONDARY. B' tracks by vertical base until B' operator hears over the observers' line that B" has identified the correct target and is sending data for horizontal base tracking. The plotter plots the target by vertical base data along the primary arm and causes No. 3, B" armsetter, to transmit the range and azimuth of the point from B". B" reader sets the instrument in azimuth while B" observer sets the instrument for the range indicated and identifies and reports, "ON TARGET", as soon as practicable.

18.Q.Is the last method prescribed in C.A.D.R.?

A.No.

19,Q.Which is the more rapid usually?

A.The first.

20.Q.When is the second to be used?

A.When the first method fails and when there are many targets of the same general appearance in the same part of the field.

21.Q.How may the battery commander check the identification of the target?

A.The battery commander may have the gun arm azimuth called to him from the plotting room for checking with his observing instrument.C.A.D.R.484.

22.Q.Is this check of any value in a battery which has but two of the three stations,B.C.,B' and B"? In a battery which has but one of the three stations?

A.It is a check in a battery having two stations only when the plotting has been by vertical base data from the station which is to be checked up.

It is of no value in a battery having but one station except as a check upon the travel correction made upon the deflection board.

23.Q.Should the azimuth mentioned in question 21 have any correction applied to it before it is sent?

A.See question 23,Duties of No.1 in Plotting Detail,page 100.

24.Q.Can either actual or corrected azimuth be used,if it is understood which is sent?

A.See question 24,Duties of No.1 in Plotting Detail,page 101.

25.Q.At what stage of the process does the battery commander indicate the target to the guns?

A.Immediately after the observers have called,"ON TARGET".See C.A.D.R.485.

26.Q.Is it necessary that the B.C.observer have his instrument set at an azimuth derived from the plotting board in order to indicate a target to the guns by azimuth?

A.It is not necessary. He may set his instrument an arbitrary (discretionary) amount ahead of the target,allowing sufficient time for the transmission and setting of data. If the reading for this setting be now transmitted to the guns,the gun pointer and B.C.observer act as outlined under question 12.

27.Q.By whom and in what manner are targets indicated to the emergency station?

A.Targets are indicated to and identified by the emergency station in the same manner,the range officer or No.7 using the speaking tube or megaphone as means of communication for this purpose.C.A.D.R.486 The"same manner"means the same as described above for other stations.

28.Q.Point out on the diagram of fleet formations the following:

(a) Line abreast (Nav.) Line (Mil.)
(b) Line ahead (Nav.)
(c) Line of sections in column.
(d) Indented line
(e) Double line
(f) Double column
(g) Exact column (Mil.)
(h) Echelon-Line of bearing 4 points.
(i) Double echelon-Retreat
(j) Double echelon-Chase

Note:Printer insert here diagram of fleet formation shown between pages 20 and 21,Coast Artillery War Game.

29.Q.What direction are the ships supposed to be moving on the chart?

A.Towards the top.

30.Q.What is the meaning of the expression "Line of bearing 4 points."

A.See "Points" in Nautical and Naval Definitions in appendix G.

31.Q.How are ships in line designated?

A.By numbering from the starboard ship toward the port ship.

32.Q.How are ships in column designated?

A.By numbering from the head of the column.

33.Q.What is the coast artillery method classifying ships for purposes of indication and identification of targets?

A.The ship is dsecribed by a number of two figures,as "Class 12", pronounced "Class One Two",meaning that it has one funnel and two masts. Similarly a ship described as "Class 42",pronounced "Class Four Two",has four funnels and two masts. The first digit indicates the number of funnels and the second digit the number of masts. See sketches of the several classes.

Note: Printer insert here illustrations from Page 21,Coast Artillery War Game.

34.Q.What searchlight beams are visible from _ _ _ _ _ _ _ _,and what is the size and location of the lights from which they come?

A.Beam No.	Size of Light inches.	Location	Area covered.

(Printer should leave about 5 inches of space for addition of proper data by battery commander)

35.Q.What advantages arise from dividing the battle area into sub-areas and announcing this sub-area immediately after the word,"Target"?

A.The announcement of the subarea as the first part of the indication of the target serves to fix the attention of all observers and gun pointers in the proper general direction. The general description which then follows is not forgotten or confused in a vain search from vessel to vessel for the one indicated. This method also enables the plotting detail to prepare for tracking in the dseignated sub area. The plotter and armsetters have time to note about what data is to be expected and to promptly report the failure of one station or the other to identify the proper target when the error is sufficiently large to be evident.

36.Q.What are the names assigned to the sub-areas of this battle command?

A.Name of Sub-area	Extent.
Bartlett's Reef	Vicinity of Bartlett's Reef Light Ship in Long Island Sound.
Plum Island	Southern half of Long Island Sound in battle area.
The Race	Vicinity of The Race.
Constellation Rock	Vicinity of Constellation Rock bouy.
Fort Pond Bay	From Constellation Rock area to Gardiner's Island.
Block Island Sound	Area beyond Constellation Rock.
Montauk Point	Area beyond Fort Pond Bay area and in direction of Montauk Point.
Gardiner's Bay	Gardiner's Bay
Plum Gut	Vicinity of Plum Gut.

37.Q.In describing the target in what order should the details be arranged?Why?

A.(a) The general type of target as Monitor,Submarine,Destroyer,Cruiser,Scout, Battleship,Tramp steamer,Oil tank,Brigantine,etc.
(b) If in a group of warships acting together,give the term which indicates the size of the group;Division,for 3 to 5 ships,Squadron for 6 to 10 ships.
(c) The formation in which the ships are moving: Line abreast; Line ahead; Double column.
(d) Location of target in group:Ship No.4,or,Port Column,Ship No.2.
(e) Direction ship is going:Coming in;or Going out. This is not always necessary and should be omitted in the interest of brevity except when needed.
The purpose of this arrangement is to have the description reach the observer or gun pointer in the order in which he requires it for selecting the target from the whole number of vessels in view.

38.Q.Point out on the Battle Chart where you would look and,on the diagram of fleet formations,the ship indicated by the following Commands:
The instructor or examiner will add the necessary number of commands from the Type Commands given or will make up new commands following the same principles. After each command the following question should be asked until each candidate has caught the distinction:

39.Q.Is this a fire commander's or a battery commander's command?

TYPE COMMANDS

FOR BATTERY COMMANDER

1.Target-. 2.Constellation Rock-. 3.Monitor Division-.Line ahead-.Ship No.1 (Observers report,"B',B",Emergency,On Target")-.4.Track-.
1.Target-.2.Bartlett's Reef-.3.Tramp Steamer-.Class 12,Coming In (Observers report, "B',B",Emergency,On Target")-.4.B' Vertical Base Track-.
1.Target-.3.The Race-.3.Submarine Division Ship No.3 (Observers report "B',B", Emergency,On Target")-. 4.Vertical Base Track-.

FOR FIRE COMMANDER

1.Battery Bradford-. Target-. 2.Block Island Sound-. 3.Fall River Line-.Coming in-. 4. Fire when in range-.
1. Battery Dimick-.Target-. 2. Gardiner's Bay-. 3. Oil Tank-. Class 13, Going out-. 4.Fire Two Rounds-. 5.Commence Firing-.
1.Battery Hagner-.Target-.2.Plum Gut-.3.Submarine Division-.4.Ship No.3-. 5. Commence Firing-.
1.Battery Floyd-. Target-.2.Gardiner's Bay-.3.Gun Boat Division-.4.Fire at ships in order in column-. 3 minute intervals-. 5.Commence Firing-.
1.Battery Kelly-.2.Target in No.6-.3.Fire Two rounds-.4.Commence Firing-.
1.Battery Campell-.Target-.2.Fort Pond Bay-.3.Destroyer Division,Double Line-. Second Line-. Ship No.2-. 4.Fire when at 7000 yards-.

The formation Line Ahead can be frequently simulated at drill by a tug towing barges or targets. In such cases,the barges or the targets,are numbered from head to rear thus:

1.Target-. 2.Plum island-.3.Coal Barge Division-.Going out-.Ship No.1 (Tug) or barge No.2 (Second barge)-.4.Emergency System-.5.Track-.
1.Target-.2.Bartlett's Reef-.3.Scully Line Division,Barge No.1-.4.B', Vertical Base-. 5.Track-.
1.Target-.2.Montauk Point-.3.Greene Division-.Target No.2-. 4. Track-.
1.Target-.2.Plum Island-.3.Sand Dredge Division-.Dredge No.1-. 4. Track-.

40.Q.What do the observers do immediately after receiving one of the above commands?

A.B' observer calls over the observer's line,"Fore mast","Funnel No.1" or other description of a narrow but distinct part of the target. B" observer calls back,"O.K." or "Can't see it" and adds description of a point he can see. When they have agreed upon an observing point,they begin to track.

41.Q.Why should the observers select the foremast or forward funnel(funnel No,1) of a ship coming in and the mast or funnel fartherest aft of a ship going out?

A.Because life boats,boat cranes,side turrets,signal flags,sails or other objects may hide points farther away from the stations from the other base end station.

.?.For the gunnery reasons for this selection,see Plotter IV,Elementary gunnery (a) Explanation of the several corrections to be applied to the observed range to obtain the corrected range,page 125.

42.Q.What advantage arises from allowing observers to select their own aiming point?

A.The battery commander cannot be sure that the point he selects is clearly visible from both B' and B". Responsibility for agreeing promptly between themselves teaches the observers to appreciate the importance of selecting proper points from the standpoint of both of the reasons given above.

43.Q.Is this command of execution,"Track" essential?

A.There is a wide difference of opinion upon this point. We are habituated to a command of execution from its necessity in infantry drill. The argument of those who favor omitting it is that the conditions which require it on the drill ground do not hold in this case,that it lengthens the telephone message,that it delays the beginning of tracking since the preliminary part of the command conveys fully the will of the superior,and that it tends toward an iron bound,rigid system which cripples proper and well directed initiative without corresponding advantage.

44.Q.Are such departures from C.A.D.R. as are covered in questions 40 and 43 permissable?

A.C.A.D.R.316 states:"The battery commander is encouraged to improvise devices and methods which in his opinion will simplify the fire control system or increase the efficiency of his command,and withthe approval of the district commander is authorized to test such devices or methods at target practice. When the result is favorable to the device or method, the test shall be made the subject of a detailed report,accompanied by drawings and models of any device used."

Note: The compilers desire to avoid the appearance of advocating something new simply because it is new. In the spirit of progress which the C.A.D.R.seeks to foster,the successful methods originated by other officers are placed before battery commanders for consideration on their own merit.

PLOTTER:

II Fire Control.

(c) Duties of Plotter.-

1.Q. What is the definition of a plotter?-
A. A member of the fire-control section in charge of the plotting.(C.A.D.R.183)

2.Q. For what specific duties is the plotter responsible?-
A. The plotter is responsible for the adjustment and operation of the plotting board.(C.A.D.R.332)

3.Q. Who is in charge of the Fire Control Section?-
. The Plotting Detachment? The Plotting Board Detail?(C.A.D.R. 283 and 285).
A. The senior noncommissioned officer of each section,detachment, and detail is its chief. Each chief commands his own subdivision whenever it acts separately and is responsible for its drill,its efficiency,and the condition of the materiel to which it is assigned.(C.A.D.R.285).

4.Q. How many men are required to be kept trained for each position in the fire-control section?-
A. Company commanders must keep two men trained for each position for which they furnish details in the manning party of the battle and fire commanders' stations and two men for each position in the fire-control section of the battery.(C.A. D.R.289).

5.Q. When the target is indicated by a description of its general locality on the water or with reference to a searchlight beam,appearance,and direction of motion,what action does the plotter take without delay?
When does he begin to plot?
A. The plotter locates the approximate position of the target on the water and causes the primary and secondary arms to be moved to this vicinity in order that he may notify the battery commander in case either station is too near its limiting azimuth to warrant its tracking and in order that he may more quickly detect a failure to identify target by either station. He begins to plot as soon as readings are received from primary and secondary.

6.Q. When the target is indicated by its azimuth and range,what action does the plotter immediately take?
How must the range correction scale set? Why?
A. He locates the position of the target on the plotting board by means of the gun arm. The range correction scale must be at normal since the range given by the fire commander is always the actual range from the battery commander's station.(C.A.D.R.481 and 554).

7.Q. Where can the plotter telephome by means of his head set?-
A. To the range recorders in each emplacement,

except that in some batteries where the plotting room is not within speaking distance of the battery commander's station, the B.C. station is also cut in on the plotter's line to the guns.

8. Q. What is the base line switch box and who operates it?
   A. In all batteries equipped with a horizontal base, the base line switch box (See Fig.) is installed in the plotting room and is operated by the range officer, or by the plotter in his absence. It contains two double pole, double throw switches. B'armsetter(No.2) is connected to the central posts of the upper switch. B"armsetter(No.3) is connected to the central posts of the lower switch. B'reader is connected to the right poles of the upper switch and the left poles of the lower switch. B"reader is connected to the left poles of the upper switch and to the right poles of the lower switch.

9. Q. What is the purpose of this base line switch box?
   A. To put both armsetters (No.2 and 3) in communication with the reader at the station indicated when "B'(or B") VERTICAL BASE" is ordered. (C.A.D.R.500).

10. Q. How should the switches be set?
    A. For horizontal base system, both switches to right.
    For B', vertical base, upper switch to right, lower to left.
    For B", vertical base, upper switch to left, lower to right.

11. Q. Should both switches ever be set to the left at the same time? Why?
    A. No. Because No.2 will be connected to B"reader and No.3 to B'reader.

12. Q. Will No.2 or No.3 ever find themselves in communication with anyone else besides the B' and B" readers? What is the purpose of these connections?
    A. In the B.C. station there is another set of switches which allow either No.2 or No.3 to be connected to B' and B" observers at the same time when the line to their own reader is out of order. Connection can be made so as to bring the battery commander, both observers, and both armsetters on to the line at once.

13. Q. What precaution should be taken by armsetters before setting data they hear?
    A. They should learn from the party talking who he is in order to guard against setting erroneous data, as in the case when both switches in the base line switch box are thrown to the left.

Horizontal Base system

14. Q. Is there any advantage in bringing the targ against one arm in preference to the other before sliding it along to the intersection?
    Which arm and why?

What does C.A.D.R.prescribe?
A. It depends somewhat upon the location of the target on the board the position assumed by the plotter,and the shadow of the targ. The secondary arm being the higher of the two arms affords a somewhat better guide for the targ. C.A.D.R. 490 prescribes the secondary arm.

15.Q. What is the plotter's next step as prescribed in C.A.D.R.?
A. To bring the gun arm to the targ,noting that the range correction scale is at 3000(until a range correction is made by the range board operator after the second range has been read).

16.Q. What step follows the bringing up of the gun arm to the targ?
A. To read the range in a distinct voice into the transmitter of his head set.

17.Q. To whom does this range go?
A. To the range recorder at each emplacement (C.A.D.R.823½) who operates the time-range board,to the B.C.station by the gun telephone line when plotting room and B.C.station are separated,and by voice when they are not separated,and to the range board operator and deflection board by voice.

18.Q. Is the first range actual range or corrected range.
A. Actual range.

19.Q. In reading actual ranges into the transmitter,how does the plotter indicate that they are not yet corrected and are therefore not to be use for firing?
A. By calling out "Actual Range" before adding the figures of the range reading.

20.Q. Show how to read the following ranges:5380,6300,5000,5050.
A. Five,three,eight,zero;Six three hundred;Five thousand;Five, zero,five,zero.

21.Q. What is the object of this method?
A. To enable the plotter to pronounce each word in a clear,strong tone distinct from the other words,to make the message brief,to avoid the confusion to the range recorder from receiving a series of zeros,and to indicate by the diffrent manner of framing the message the difference in character of the four typical ranges shown above.

22.Q. What step follows the reading of the range?
A. Plotting the position of the target on the paper placed on the plotting board for that purpose,(C.A.D.R.490).

23.Q. What two methods of plotting the target are used:?
A. Plotting with and without the targ? Both require for accurate work a hard pencil (3H to 6H) carefully sharpened and with the wood trimmed back about an inch and a half from the point in order that the point of the pencil may be accurately placed under the intersection. Which method is best appears to be a matter of opinion.

Without the targ the pencil must be held so that the side of the sharpened part of the pencil next to the station arms is vertical. Perhaps the best method is to sharpen the pencil in such a manner as to expose about 5/16 inch of lead so that only the lead touches the secondary arm thus bringing the plotted point within one half of the thickness of the lead from the inter-section.

24.Q.When a point falls materially to one side of the probable track as established by prolonging that obtained by the last few plotted positions,or when the interval is too small or too great what action must the plotter take.

A.He must decide instantly whether the variation is a reasonable one due to the target starting to turn,to increasing speed, or to stopping. If it is reasonable he calls out the cause before announcing the range as,"Target Turning","Target Stopping". The increases in speed are usually too slow to make the announcement of much value to the persons receiving his message. When the change is an unreasonable one he calls, "Reading Lost"and investigates the cause without interrupting the tracking.

25.Q.When the track approaches the inner or outer limits of the board, what action does the plotter take?

A.He calls to the B.C.station about two readings before the limit is reached,"Inner Range Limit","Outer Range Limit"as the situation requires.

26.Q.When the track approaches either limiting azimuth for horizontal base plotting,what action does the plotter take?

A.He calls to the B.C.station about two readings before the limiting azimuth is reached,"Secondary Azimuth Limit"or "Primary Azimuth Limit" as the situation requires.

27.Q.What purpose does this warning serve?

A.It enables the B.C.to determine at once whether he can continue tracking by ordering "B',(or B") Vertical Base, Track" for some time longer or whether the target is going under the gun arm azimuth circle or off the board. When "Inner Range Limit" or "Outer Range Limit" is reached the target can no longer be tracked and "Cease Tracking" or Change Target" will follow.

28.Q.What are the usual factors in fixing these limits for horizontal base plotting?

A,The following conditions are the ones which are most frequently found to be the causes which fix these limiting azimuths:

Some obstruction in the field of view external to the observing station as a hill,forest,buildings or other object.

Some feature of construction of the observing station itself as the side of a window frame or a post.

Secondary arm or coupler hitting index box on auxiliary arm as the two arms approach each other near the right or left hand end of the board.

29.Q.What lines should be permanently marked on the board?

A.The azimuth limit for horizontal tracking for each station and the azimuth limit for vertical base tracking for each station.

30.Q.Where should these lines be marked?

A.Along the graduated edge of the primary,the secondary arms, and the gun arm when set to the limiting azimuths for their respective stations.

31.Q.What other lines may it be advisable to have permanently marked upon the board and why?

A.Azimuth lines from each station to the several salvo points and to light Houses,datum points or other fixed points of reference. This enables these fixed points to be quickly located and the time at which firing should begin to be determined when the command,"Fire on salvo point No.1," is received. The location of other fixed points assists in checking up emergency range finding.

II FIRE CONTROL SYSTEM.

(c) Duties of No.1 (Assistant Plotter)

1.Q. What are the duties of No.1 upon arriving at the plotting room?

A. To prepare for service and adjust the wind component indicator the range correction scale, the azimuth correction scale, gun arm azimuth scale pointer, and tally dials.

2.Q. How soon should he begin to operate the wind component indicator

A. As soon as the meteorological message is received, which should be in the first five minutes of the drill period after arrival at the battery.

3.Q. What data in the meteorological message is used on the wind component indicator?

A. Azimuth and velocity of wind.

4.Q. Where does the meteorological message originate? Trace the telephonic channels thru which it comes.

A. It originates in the meteorological station and is telephoned to the fire command stations which stations relay it to each of their respective B.C. stations. Each B.C. station then relays the message to its own plotting room. See C.A.D.R.617.

5.Q. How many opportunities are there for its being misunderstood?

A. It may be misunderstood by the F' telephone operator who receives it, by the F' telephone operator who receives it by voice and sends it to B.C., by the B.C. telephone operator on the F' line and by No.1 when he hears this last operator call it out or four opportunities all told. When the plotting room is separated from B.C., the B.C. operator on the plotting room line and the plotter may also misunderstand it, making a total of six times.

6.Q. How many opportunities are there for the meteorological message being improperly transmitted.

A. By the meteorological observer, in relaying by voice in F', in transmitting to B.C., in relaying by voice in B.C., or a total of four times. When the plotting room is separated from B.C., the B.C. operator on the plotting room line and the plotter may also transmit it improperly, making a total of six times.

7.Q. What should No.1 do when he receives this message?

A. He should record it in order that it may be checked with the message originally sent from the meteorological station.

8.Q.Is this data required for any target practice record? Which?

A.Yes. It is required on Form No.821-Record for Plotting Room.

9.Q.How frequently should this data be received?

A.The velocity and azimuth of wind should be recorded at least every twenty minutes,and oftener if necessary;any sudden change,either in direction or velocity,of any considerable magnitude is reported at once to the fire commanders. When the atmosphere reference number changes by more than 1 per cent,the barometer and thermometer readings and the new atmosphere reference are reported to the fire commanders. (C.A.D.R.618).

10.Q.What action must be taken when this message is not promptly received?

A.The plotter's attention must be called to it so that he may promptly report the delay to the B.C.

11.Q.From what source does No.1 obtain the azimuth of the target?

A.From the gun arm azimuth circle.

12.Q.How closely is it necessary to read azimuth of target for this purpose?

A.To the nearest degree.

13.Q.Should he set the wind component indicator to the actual azimuth or the corrected azimuth of the gun arm.

A.The corrected azimuth,which is the one that is read from the gun arm azimuth circle when any azimuth correction is made,as in Case III,is the proper one but the difference is immaterial.

14.Q.How often does No.1 change the setting of the wind component indicator?

A.He sets the target arm to the azimuth of the gun arm after each setting of the latter.(C.A.D.R.491).

15.Q.Who uses the range component?

A.No.4,the range-correction computer.

16.Q.Who uses the deflection component?

A.No.5,the deflection computer.

17.Q.Does No.1 call off the component or do these men read it for themselves?

A. No.4 and No.5 read their own values themselves. No.1 does not call them off. See par.7, O.P.1794-1908.

18.Q. Describe and illustrate the method of obtaining the wind components.

A. Set the pointer to the wind velocity, turn the azimuth ring until the azimuth of the wind is under the triangular index and keep the target arm set to the approximate azimuth of the target as indicated by the gun arm on the plotting board. Should the wind change, make the necessary changes in velocity and azimuth of wind. See C.A.D.R.828.

INDICATION AND IDENTIFICATION OF TARGETS.

19.Q. When a new target has been indicated by range and azimuth of a predicted point from B.C. what are the duties of No.1.

A. To set the gun arm to the azimuth of the predicted point by means of the gun arm azimuth circle, the azimuth correction scale having been first set at normal. He must also note that the range correction scale is set at normal. See C.A.D.R.481.

20.Q. Does No.1 ever have occasion to read the gun arm azimuth except when the battery is firing under Case III?

A. Yes. The battery commander may have the gun arm azimuth called to him from the plotting room for checking with his observing instrument. (C.A.D.R.484).

21.Q. Who listens to this call and what does he do with it?

A. B.C. observer when B.C. station is immediately above plotting room. When stations are separated the plotter telephones the azimuth to B.C. The observer sets his instrument to this azimuth. If the target comes on to his vertical wire at the proper time it shows that the observations from stations furnishing data and the plotting are correct.

22.Q. When should it be sent?

A. Only when ordered by B.C. and then as promptly as it can be determined.

23.Q. Should this azimuth have any correction applied before it is sent?

A. B.C. observer can utilize the azimuth of the predicted point best, i.e. the azimuth of the plotted point corrected for travel during prediction interval only. Corrections for wind and drift should not be made.

The above is the method followed in mortar batteries before firing each salvo.See C.A.D.R.511. When the purpose is merely to ascertain whether or not the proper target is being tracked a less exact azimuth reading is usually sufficient.

24.Q.Can either actual or corrected azimuth be used,if it is understood which is sent?

A.Yes. If actual azimuth of plotted point is sent the B.C.observer can cease tracking on the sounding of the bell on which it is desired to check. If corrected azimuth is sent it would be best to correct for travel during prediction interval only.

HORIZONTAL BASE SYSTEM.

CASE I OR II.

25.Q.Name the operations performed by No.1 in the order of their performance,after tracking begins.

A.Note the setting of the range correction and azimuth correction scales,calling the plotter's attention to settings if he believes them to be improper.
Set the velocity of wind on wind component indicator.
Set the azimuth of wind on wind component indicator.
Call the reading of tally dials(This operation is omitted on first observation)
Set tally dials to normal.
Note azimuth of target.
Call,"Set":
Set azimuth of target on wind component indicator.

26.Q.In what position must the gun arm be when he reads and sets the tally dials? Why?

A.The gun arm must be set against the targ held at the intersection of primary and secondary arms. If this is not done,the readings will be of no value since they refer only to the chance position of the gun arm when it is thrown aside.

27.Q.Why should he wait for the plotter to announce the range before calling off angular travel?

A.Because both the range correction and deflection computers require the range,the latter requiring range earlier than he does angular tarvel. Failure to do this will be confusing especially if both range and travel are called at the same time.

28.Q.Why should he call off angular travel of target as soon as the plotter announces the range?

A. To reduce the time required for operation of the deflection board and to lessen the time the plotter is required to hold the gun arm in position.

29. Q. Why should the assistant plotter call "Set" as soon as he has his tally dials reset? Is this prescribed?

A. To free the plotter from the necessity of observing the dials before casting the gun arm aside for the next plotting.

30. Q. What is the normal?

A. The normal on degree tally dial is 15 and on the tally subdial is zero.

31. Q. What does "the normal" mean?

A. "The normal" in this sense means a standard condition of reference. In this case, a condition of no angular travel. For the use of this term with the sense of being perpendicular to something else, see definition of the normal of the plotting board under III Fire control apparatus, page 121 and the definition of the angle of incidence, C.A?D.R.27 and Fig.____, Page 123.

32. Q. Why is it used?

A. To avoid the use of plus and minus or right and left in describing the direction of travel. It has been found that even with highly trained personnel, the correction will not infrequent;y be made in the wrong direction. The use of some arbitrary number, like 15, gives but one possible setting for the figures called out. 15 was chosen because it was large enough to insure that no case of negative travel would arise.

33. Q. What do the tally dials read?

A. The tally dial marked 15 at the normal reads whole degrees of movement of the gun arm. The tally sub-dial reads hundredths of degrees. Test by means of the gun arm azimuth circle.

34. Q. What precaution must be exercised in reading the decimal part?

A. To read the hundredth of degrees on the tally sub-dial and not on the gun arm azimuth sub-dial inside.

35.Q.How may No.1 guard himself against error in tally dial reading and what should he do when he detects an error?

A.He should accustom himself to noting the regularity of his readings. If they are the same or gradually increasing or decreasing his readings are correct. A single irregular one indicates an error in observation,in azimuth readings,in plotting,or in tally dial setting. The armsetters will detect the first two,the plotter the first and third. No.1 must detect the fourth and call,"Reading Lost",except when the target is turning. When the target is turning the first irregular reading will be followed by others still more irregular in the same direction. The turning of the target will usually be noted by observers,armsetters or plotters before No.1 can notice it.

36.Q.Which way is a target travelling when tally dials read 17.25?

A.From left to right.

37.Q.Can you tell from the above how fast the target is travelling? What else must you know to do so?

A.No.If the speed of the target was to be computed it would be necessary to take its range into account. This is done by the mechanism of the deflection board but even this board by its system of graduation gives the result in degrees and hundredths instead of yards per second or miles per hour.

38.Q.Why measure this component of travel at right angles to the gun arm in degrees instead of yards?

A.Because the gun pointer observes the change of position of the target as a change in angle from his position. He could not use the travel if it were given to him in miles per hour or yards per second.

39.Q.Who listens for your call of the travel reading?

A.No.5,the deflection computer.

40.Q.For whose ultimate use at the gun are you obtaining this data?

A.For the gun pointer.

41.Q.Who is charged with setting the range correction scale?

A.No.4,the range correction computer.See C.A.D.R.493.

42.Q.Who is charged with setting the azimuth correction scale?

A.No.5,the deflection computer.See C.A.D.R.494.

43.Q.Should No.1 ever change the setting of either of these scales?

A.Only when directed to do so by the Plotter.

CASE III.

44.Q.Does No.1's duties change when Case III is ordered? In what way?

A.Yes. He calls off the corrected azimuth of the target.

45.Q.What is the new order in which he performs his duties?

A.There is no change except to announce the corrected azimuth of the target in degrees and hundredths where under Case I or Case II he would have read to himself the azimuth to the nearest degree only.

46.Q.What additional correction must be made to the gun arm now? Who makes it?

A.The azimuth correction must be set on the azimuth correction scale by No.5,the deflection computer.

47.Q.Why is this correction made?

A.It is made so that,after correcting for drift of the projectile and wind,the gun will be so pointed that the projectile will be directed ahead of the target by the amount necessary to arrive at the set forward point at the same instant that the target arrives.

48.Q.Where is the azimuth of the gun arm read?

A.The whole degrees are read at the pointer in the window over the gun arm azimuth circle and the hundredths of degrees on the gun arm azimuth sub-dial.

49.Q.What precaution must be exercised in reading the decimal part?

A.To read the hundredths of degrees on the gun arm azimuth sub-dial and not on the tally sub-dial just outside of it. If the order of operations given in Question 35 is followed the tally sub-dial will now be reading zero and this mistake will not be made.

50.Q.Why does C.A.D.R.491 prescribe that No.1 shall call off the corrected azimuth at every setting of the gun except the first two.

A.Because it takes two settings to obtain a travel reading. After the second reading the deflection computer must have time to compute and set the azimuth correction.

51.Q.Who listens to this call and what does he do with the data?

A.The plotter. He transmit it to the deflection recorder who records it as he would deflection for Case I or Case II.See C.A.D.R.768½.

52.Q.Who uses corrected azimuth and where?

A. The gun pointer uses it to set the gun in azimuth by means of the azimuth pointer.

53.Q.Under what conditions is Case III used?

A.When fog or other conditions obscure the target or after the sight has become unserviceable. See C.A.D.R.533.

AUXILIARY HORIZONTAL BASE SYSTEM.

54.Q.Do the duties of No.1 change when "B' (or B") AUXILIARY BASE, TRACK," is ordered.

A.No.

VERTICAL BASE SYSTEM.

55.Q.Do the duties of No.1 change when,"B'(or B") VERTICAL BASE, TRACK," is ordered.

A.No.

EMERGENCY SYSTEM.

56.Q.Do the duties of No.1 change when,"EMERGENCY SYSTEM,TRACK," is ordered.

A.No.

SERVICE TARGET PRACTICE.

57.Q.Do the duties of No.1 change from those in drill or action during service target practice.

A.No,except as stated in next answer.

58.Q.Are any data observed by No.1 required for service target practice reports? What data are required and on what reports?

A.Yes. The tide,atmosphere,range and deflection components of wind,setting of range correction scale and angular travel of target at time of firing each trial and record shot are required for form 831,Record for Plotting Room. In some batteries it is customary,when no range officer is present, to have No.1 note all of this data under direction of the plotter

PLOTTER

II FIRE CONTROL SYSTEM.

(a) Detailed knowledge of system employed at the battery.

Note: This is also subject II(a) of the examination for Observer. Subject VII (a) for Gun Commander and Gun Pointer requires a "general" instead of a "detailed" knowledge of that in use at the battery. Examining officers should therefore require only a general knowledge of the following from candidates for the positions of gun commander and gun pointer.

1.Q. What two types of fire control installation are there in service?

A. Provisional system and standard system.

2.Q. When is each installed?

A. The provisional system is installed for all the armament to which personnel is assigned at all posts in the service.

The standard system is installed, coast defense by coast defense, for the entire completed armament, whether in commission or not, as funds become available, utilizing such materiel of the provisional systems as is suitable.

3.Q. Which system is at present in use in this coast defense?

A. The - - - system.

4.Q. Is the standard system the same in each place where it has been installed? Why?

No. Because fire control materiel is subject to constant change and improvement; so also is the method of installing it and to a limited extent the method of using it. Moreover, each installation is dependent upon local conditions of such varied character as to modify not only the scheme of installation but also the methods of its use.

5.Q. What purpose does the adoption of a type installation serve?

A. A particular installation can not be well adapted as a permanent type; but assuming certain general conditions as to the site and location of stations, there may be formulated from time to time a type installation which will show the approved material and the general features of the scheme of installation believed to be best adapted to the assumed conditions. Such a type installation is that given below.

6.Q. Where does this type installation assume the battery commander's station and the plotting room are located?

A. B.C. station at the battery and plotting room adjacent to B.C. station.

7.Q.How many stations does the type installation provide for a gun battery of the primary armament?

A.Two observing stations(which may be used together in the horizontal base system or individually in the vertical base system),a B.C.station,and an emergency station.

8.Q.What new feature does this type provide for batteries of the intermediate and secondary armament?

A.A separate range finding system.

9.Q.Explain the terms,"primary armament","intermediate armament" and "secondary armament"?

A.Primary armament.--Guns of 8 inch caliber and upward and 12 inch mortars.
Intermediate armament.--Guns of 6 inch,5 inch,and 4.7 inch calibers.
Secondary armament.--Guns of 4 inch and 3 inch caliber.

10.Q.What equipment does a battery of the intermediate armament receive?

A.It may be similar to either that for a battery of the primary armament or that for a battery of the secondary armament,depending upon the location of the battery,its field of fire,and the probable objective of its fire.

Note: Questions 11 to 14 inclusive concern candidates for observer only.

11.Q.What is the equipment of a Battle Commander's Station?

A(Printer: Copy Table I from C.A.M.No.4-09.)

12.Q.In what way does the equipment of the local battle commander's station differ from the above?

A.(Printer leave 2 inch space for addition of answer.)

13.Q.What is the equipment of a Fire Commander's Station?

A.(Printer: Copy Table II from C.A.M.No.4-09.)

14.Q.In what way does the equipment of F'--station differ from the above?

A(Printer leave two inch space)

Note:-Candidates should be required to study either questions 15 to 24 inclusive or 25 to 30 inclusive depending upon the character of installation at their respective batteries.

15.Q.What is the equipment of a B.C.station of the primary armament?

A.(Printer: Copy Table III from C.A.M.No.4-09).

16.Q.In what way does the equipment of a B.C.station of the primary armament n differ from the above?

A.(Printer leave two inch space for addition of answer.)

17.Q.What is the equipment of a Plotting Room?

A.(Printer: Copy Table IV from C.A.M.No.4-09.)

18.Q.In what way does the equipment of the plotting room differ from the above.

A.(Printer leave two inch space for addition of answer).

19.Q.What is the equipment of an Observing Station?

A.(Printer:Copy Table V from C.A.M.No.4-09.)

20.Q.In what way does the equipment of the observing stations differ from the above?

A.(Printer leave two inch space for addition of answer.)

21.Q.What is the equipment of an Emplacement?

A.(Printer: Copy Table VI from C.A.M.No.4-09.)

22.Q.In what way does the equipment of the emplacements differ from the above?

A.(Printer leave two inch space for addition of answer.)

23.Q.What is the equipment of an Emergency Station?

A.(Printer: Copy Table VII from C.A.M.No.4-09.)

24.Q.In what way does the equipment of the emergency station differ from the above?

A.(Printer leave two inch space for addition of answer.)

25.Q.What is the equipment for B.C.station for a battery of the secondary armament?

A.Artillery Bulletin No.94,April 17,1913 prescribes the following for rapid fire batteries:

1. Battery Commander's Station:
   Self-contained range finder.
   Telephone (head set) to range observers.
   Telephone (head set) to spotting station and Fire C Commander.
   Deflection Board.
   Display Board.
   Range Board.
   Telescope (3")
   Field Glasses.
   Stop Watch.

3.

26.Q.In what way does the equipment of the B.C.station at Battery------- differ from this?

A. (Printer leave about 2 inch space for addition of answer)

27.Q.What is the equipment for the Gun Platform of a battery of the secondary armament?

A. Gun Platform:
Telephone to B.C.Station.
Signal Bell
Stop Watch.

28.Q.In what way does the equipment of the Gun Platform at Battery----- differ from this?

A.(Printer leave about 2 inch space for addition of answer.)

29.Q.What is the equipment for the Spotting Station of a battery of the secondary armament?

A.Spotting Station:
Telephone to B.C.Station.

30.Q.In what way does the equipment of the spotting station at Battery------ differ from this?

A.(Printer leave about 2 inch s ace for addition of answer.)

31.Q.How many parts are there to a triangle? What are their names?

A.Six. Three angles and three sides.

32.Q.How many parts must you know in order to construct the triangle?

A.Any three part,except the three angles.

33.Q.Why is this exception made in the case of the three angles?

A.See Fig.   ,marked,"PRINCIPLE OF HORIZONTAL BASE SYSTEM.
Note that in the nest of triangles on the left that all of them have the same angles as triangle PB"B' and that many more could be similarly drawn.

34.Q.What conclusion can you draw when you know any other combination of three parts?

A.AS soon as any one side and two angles, any two sides and one angle, or all three sides are known,there can be but one triangle which will have these three parts.
To those who have had geometry this will be a familiar principle which will be recognized as easy of proof. To those who have not,a little experimentation with a pencil and piece of paper on which to make the angles and matches broken to different lengths to represent sides will be reassuring.
By constructing the triangle,you discover the principle of both horizontal base and vertical base system.

Note: In the sketch the three parallel dash and dot lines, marked S, represent meridian lines, i.e. north and south lines thru each of the two stations B', and B", and the directing point of the battery, D. point.

35. Q. Why are the angles 1, 1, 2, 3, and 6 in the sketch all measured in a clockwise direction from the southern end of the meridian lines to the other bounding line of each angle?

A. Repeat the definition of azimuth.
What is the azimuth of a point directly south of a station?
Note: It is well to remember that in civilian practice it is customary to take north as zero instead of south.

36. Q. Point out the triangle involved in horizontal base system and name its parts?

A. The triangle is the triangle B' B" P; its sides are the base line B' B", and the range of the point P from B' and from B"; its angles are:
(a) The azimuth angle 2, of the observer's line of sight from B' (represented on the plotting board by the graduated edge of the primary arm) minus the azimuth, angle 1, of the base line equals angle 4, the angle included between the base line, B' B", and the observer's line of sight from B' upon the point P.
(b) The sum of the back azimuth of the base line, i.e. the azimuth of B' from B", plus (for the particular case shown) 360°, which is represented also by the figure 1 in the sketch, minus the azimuth, angle 3, of the observer's line of sight from B" (represented on the plotting board by the graduated edge of the secondary arm) equals angle 5, the angle included between the base line, B' B", and the observer's line of sight from B" upon the point P.
Note: One of the most complicated situations which can occur has been purposely assumed in the case of the angle 5 in order to bring out the ease with which angle 5 can be found by adding 360° to the back azimuth of the base line in order to obtain the angle 1 shown around the secondary station, B". The same value for this angle 1 can be obtained by adding 180° to the value of angle 1 shown around B'.
Under more simple conditions, the method would be the same as under (a) above, i.e. to subtract the azimuth of the base line, angle 1 around B' from the azimuth of the line B" P. All depends upon the relation of the meridian lines to the sides of the triangle.
(c) The angle B' P B".

37. Q. Which of these six parts can we call the three known parts after we have made use of the data obtained from the observers?

A. The length of the base line and its azimuth are known. The length is the first known part. By proper subtraction between the azimuth of the base line and the azimuths read at B' and B" on the target P, we obtain the other two known parts, the angles 4 and 5 adjacent to the base line.

38. Q. Which of the six parts are the three unknowns?

A. The sides B' P and B" P and the angle B' P B".

39.Q.How can they be determined?

A.They could be computed by the principles of geometry and trigonometry but,even for a person familiar with these processes,this method is long and laborious. By reducing the actual layout on the ground and over the water to $\frac{1}{10800}$ of its size and representing the different parts with suitable metal pieces,we have the device known as the plotting board,where one inch on the plotting board in any direction represents 300 yards in the same direction on the surface of the earth. By making the arms representing the observer's lines of sight movable and by adding suitable azimuth and range scales we can find automatically within a few seconds the unknown parts which we wish to know. The parts are the length of the sides B' P and B" P or the ranges of the target from B' and B". We do not need to find the size of the angle at P.

40.Q.How do we learn the range by which to set the guns before firing?

A.By locating the gun arm center,marked by a small hole in the top of azimuth correction box cover,over the point on the plotting board which represents the directing point of the battery. Then by swinging the gun arm up to the point P on the plotting board we can read off the range scale the range of the target,P,from D.Point and from the gun arm azimuth scale,the azimuth of the target P from the directing point,D Point.

41.Q. Is this exactly the range which should be set on each gun? What corrections are applied?

A.It is not. The corrections which must be applied are shown below:

No.	Correction	By whom applied.
1	For travel of target until next bell	Plotter
2	For travel of target during time of flight	"
3	For tide	Range board computer
5	For atmospheric conditions	" " "
6	For abnormal muzzle velocity	" " "
7	For direction and intensity of wind.	" " "
8	For gun differences	Range setter
9	For time elapsed from last bell until the instant of discharge.	" "
10	Arbitrary correction from observation of splashes	Battery commander.
4	Adjustment of center of impact	Range board computer,.

For the details of the method of making these corrections,see Gun commander and Gun Pointer,V, Service of the Piece (a) Duties of Range Setter,page , and Plotter,IV,Elementary gunnery,(a) explanation of the several corrections to be applied to the observed range to obtain the corrected range,page 122.

VERTICAL BASE SYSTEM.

42.Q.How many stations and what kind of equipment are required for this system?

A.One station equipped with a depression position finder and the usual accessories.

43.Q.Where is the base line of this system? Point out its upper end?

A.See Fig. ,marked PRINCIPLE OF VERTICAL BASE SYSTEM. The base line is the height of the telescope trunnions,H.I.(meaning height of instrument) above mean low water,M.L.W.,corrected for tide,T,and for curvature of earth and normal refraction,C.C. In order not to complicate this sketch, the correction for curvature and normal refraction is shown as a correction for curvature only. For the correction for normal refraction and discussion of its combination with correction for curvature,see Observer, III Fire Control Apparatus,questions to inclusive,page . The upper end of the base line is at the telescope trunnions.

44.Q.Point out the triangle involved in the vertical base system.? And name its parts?

A.The triangle is B' R P; its sides are the base line B' R,the range of the target R P and the line of sight B' P; its angles are the right angle at R,the angle R P B ' at the target,which by the principles of geometry is equal to the depression angle,and the angle A at B' which is the complement of the depression angle (the angle which it is necessary to add to the depression angle to make the sum equal 90°).

45.Q.Which of these six parts can we call the three known parts after we have made use of the tide message and the depression angle?

A.The length of the vertical base,B'R,the angle R(which does not have to be measured because it is always a right angle),and the angle A .

46.Q.Which of the six parts are the unknowns and how many of these do we need to determine?

A.The range of the target,R P,the side B'P and the angle R P B' at the target, the latter is practically known since,ignoring refraction,it is equal to the depression angle.
The only unknown we need to determine is the range of the target,R P.

47.Q.How can this be determined?

A,It could be computed by the principles of geometry and trigonometry but this method is too long and laborious. To accomplish this authomatically it is arranged in the instrument so that the movement of the telescope in depression moves a pointer over a range scale instead of a degree scale. Thus the pointer, instead of pointing out the exact size of the depression angle, points out the range which corresponds to this angle when the tide is at mean low water (M.L.W.) and normal refraction exists. The methods of correcting for tide and abnormal refraction are explained under Observer,III Fire Control Apparatus,(a) Depression Position Finders-Warner-Swasey,questions to inclusive,pages .

48.Q.How do we learn the range by which to set the guns before firing?

A.The target is located on the plotting board from any station which may be acting as the vertical base station,B',B" or B.C.,by setting the primary, secondary,or gun arm respectively,to the azimuth called and then plotting the point,P,at the range called.
The process of obtaining the range from the directing point is the same as is described under question 40 above.

49.Q.Is this exactly the range which should be set on each gun? What corrections are applied?

A.It is not. The corrections which must be applied are the same as with the horizontal base system. See question 41 above.

AUXILIARY BASE SYSTEM.

50.Q.What stations are used for this system? Does this system use the horizontal or the vertical base system?

A.The B.C.Station is used as the primary station and either B" or B' as the secondary station.See C.A.D.R.499.
For details of the methods of plotting see Plotter,II Fire Control System, (a) Duties of No.1 and No.2 (armsetters),questions 13 to 16 inclusive, page .
This system uses horizontal base.

EMERGENCY SYSTEM.

51.Q.What stations are used for the emergency system? Does this system use horizontal or vertical base?

A.The emergency stations are used for range and the B.C.instrument for azimuth until the latter becomes unservicable. Thereafter the azimuth is sent from the azimuth instrument transferred to or permanently at the emergency station. Azimuth can be also be read from the Barr and Stroud self contained base instrument. This instrument has a short horizontal base,approximately as long as the instrument. Prisms at each end receive rays of light from the target,at one end from the upper half,at the other end fromthe lower half. Prisms at the center,receiving these reflected rays,reflect them again to the eye. The instrument is manipulated until the two parts of the image match. The range pointer then indicates the approximate range of the image.

Summary

52.Q.How many means of finding range does a battery with the standard installation possess?

A.Three horizontal bases B' to B"
B.C.to B'
B.C.to B"

Three vertical bases,one at B.C.
one at B'
one at B"

Emergency system at emergency station.
Salvo point firing.
Or a total of eight methods.

53.Q.How many of these are lost with the destruction of one station?

A.Two horizontal bases and one vertical base.

54.Q.How many are lost with the destruction of the second station?

A.The remaining horizontal base and one vertical base.

FIRE CONTROL SYSTEM.

(c) Duties of No.2 and No.3 (Armsetters.)

1.Q.What are the duties of No.2 and No.3 upon arriving at the plotting room?

A.To test their respective telephones, to examine their respective arms and index boxes and the azimuth circle, to sharpen pencils, and to place a clean sheet of paper upon the board for plotting when required.

2.Q.How should an arm be manipulated?

A.Grasp the protuding end of the arm with the left hand, fingers underneath, first and second fingers operating the locking lever, thumb on top operating the index disc clamp. Turn the index disc with the thumb and first finger of the right hand.

3.Q.To whom does No.2's telephone lead ordinarly? No.3's.

A.No.2's telephone is ordinarly connected to the primary station reader and No.3's to secondary station reader. For other persons to whom either No.2 or No.3 or both may find themselves talking, see Question "Plotter 12".

INDICATION AND IDENTIFICATION OF TARGET.

4.Q.When a new target has been indicated by range and azimuth of a predicted point, what are the duties of No.2 and No.3?

A.As soon as the plotter has located the predicted point by means of the gun arm, No.2 and No.3 bring their respective arms, with index discs at zero, to the whole degree notch on their own right of the point, clamp the locking lever, turn the index disc until their arm touches the targ, then clamp, and read over the telephone to their reader the azimuth of the predicted point to enable the instrument at that station to be set before the call,"Now" reaches the observers from the battery commander's station.

5.Q.When one station fails to identify target, say B",and "B' Relocate for secondary" is ordered, what are the duties of No.2 and No.3?

A.No.2 listens for both azimuth and range, sets the primary arm to the azimuth, and repeats the range to the plotter. The plotter plots the target. No.3 brings his arm up to the targ as described above,reads the azimuth to B" reader, and then repeats to him the range from B" called out by the plotter.

HORIZONTAL BASE SYSTEM.

6.Q.What are the operations performed by No.2 after a target has been assigned for tracking?

A.He unclamps the index disc latch, turns the index disc until it reads zero, and unclamps the locking lever. He listens for the azimuth of the target from primary, and calls "Repeat" in a low tone if he does not catch the reading distinctly. He moves the index box pointer to the whole degree graduation on the azimuth circle strip, feeling his way into the proper notch with the locking lever, clamps the primary arm, then sets the index disc to the fractional part of the reading and clamps the index disc by means of its latch, calls "Set",then with a soft pencil marks the position of his arm on the plotting board paper along the side of the arm opposite to the direction of travel.

7.Q.What is the purpose of the pencil marks showing the successive settings of the arm?

A.To detect errors in observation or reading. When the several lines are equally distant or when the distance between successive marks is increasing or decreasing regularly both observation and readings are free from large errors. Any sudden changes show that something is wrong.

8.Q.Which are the characteristics of errors in observation?

A.Once an observer is on a target he usually follows it carefully. Failure to do so may give results which have the appearance of errors in reading. When on the wrong target, if the first few settings do not show it, the successive positions of the arm will give equal, uniformly increasing, or uniformly decreasing differences but the intersections made with the other arm will throw the track over shoal water, close in, or way out, enabling the plotter to quickly detect this error and report it to the battery commander.

9.Q.What are the characteristics of errors in reading?

A.Irregular differences between the lines marking successive settings of the arm.

10.Q.What are the most frequent errors in reading?

A.Errors of one whole degree or of 0.1 degree. The first is not infrequent with all but the most experienced readers. It usually occurs when the hundredths of a degree are in the eighties or ninties because the index mark on the azimuth circle is then much closer to the whole degree next greater than the one which should be read. For the same reason 0.29 is sometimes erroneously read 0.39 on the azimuth drum.

11.Q.How can the armsetter detect an error of a whole degree?

A.He soon becomes accustomed to estimating the distance on the paper by comparing the interval between successive settings with the space between the notches on the azimuth circle. When the lack of regularity in settings is about this amount the armsetter should say over his telephone,"One degree too large" or "One degree too small".

12.Q.How can the reader detect an error of a tenth of a degree in reading?

A.This cannot be done with certainty and even when suspected the armsetter should not be too insistent upon his opinion. There must be no wrangling over the telephone. The armsetter should train himself to note how many degrees and hundredths the setting changes and then to predict to himself what the next reading will be. Differences between his prediction and the reading telephoned may be due to his own error in predicting, to failure to set the azimuth read, to change in speed or course of the target as well as to an error on the reader's part. At night such errors may be due to flickering of search-light beams or failure to keep the beam accurately on the target.

AUXILIARY HORIZONTAL BASE SYSTEM.

13.Q.What are the duties of the armsetter whose observing station goes out of action when "AUXILIARY BASE TRACK" is ordered?

A.He sets the gun arm by means of the diagonal scale azimuth circle to the azimuth called out by the B.C.reader (by the plotter in batteries where the B.C.station and plotting room are separated).

14.Q.What is meant by the diagonal scale azimuth circle?

A.It is the device plotted, usually in ink, near the margin of the plotting board by means of which the gun arm can be set in azimuth from its outer end.

15.Q.How is the gun arm set by this device to azimuth 359.35?

A.Move the gun arm up to the radial line marked 359 at each end. Place a pencil or pin on the diagonal line joining the figures 359 and zero at a point five tenths of the distance between the 0.3 and 0.4 degree lines measuring from the 0.3 degree line. Bring the gun arm up to this point and call set. See Fig.______.

Printer: Insert figure marked Diagonal Scale Azimuth Circle C.A.D.R.489 & 502".

16.Q.Why use this device when you have a gun arm azimuth circle?

A.One armsetter is unemployed. The use of the gun arm azimuth circle increases the duties of either the plotter or No.1, both of whom are already busy. When firing Case III and plotting from B.C.data, the gun arm must be set to the plotted point by actual azimuth from B.C. The azimuth correction having been set by No.1 to enable him to read corrected azimuth on the gun arm azimuth scale, the gun arm must be set to actual azimuth by means of the diagonal scale azimuth circle.

VERTICAL BASE SYSTEM.

17.Q.What are the duties of No.2 and No.3 at the command,"B',(OR B") VERTICAL BASE,TRACK"?

A.The B" (or B') arm is laid aside. The range officer (or the plotter in his absence) throws the base line switch so that both armsetters hear the B' (or B") reader. No.2 (or No.3) listens for azimuth and sets the B'(or B") arm. No.3 (or No.2) listens for the range and repeats it to the plotter as soon as No.2 (or No.3) calls,"Set".

18.Q.What are the duties of No.2 and No.3 at the command,"B.C., VERTICAL BASE,TRACK"?

A.No.2 sets the gun arm to the azimuth called out by the B.C. reader by means of the diagonal scale azimuth circle as described under Question 15 above.
No.3 has no duties.

EMERGENCY SYSTEM.

19.Q.What are the duties of No.2 and No.3 at the command,"EMERGENCY SYSTEM,TRACK"?

A.No.2's duties are the same as at the command,"B.C.VERTICAL BASE, TRACK".When B.C.station is out of commission, the azimuth are sent from Emergency Station to No.7 who repeats them just before the range.No.3 has no duties.

CASE I, CASE II, AND CASE III.

20.Q.Is there any change in the duties of No.2 and No.3 when the method of firing changes from anyone of the three cases to another?
A.No.

SERVICE TARGET PRACTICE.

21.Q.Is there any changes in the duties of No.2 and No.3 during service target practice as compared with drill or action?

A.At the firing of trial shots the location of the splash of the tug and of the target are plotted in the order named.

SUBCALIBER TARGET PRACTICE.

22.Q.Is there any change in the duties of No.2 and No.3 during subcaliber target practice as compared with drill or action?

A.No.

II FIRE CONTROL SYSTEM.

(c) Duties of No.5 (Deflection Computer).

1.Q.What are the duties of No.5 upon arriving at the plotting room?
A.To make sure that his instrument has the proper scales updn it for the drill, practice, or action which is to follow and that it is in adjustment. For details of these adjustments, see III, Fire Control Apparatus, page 121.

INDICATION AND IDENTIFICATION OF TARGET.

2.Q.What are the duties of No.5 during the period of indication and identification of target.

A.He has none.

HORIZONTAL BASE SYSTEM.

3.Q.When does No.5 begin to operate the deflection board?

A.As soon as the plotter calls off the second range.

4.Q.Name the operations performed by No.5 in the order of their performance?

A.First. Set the wind arm at the "Deflection Component" reading on the wind component indicator.
Second. Set the platen so that the drift curve at the range called is accurately over the right hand edge of the wind arm.
Third. Set the travel arm (right edge) for travel reference number as called out by No.1.
Fourth. Set the azimuth correction scale so that the travel reference number is under the normal of the deflection scale.
Fifth. Set the T-square so that the point of its scale corresponding to the range will be accurately over the right edge of the travel arm.
The bevel edge of the T-square then indicates:
(a)Onthe deflection scale the deflection to be used on the sight with Case I or II.
(b)On the azimuth correction scale the correction to be applied to the gun arm, when using Case III.

5.Q.Does No.1 call out the deflection component reading to No.5?

A.No. The wind component indicator is placed where both No.4 and No.5 can read it distinctly from their respective positions.

6.Q.Under what conditions is the multiplying scale used?

A.For use with systems of firing at a predicted point which requires more than one observing interval to lay the gun in azimuth two multiplying scales are furnished with each board to be attached to the semicircular brace of the platen. One of these scales is intended for use when a fifteen-second interval is employed and the other with a twenty-second interval. They permit the making of allowance for travel during time of flight plus the travel during two observing intervals.

All of the operations are the same except the fourth, which reads as follows:

Fourth. Set the azimuth correction scale to the reading of the multiplying scale.

Note. Since the thirty-second interval is used, the multiplying scale should be used exclusively. The platen scale is not required.

7,Q.What action should No.5 take when No.1 gives him an irregular travel, that is, one which is neither the same as those which have preceded it nor regulary increasing or decreasing as compared with previous travel?

A.Call "Reading lost" and report the trouble to the plotter.

8.Q.Who listens to his call of his results and what does he do with them?

A.When firing Case I or II, the plotter repeats the deflection to the range recorder over the gun line.

When firing Case III, No.5 himself sets the azimuth correction on the azimuth correction scale,(C.A.D.R.494),and calls off the corrected azimuth (See C.A.D.R.490).The plotter transmits the corrected azimuth to the guns.

AUXILIARY HORIZONTAL BASE SYSTEM.

9.Q.Are No.5's duties affected by a change to this system?

A.No.

VERTICAL BASE SYSTEM.

10.Q.Are No.5's duties affected by a change to this system?

A.No.

EMERGENCY SYSTEM.

11.Q.Are No.5's duties affected by a change to this system?

A.Not as long as the plotting board remains in action.

SERVICE TARGET PRACTICE.

12. Q. Are the duties of No.5 different at service target practice from those at drill or in action?

A. He must see that he has the service leaf range scale and the service T-square scale in place and not the subcaliber scales.
The operation of the board is the same.

SUBCALIBER TARGET PRACTICE.

13. Q. Are the duties of No.5 different at subcaliber target practice from those at drill or in action?

A. He must see that he has the subcaliber leaf range scale and the subcaliber T-square scale in place and not the service scales.
The operation of the board is the same.

II FIRE CONTROL SYSTEM.

(c) Duties of No.6 (Gun communication detail).

1.Q.What are the duties of No.6 upon arriving at the plotting room?

A.To inspect and adjust his instrument.
For details, see instructions for the instrument under III Fire Control Apparatus-Communications.

2.Q.What are No.6's duties during tracking?

A.To transmit to the guns the corrected range announced by the plotter. (C.A.D.R.485).

3.Q.What are No.6's duties during tracking when the plotter wears a telephone head set to the range recorders?

A.He is usually employed to record data sent to the guns, his record being used to check up and fix the responsibility for errors.

4.Q.Are these duties affected by any change in the system of firing or of tracking, or, from drill to target practice or action.

A.No. Except that when the plotter's line becomes unserviceable, he transmits the range and deflection or range and corrected azimuth to the guns by the auxiliary means of communication.

II FIRE CONTROL SYSTEM.

(c) Duties of No.7 (Emergency communication detail).

1.Q.What are the duties of No.7 upon arriving at the plotting room?

A.To inspect and adjust hisinstrument.
For details, see instructions for instrument under III Fire Control Apparatus-Communications.

2.Q.What are the duties of No.7 during tracking?

A.He keeps a record of the ranges received from the emergency station and calls these ranges to the plotter when the emergency system is used.(C.A.D.R.496).
After the B.C.station is out of action, he repeats and records the azimuth received from the emergency station which will precede the range in the message.

3.Q.Are these duties affected by any change in the system of firing or tracking?

A.They are unaffected by changes from one system of firing to another.
They are affected by changes in system of tracking and by action only as indicated above.

Plotter.

II Fire-control system.

(d) Emergency system and salvo points.

Note:- This is also part VIII (d) of examination for Gun Commander and Gun Pointer and part II (c) for Observer.

1.Q.Define"Emergency condition"."Emergency system".

A.A term to denote damage or assumed damage to any element of coast defenses,rendering it,or assumed to render it,out of action for the time being.C.C.A.D.R.105½.

The position finding system used in our service includes-

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(c)The emergency system,which ordinarly employs a self-contained instrument located at the battery,with or without a plotting board.C.A.D.R.189.

2.Q.What equipment is furnished for the emergency station of a 6-inch battery? For batteries having the equipment of a battery of the primary armament?

A.Self contained range finder,usually of the Barr & Stroud design. Azimuth instrument until self contained range finder is available.

Time interval recorder (stop watch) Speaking tube to plotting room.
Megaphone.
Salvo table.
Orientation table.(See table VII,C.A.M.No.4-1909).

Batteries whose fire control equipment conforms to that of batteries of the secondary armament are not equipped with an emergency station.

Artillery Bulletin No.94,April 17,1913 contemplates firing under emergency conditions being conducted from the most available point after the B.C.station becomes unserviceable.

3.Q.What personnel is required for the emergency station?

A.Observer,and assistant observer.

4.Q.When is the emergency system used?

A.When failure of communications or damage to B' or B" renders it necessary,or when the change is made for drill or target practice.

5.Q.How is the transfer from other systems to emergency system accomplished?

A.The battery commander orders it and the range officer commands, EMERGENCY SYSTEM,TRACK.C.A.D.R.503.

6.Q.Why is this action on the part of the range officer necessary?

A.Because the battery commander has no way,except by megaphone,to reach the emergency station. The speaking tube runs from the plotting room to emergency station.

7.Q.How is the data from the emergency station transmitted?

A. (a) Plotting room serviceable.
The assistant observer at the emergency station transmits the ranges to No.7 who repeats them to the plotter.

(b) Plotting room unserviceable
In case of damage to the plotting room,ranges as read from the emergency instrument may be megaphoned or called through the speaking tubes directly to the gun platforms.(C.A.D.R.503.).

8.Q.Does the emergency detail track all targets.

A.Yes.

9.Q.Does the observer send all data to the plotting room or only that obtained after EMERGENCY SYSTEM has been ordered.

A.He causes all observations to be sent to the plotting room where No.7 records them for the information of the range officer. When Emergency System is ordered the ranges are repeated to the plotter.

10.Q.From what sources are the azimuths of the target obtained where EMERGENCY SYSTEM is ordered.

A. (a) B.C.station serviceable.
From the B.C.instrument No.2 of the plotting detail sets the gun arm,using the diagonal scale azimuth circle. The Plotting proceeds as prescribed for the vertical base system except that No.3 has no duties.

(b) B.C.station unserviceable.
The B.C.observer transfers the azimuth instrument (unless one is already there) to the pier mount in the emergency station, levels and orients it as quickly as possible; he observes and reads the azimuth of the target at each bell. These azimuths are transmitted by the assistant to the plotting room in advance of the ranges read from the emergency instrument.(C.A.D.R.502 Azimuth can also be read from the Barr & Stroud self contained base instrument.

11.Q.Define "salvo point"?

A.A selected point at which fire is to be concentrated.(C.A.D.R.226 To order restricted fire,he (fire commander) may give any of the following commands:
BATTERY________, BATTERY COMMANDER'S ACTION.
This places the action of a battery entirely in the hands of its commander.(C.A.D.R.545).

12.Q.Does the above regulation mean that the guns are to be discharged at the instant each vessel passes the designated salvo point? Explain.

A.No. It means that the pieces should be discharged at the proper time for the projectiles to reach the salvo point at the instant the target arrives there,that is the battery should fir the time of flight before the target will arrive at the salvo point.

13.Q.When is the exact determination of this time important and when is it not?

A.It is important when firing at a target coming in head on or when retiring in the opposite direction because the travel of the target affects the range almost altogether and has little effect on the deflection. The difficulty under normal conditions of making a hit for deflection is very much less than that of making a hit for range. Even when the sight is disabled,the gun can still be laid in azimuth under cover, all necessary travel corrections being made on the plotting and deflection boards. The higher probability of obtaining hits for deflection is not more than offset by the fact that under the above conditions the gun pointer has but the width of the vessel in which to place his shots instead of its length. It is not so important when the travel of the target is almost entirely in azimuth. The range changes are small and easy to estimate,should the condition of the fire control system prevent their accurate determination but it must be recalled that now the range dispersion of shots must be much less to insure hits since the shots must strike from a very small distance short of the target to the far side of the dec while before the same height of freeboard and the whole length of the deck was presented in the direction of range dispersions.

14.Q.What is the best location for salvo points? Why?

A.At mid and short range because the fire control system will remain serviceable for long range fighting Mid and short range are the only distances at which salvo point firing can be forced upon the defense or at which economy of ammunition and gun life would make it advisable to fire by this means.

15.Q.Under what conditions does the angle at which the ship presents itself at mid and short range favor hits? Under what conditions is its presentation unfavorable?

A.At mid range the target is usually forced by the channel to present its longitudinal axis at an angle to the battery while at short range it is usually broadside on. This favors hits when the greatest error is due to difficulty in determining either range or range change. When the guns are badly worn the powder erratic or the personnel inaccurate or inexperienced in laying the guns,the presentation of the target would be unfavorable to hits.

16.Q.Where is the salvo point data posted?

A.It is customary to stencil it on the emplacement wall.

17.Q.Under what conditions will firing at salvo points usually employed?

A. Firing at salvo points may be ordered by the battery commander or higher commander when

(a) When, in order to conceal the strength of the defense, firing is not to commence until just before the target reaches a certain salvo point.

(b) When, under emergency conditions, it becomes necessary to fire guns by salvo data. There will be two stages of firing under this condition.

(1) Position finding system unserviceable and sights serviceable.

(2) Position finding system and sights unserviceable.

18.Q.How will firing be conducted when some form (horizontal base, auxiliary base, vertical base, or emergency) of the position finding system remains serviceable but the sight has been rendered unserviceable.

A.By Case III.

19.Q.What should be done when only one sight of a battery becomes unserviceable?

A.It would probably be advisable to send deflection to the guns whose sights were still serviceable and corrected azimuth to the gun with unserviceable sight. This would depend upon the skill of the personnel. It would be better to send corrected azimuth to all guns than to eliminate one gun entirely.

20.Q.Who would order salvo point firing under condition (a) in Question 17? Under condition (b)?

A.Some commander higher than the battery commander would be the one ordering it under condition (a).

The battery commander would be the one to order it under condition (b) since higher commanders would not know that the battery had been reduced to this extremity, except after report had been mad from the battery.

21.Q.Would it be advis~~e~~able under condition (a) to interpret the order, during action, as requiring firing by salvo point data or simply as indicating the stage of the engagement at which firing was to begin.

A. It should be interpreted in the latter sense, since to begin firing by salvo point data, would be a complete sacrifice of all the advantage of the fire control system to slavish adherence to the primary military rule of obeying orders. This is a case where obeying the spirit of the order would be much better than obeying the letter of it. Firing should proceed in the normal way after the battery commander has assured himself that the first vessel has reached the designated salvo point.

22. Q. Should the battery commander interpret the order strictly during drill? Why?

A. Yes. The higher commander probably desires him to drill as if his battery were reduced to condition (b).

23. Q. In the light of Question 21, is it advisable to require the plotter to predict, as in the mine system of plotting, the time for firing from the observed travel of the ship?

A. No, since firing by salvo point DATA will be conducted from gun batteries only when all forms of the position finding system are out of commission. If the plotting room equipment is still undamaged, it will be useless.

24. Q. When will the gun pointer resort to the trunnion bracket for holding his sight?

A. In drill and, in action, after the sight standard is unserviceable. For details of firing from sight standard and trunnion bracket, see Gun Commander and Gun Pointer, VIII Pointing, (a) Methods of pointing, page 37.

PLOTTER.

III Fire-control apparatus.

(a) A detailed knowledge of adjustment and use of all fire-control apparatus used in the plotting room.

See illustrations and C.A.D.R.757-779,782-787,792-81[illegible], 819-822,and 823 1/2-828.

PLOTTER.

IV Elementary gunnery

(a) Explanation of the several corrections to be applied to the observed range to obtain the corrected range.

Note: For range corrections for variations in the density of air: the direction and velocity of wind, see Elementary Gunnery (b), page .

1.Q. What is meant by Range Table condition?

A. In computing the ranges corresponding to different angles of departure for a particular caliber and Model of gun, the following conditions are assumed:

1. That the gun and target are in the same horizontal plane.
2. That the density of the atmosphere is standard, or in other words, that the thermometer and barometer readings are normal.
3. That there is no wind.
4. That the projectile has a certain muzzle velocity.
5. That the projectile is of a particular caliber and has a particular weight and form.

These conditions are called range table conditions because the ranges and corresponding angles of departure given in range tables are based on them.

2.Q. Why is it necessary to provide for range corrections?

A. All the range table conditions will rarely exist at the time of firing, It is evident that if any of these conditions change, the range tables ranges will not be correct for the new conditions.

3.Q. Explain the principle on which range scales are graduated?

A. The range scales are graduated in yards, each graduation being so located that when the elevation pointer coincides with it, the angle of departure is that necessary to give this particular range, if the gun be fired under the range table conditions except the first. The graduations may therefore be considered as merely representing angles of departure under normal (range table) conditions. Under abnormal conditions, to obtain a particular range the angle of departure must be different than that under normal conditions. The object to be attained in making the several range corrections is to determine the particular range setting corresponding to the angle of departure which will cause the projectile to reach the target under the abnormal conditions.

4.Q. Why is the range disc not graduated for the first range table condition?

A. Because it is desirable to have the range graduations correct for the height of gun trunnions at each battery above mean low water.

5.Q. What other range corrections must be provided for?

A. See Plotter, II Fire-control System, (a).

Printer: Insert here facing matter on page 123, cut of drawing, Elementary Gunnery and Warships. See print in pocket.

6.Q.How is the first correction, that for height of gun trunnions (height of site) made in graduating the range discs?

A.Range tables are computed for guns whose trunnions are at sea level. The height of the trunnions of the gun above sea level being known, the position angle for each range may be determined.
See figure, Elementary Gunnery and Warships, facing page 123 . To fire to hit a point at the same height as the muzzle, say the point of fall indicated by the dotted letters, we must set the gun to an elevation which will give the dotted trajectory. This would be all right for a sea level battery but our gun is above mean low water by the height of sight, H.S., and above the target by the sum of H.S. and correction for curvature. To hit a target, the ship that is lower than the muzzle, we depress the muzzle by the amount of the position angle, P.A., the same amount that the sight must be depressed from horizontal to see the target. For sea level condition, quadrant elevation is the same as sight elevation. Our sight elevation is now the same as before but our quadrant elevation is diminished by the amount of the position angle. The projectile will now follow the trajectory shown in full lines. The climometer on the bore rest, by which the machinist sets the gun in elevation, depends upon a level bubble which measures all angles from the horizontal. The machinist will therefore be setting off quadrant elevation angles. The higher the site of the battery, the smaller the quadrant elevation for range. He must not use the printed range table then, since this gives sight elevation; but he should use the emplacement book special range table which gives the quadrant elevations desired.
Having brought the gun to the elevation indicated by this special range table, a mark on the disc opposite the pointer locates the range mark.

7.Q.What method is used in graduating range scales?

A.The range scales are marked with the ranges at fixed intervals (say 200 yds) in the manner described in the preceding question. The smaller divisions are afterward marked, generally in the shop.

8.Q.In case the personnel of a battery is required to graduate the range scales what method would be used?

A.The graduations are applied to metal scales under the supervision of the Ordnance Dept. If however, conditions should arise under which it has to be done by the personnel of the battery, the graduation should be made on durable paper applied to the surface of the range scale by an adhesive which does not stretch or shrink the paper and, after it has set until the paper is firmly in place, the paper should be graduated by use of the clinometer as already dsecribed. The scale should then be coated with shellac to prevent injury or distortion by moisture.

9.Q. How does tide affect the range?

A. On the diagram, Elementary Gunnery and Warships, facing page 123, note that the target, the ship, is shown in full lines on the water surface marked "mean low water". If the tide falls to -10 feet, the ship would then be in the position shown in dotted lines. If the gun is still fired at the same range setting as before (same elevation of gun), the projectile strikes considerably farther over than before and tide alone requires, in this case, that the range be diminished. The tide correction must therefore be negative for a falling tide and equal in amount to the difference in the range of the points of impact on the two surfaces

10.Q. How is the correction made?

A. The ruler range scale on the range board reads from left to right. Therefore negative corrections must be plotted on the right side of the normal line so that a movement from the -10 foot tide line to normal will decrease the range. A range scale is shown on both the right and left hand edges of of the range board chart, reading from bottom to top. If each correction for a given tide is plotted opposite the range for which it is proper, we have a series of tide curves from which any desired tide correction may be obtained.

11.Q. What is meant by adjustment of the center of impact?

A. When firing at a given target the probability of hitting is always increased by having the center of impact of the group of shots to be fired fall on the center of the target. The correcting of the range setting (elevation of gun) to accomplish this object is known as adjustment of center of impact.

12.Q. Where is the center of the target offered by the 30 by 60 foot target?

A. For deflection, if is on the vertical center line , but for range there is more than the mere height of target since, if the shot falls within about 1/4 of the danger space short, it will usually ricochet and hit the target. This then gives an equivalent vertical target 5/4 as high as the real target, or 12.5 yards instead of 10 yards high, hence the center of impact for range will be 5/8 pf the real target down from the top or 3/8 (3.75 yards) above the water line. On the sketch, AIMING AND OBSERVING POINTS the point A is the center of the target offered while O is the observing point.

Ricochets, however, occur only on angles of fall of less than 9°, hence no ricochets can be depended upon for ranges greater than 6000 yards for 6 inch gun with a muzzle velocity of 2600 feet per second.

13.Q. Upon what point does the gun pointer aim? Why?

A. He aims at the waterline, because it is a sharply defined line.

14.Q. Does his waterlining with the horizontal wire affect the gun?

A. It does not, except when he is firing by Case I from the trunnion bracket.

15.Q. What determines the location of the point on the target for which the data usually obtained is correct, or, in other words, the point around which the shots of a group would be expected to fall as a center?

A. The point on which observation is made, selected by the observer. See Plotter, II(b), Questions 40 to 42 inclusive. They would select the waterline naturally. See question 13 above.

16. Q. What is the effect of this?

A. It should place the center of impact on the target's vertical centerline at the waterline, i.e., at the point C.

17. Q. How may the center of impact be raised to the proper point?

A. By drawing a line on the range board chart to represent a +11.25 tide curve between the tide curves already on the board, or by estimating by the existing curves and making the correction in the same manner as for a tide of that height.

18. Q. Why use tide curves for this correction?

A. Because correcting for a deliberate raising of the center of impact is the same in principle as correcting for a tide which slowly raises the waterline the same amount. Note in this connection that the tide curves differ from all others on the board in that they spread more at short range than at long range, while the reverse is true with the other curves.

19. Q. Is a similar adjustment of center of impact necessary when in action when the targets are ships? Explain.

A. It would be if approximately proper results were not obtained in the usual selection of observing points. The difficulty lies in determining the proper amount to allow for this adjustment.

20. Q. What are the considerations affecting the selection of observing points.

A. They are of two kinds, those affecting the ability of observers to see, and those affecting the adjustment of the center of impact in such a way as to insure nearly the maximum probability of hitting.

The first kind are discussed under Plotter, II(b) Indication and Identification of Targets, Question 41, page 92.

It is a fortunate coincidence that the points which favor the considerations affecting the ability to see, give a fairly satisfactory adjustment for the center of impact.

Assume the U.S. battleship Deleware as the target, 510 feet long, 85.25 foot beam, 27 foot draft, first "head on" and then "stern on" to the battery at ranges of 8000 and 4800 yards where the slope of fall is respectively 1 on 4 and 1 on 10. If the ship has a free board of 30 feet, then the equivalent vertical target is for "head on", range 8000, 30 feet for freeboard plus 127.5 for deck danger space, or 157.5 feet. With the observing point at the waterline at the foot of the foremast, this vertical target is divided so that one third is below the trajectory which just reaches the observing point, i.e., the trajectory having zero longitudinal deviation, while two thirds of the target is above this trajectory.

On page 38, Regulations for the Instruction and Target Practice of Coast Artillery : 1913, we find that the probability of hitting the material target, height 30 feet, is 14%. From Major Hamilton's Notes on Ballistics, page 287, Journal of the U.S. Artillery, Nov.-Dec. 1909, we find that for a probability of 14% the target is but 26% as wide as the 50% zone (the zone in which one half of the whole number of shots fired may be expected to fall), hence we conclude that the vertical 50% zone at this range is 115.4 feet wide. Referring to the upper view of the Deleware

on the sketch, AIMING AND OBSERVING POINTS, we find that the third of the equivalent vertical target which is below the trajectory to the observing point, O, is 90.8% as wide as one-half of the 50% zone. Referring again to Major Hamilton's table we find that the probability for this width is 46%, i.e., 46% of the shots which fall short will strike the ship if a reasonably large number of shots be fired. Similarly the two thirds of the equivalent target above the trajectory to the observing point, O, should be struck by 78.1% of the overs. The expectancy of hitting the Deleware without an adjustment for center of impact under these conditions will then be the mean of these two percentages, or 62.0% Now if we adjust the center of impact so that it will fall in the center of the equivalent vertical target, we find by the same table that our probability of hitting is increased to only 64.2%.

If the Deleware were stern on (not shown on sketch), the trajectory of the perfect shot would divide the equivalent target into a lower part of 62.5 feet and an upper part of 95 feet, giving probabilities of 53;3% and 73.% respectively or an average of 63.% for both parts without any adjustment for center of impact.

When the Deleware is "head on" at 4800 yards (not shown in sketch), we have an equivalent vertical target of 7.5 feet for ricochet danger space plus 30 feet freeboard plus 51 feet for deck danger space, or a total equivalent vertical target of 88.5 feet divided by the trajectory of a perfect shot to the observing point into a lower part of 38.5 feet and an upper part of 50 feet. Our probability against the material target, height 30 feet plus 7.5 feet for ricochet danger space, or 37.5 feet, is given as 80% in the Regulations for the Instruction and Target Practice of Coast Artillery : 1913. From this we find by the same method as before that our 50% zone at 4800 yards is 19.72feet high, that the lower part of our equivalent target should be struck by 99.5% of the shots falling short, while the upper part of the equivalent target is somewhat wider than necessary to give a probability of 100% of the overs hitting. Without adjustment for center of impact, the expectancy is then 99.75% of hits. If the adjustment of the center of impact be made, the equivalent vertical target is found to be somewhat wider than necessary to give an expectancy of 100%.

When the Deleware is "stern on" the equivalent vertical target is practically the same as before since the lower freeboard is partially balanced by the greater ricochet danger space. The trajectory of a perfect shot to the point of observation divides this target, as shown in the sketch, into a lower part of 32.5 feet having a probability of 97.33% and an upper part of 56 feet which is wider than necessary for a probability of 100%. Without adjustment for the center of impact, the expectancy is then 98.67%. As in the case of the "head on" position, if the adjustment for center of impact is made, the equivalent vertical target is found to be somewhat wider than necessary to give an expectancy of 100%.

When the Deleware is "broadside on" at the long range, 8000 yards, the equivalent vertical target is 30 feet high for freeboard plus 21.4 feet for deck danger space. The trajectory of a perfect shot to the observing point divides the target into a lower part of 10.7 feet having a probability of 10.25% and an upper part of 40.7 feet having a probability of 36.33%. Without the adjustment for center of impact, the expectancy is 23.3% while with it, ~~it~~ the expectancy is increased to 23.75%.

When the Deleware is "broadside on" at the short range, 4800 yards, the equivalent vertical target is 7.5 feet for ricochet danger space plus 30 feet for freeboard plus 8.5 feet for deck danger space, or a total of 46 feet. The trajectory of a perfect shot to the observing point, O, di-

vides this target into a lower part of 11.75 feet having a probability of 58% and an upper part of 34.25 feet having a probability of 98%. Without an adjustment for center of impact, the expectancy is 78%, while with it, the expectancy is 88.8%.

21.Q.Why is no allowance made for ricochet hits at 8000 yards?

A.Because the range is beyond the 6000 yard limit where ricochets may be expected. See question 12 above.

22.Q.What is the probability of hitting a 30 by 60 ft target at these ranges?

A.At 4800 yd-80%
8000 yd-14%

23.Q.What is the probability of hitting the above battleship with and without the adjustment of the center of impact?

A. Range Yards	Position of ship.	Probability Without adjustment	With adjustment
8000	Head on	62%	64%
8000	Stern on	63%	64%
8000	Broadside on	23.3%	23.75%
4800	Head on	99.75%	100.%
4800	Stern on	98.67%	100.%
4800	Broadside on	78.%	88.8%

24.Q.Will any other shots be hits?

A.A few shots falling short might be close enough to give underwater hits and a few over might hit the upper parts of the masts and funnels, particularly when the ship is in the "broadside on" position. Hits of this kind are not to be relied upon but accepted as offsets for misses on account of errors by the personnel.

25.Q.What is the permissable variation in range dispersion in the three cases shown?

A.At 4800 yards, 295 yards
" 4800 " 153 "

At 8000 yards 210 yards
685

26.Q.How far may a shot be short, or how far over and still be a hit when no adjust of center of impact is made?

A.Range	Position	Over yd.	Short yd.
8000	Head on	140	70.
8000	Stern on	126.7	83.3
8000	Broadside on	54.7	142.7
4800	Head on	166.7	128.3
4800	Stern on	186.7	108.3
4800	Broadside on	~~153.0~~ 114.	39.0

27.Q.Where should the observing points be for a ship "broadside on" to the battery?

A.In the same place as for other positions. See sketch of the Deleware.

28.Q.Upon what point should the gun be laid in deflection?

A.Upon the vertical centerline of the target for the "head on " or "stern on " positions. When the target approaches close enough to be "broadside on " the gun pointer should then be laying on selected points. For heavy guns,this should be the belt amidships,a particular turret,the conning tower or other heavily armored part. For intermediate guns,the gun should be laid on that portion of the ship given to armament of the same caliber,on signal stations,searchlights at night,etc. Secondary armament would only be employed against armored ship in an extremity.

29.Q.Will the range for the observing point in the " broadside on " position be proper for these selected parts.

A.Yes. All parts on the centerline have almost exactly the same range from the battery. See discussion on the angles of ship presentation to the line of fire in questions 13 to 15 inclusive under Plotter,II Fire Control System (d) Emergency System and Salvo Points on page 116.

Muzzle Velocity

30.Q.What are some of the causes of variations in muzzle velocity?

A.1.Variations in strength of powder due to age;
2.Variations in manufacture;
3.Variations in rate of burning upon discharge;
4.Variations in temperature of powder;
5.Variations in weight of charge;
6.Powder in different charges not under uniform condition of storage;
7.Black powder igniters damp or caked;
8.Variations in weight of projectiles;
9.Variations in condition of rotating bands;
10.Variations in ramming;
11.Variations in temperature of gun;
12.Condition of bore.

31.Q.How are these variations eliminated or minimized?

A.Causes 2 and 3 are controlled by careful inspection during manufacture.
Causes 1,4,6,7,and 9 are controlled principally by the care exercised in handling and inspecting while in storage and in the selection of the lots to be fired.
Causes 5,and 8 are entirely within the personal control of the battery commander.
Carelessness in handling preparatory to practice will affect causes 4,5,6,7,8,and 9 enough to seriously affect practice.

Cause 6 is neutralized by careful blending.
Cause 10 is minimized by careful drill.
Cause 11 cannot be avoided but affects only the first few shots seriously. Little account of it is taken in practice.
Cause 12 is, aside from the question of cleanliness and freedom from rust, a matter of the age of the gun relative to its effective life. It does not cause serious variations from round to round with broad banded projectiles until the number of rounds fired becomes excessive.
The most important to an artilleryman are those affect the round to round variation since corrections can be made for the others. Considering No.6 to mean care in blending the causes important to good shooting in any one practice are Nos.4,5,6,7,8,9,10, and 11.

~~Muzzle Velocity.~~

32.Q. For which of the above conditions may corrections be made directly on the range board?

A. For known or assumed variations in muzzle velocity
For variations in strength of powder
For variations in manufacture of powder
For variations in rate of the burning of powder
For condition of bore
The last four affect the muzzle velocity directly and are measured in terms of muzzle velocity.

33.Q. For which of the above conditions may corrections be made indirectly on the range board?

A. For variations in the weight and form of projectile.
For variations in temperature of powder

34.Q. For which of the above conditions can no correction be made on the range board?

A. For variations in weight of charges.
For variations in diameter and condition of rotating bands
For variations in length of travel of projectile in bore
For variations in ramming

35.Q. How is the variation in muzzle velocity due to a variation in weight of charge determined? Is it different for different ranges?

A. By the formula:

$$\Delta V = \frac{6}{5}\,\frac{\Delta\omega}{\omega}\,V$$

in which ω = weight of charge and Δ indicates the increment. (increase or decrease in the value.)

This formula is applicable for small variations only.
A more exact formula is that given in C.A.D.R.796:

$$\frac{V}{V_1} = \left(\frac{W}{W_1}\right)^y$$

, where V and W are the normal muzzle velocity and the normal weight respectively. The average value of y is: for nitrocellulose powder, 1.2; for nitro glycerine powder, 0.8.

Differences in ranges (elevation of gun) can have no affect upon the amount of energy developed by a powder.

36.Q.How much will the muzzle velocity be affected by a variation in weight of 1 pound?

A.6 inch gun model of 1897 M I ω= 29 pounds M.V.= 2600 ft.per second.

$$\Delta V = \frac{6}{5}\ \frac{1}{29}\quad 2600 = 107.5 \text{ ft per second.}$$

37.Q.How is the variation in muzzle velocity due to a variation in weight of projectile determined? Is it different for different ranges?

A.By the formula:

$$\Delta V = -\frac{7}{16}\ \frac{\Delta w}{w}\ V, \text{in which } w = \text{wt.of projectile}$$

The range (elevation of gun) has nothing to do with muzzle velocity but at any point along the trajectory the remaining velocity will vary from the normal remaining velocity,being greater for heavy projectiles starting <u>with the same muzzle velocity</u>. In other words the flight in air of projectiles of different weights partially counteract the change in muzzle velocity due to the same condition but the effect of the variation of weight on muzzle velocity is predominant. It is not a service condition for the muzzle velocity to remain the same for projectiles of different weight.

38.Q.How much will a the muzzle velocity be affected by a change in weight of projectile of 1 pound?

A.6 inch gun,model of 1897 M I w= 106 lbs.
M.V.= 2600 ft.per second.

$$\Delta V = -\frac{7}{16}\ \frac{1}{106}\quad 2600 = 10.73 \text{ ft per second.}$$

39.Q.How may the effect on the remaining or striking velocity and the range for variation in weight of projectiles be determined?

A.The so-called atmosphere curves on the range board are really curves representing variations in the ballistic coefficient (a factor showing the ballistic efficiency of the projectile and involving effect of atmospheric density,form of projectile,its weight,diameter, maximum altitude of trajectory,etc). The reference number 16 represents the value of the ballistic coefficient taken as standard. when any one of the above conditions produces a change,the percentage of change is represented by the reference numbers. Thus a + 10 % change in weight of projectile,hence a + 10 % change in ballistic coefficient is represented by the reference line No.26 while a similar negative change is represented by reference line No.6.

40.Q.Is the correction of the muzzle velocity for difference in weight of projectiles sufficient? Does it take into account the partially compensating effect of the variation in weight while the projectile is in air?

A.It does not. The correction for the latter effect must be made on the atmosphere curves.

PLOTTER.

IV Elementary Gunnery.

(b) Effect on the flight of the projectile of varations in the density of the air: the direction and velocity of the wind.

Under this subject will be discussed the deflection corrections only. All range corrections were discussed in the preceding subject IV (a).

1.Q.For what are deflection corrections required?

A.For wind drift and travel of the target.

2.Q.May the gun pointer apply a deflection correction for an observed error?

A.Guns will be laid for range upon data furnished by the deflection board only; under no circumstances will gun pointers apply any other deflection correction. Regulations for the Instruction and Target Practice of Coast Artillery Troops : 1912.

A.Formerly he kept gun and crosswire on the target until he saw the splash then traversed crosswire from target to splash, then gun and crosswire back to splash. See C.A.DR. 675 and 676, also "Observed Error" on upper diagram of plate, Elementary Gunnery and Warships under Plotter IV(a), facing page 123.

3.Q.What is drift?

A. See Definitions in Appendix A.

4.Q.What are the conditions which affect the density of the air. How?

A.Temperature as shown by the thermometer.
Atmospheric pressure as shown by the barometer.
As air becomes heated it expands and becomes lighter. This is the reason for hot air rising and for cold air settling as exemplified by the rising of a balloon filled with hot air and gases and by the settling of cold air along the bottom of ravimes and gullies at night.
We are at the bottom of an ocean of air some fifty or more miles in depth. Like the ocean of water this ocean of air has ~~comparatively~~ pressures at its bottom vastly greater at the bottom than at the top, about 14.7 pounds per square inch at sea-level and next to nothing near the top, due to the weight of the air piled up above the bottom layers. The oceans of water have this same pressure of 14.7 pounds per square inch at their surfaces with several tons to the square inch at their bottoms.
The ocean of air is also like those of water in that it has its waves, much higher and farther between than in water. its warm currents and cold currents determined by the shapes of its deeps and its shoals, its great movements somewhat similar to tides. and its eddies and and counter currents, these last being of greater extent and more rapid in their movements than the same things in water.

5.Q.Which of these characteristics affect the atmospheric pressure as shown by the barometer?

A.All of those which increase the height of the air piled up above us and the weight of that air per cubic foot or per gallon.

6.Q.Which of these characteristics give rise to wind?

A.All those which produce air currents or eddies and swirls.

7.Q.What is the effect on the flight of a projectile of the variations in density?

A.The greater the density the more the atmosphere will resist the flight of the projectile. Variations in resistance produce the effects shown below:

Increase in resistance.	Decrease in resistance.
Velocity falls off more quickly.	Velocity hold up longer.
Smaller striking velocity	Greater srtiking velocity.
Projectile does not go as far	Projectile goes farther
Gun must be given greater elevation.	Gun must be given smaller elevation.
Gun must be given increased range correction.	Gun must be given decreased range correction.
Trajectory more curved	Trajectory flater
Greater angle of fall	Smaller angle of fall.

Changes in density of air have no appreciable effect upon drift.

8.Q.What effect has the direction and velocity of wind upon deflection?

A.The direction may perhaps be said to be the more important of the two since a strong wind blowing directly with or against the projectile has no effect upon deflection while the deflection is affected by very moderate cross winds. The greater the velocity the wind the greater the deflection when the direction is such that the wind has any cross (deflection) component upon thewind component indicator. Careful study of that instrument is a first essential to grasping the principles involved under this question.

9.Q.How is a correction for drift applied?

A.Muzzle and 3 point on deflection scale in the opposite direction-to the left in our service except with mortars firing at the higher elevations. Deflection always reads-2° for 1° of drift,i.e.1° less than the normal reading 3°

10.Q.How is a correction for wind applied?

A.Muzzle and 3 point on deflection scale move into the wind. Cross wire moves with the wind. Think of it as the light cross wire being blown across the deflection scale with thewind.

11.Q.

11.Q.How is a correction for travel aplied?

A.Muzzle and 3 point on deflection scale must be ahead of the target when cross wire is on the target. If you would kill a goose don't shoot for where he is but shoot ahead of him for where he is going to be.

Note: The figure at the top of the plate on Elementary Gunnery and warships shown the effect of having wind,travel,and drift all acting in the same direction. The heavy line marked"Drift Curve" shows how the drift throws the trajectory to the right and is itself the trajectory when no wind is blowing,The Broken line G3' shows the axis of the bore moved to the left the amount necessary to correct for the drift. Similary the line mark d "Trajectory" shows the position of the trajectory when acted on by both the wind and the drift. The distance of the trajectory to the right of the drift curve shows the amount the wind throws the trajectory to the right. The broken line G3" shows the axis of the bore moved to the left to compensate for wind and drift. The broken line target is the position the target has reached at the end of the time of flight, Therefore G3" is moved to G''' ahead of the target so that the distance between G3" and G3''' is equal to the travel of the target. G3''' is the final and correct position of the axis of the bore for hitting the target in its advanced position. The lateral scale (of deflection) of this figure is great as compared with the longitudinal scale (of ranges) in order to make the figure clear. False conclusions may be drawn unless this fact is borne in mind.

This diagram is intended to emphasize the fact that the <u>3 point on the deflection scale and the axis of the gun always stay together. Look over the 3 point to see which way your muzzle is pointing.</u> The splash of the shot is indicated to bring out the " observed error" and the difference between line of shot and line of direction.

IV ELEMENTARY GUNNERY

(a) Use of trial shots and application of data obtained from them.

(problem)

PROBLEMS

Condition	I	II	III	IV
Cal. of Gun	6"	6"	6"	6
Temp. of powder	70°	65°	62°	73°
Atmosphere Reference No.	20	12	18	13
Wind " "	70	30	80	40
Vel. assumed, f.s.	2530	2587	2473	2512
Range to Target 1st shot	5830	6490	7310	4550
" " " 2nd "	5840	6480	7350	4550
" " " 3rd "	5850	6460	7350	4560
" " " 4th "	5865	6450	7340	4580
Side of target on which tug appears	right	right	left	left
Range of tug from battery compared with target	shorter	longer	longer	shorter
Angle of tug-target line with line of sight.	55°	65°	75°	50°
Distance tug to target yards	375	410	335	355

Range deviations in mils from tug				
1st shot	-540	+560	+480	-580
Change in range after 1st shot	+300	-300	-250	+300
Mils, 2nd shot	+215	+290	-220	+ 10
" 3rd "	+180	+242	-115	- 50
" 4th "	- 40	+210	-285	+ 60
Deflection yds.				
1st shot	14L	21 R	3 R	4 L
2nd "	22 L	13 R	13 L	3 R
3rd "	11 L	7 R	8 R	5 L
4th "	17 L	18 R	5 L	7 R

Find muzzle velocity to be assumed for record shots.

Plotter

V Preparation of target-practice records.

See notes on forms supplies for this purpose By the Ordnance Department.

The following point is not well covered and the list below will be of special assistance in this subject:

Q. How is the"actual range, piece to target" determined from the "corrected range at which the piece was fired".

A. Deduct the following:
Mistakes in setting;
" " transmission;
" on plotting board;
" " range board;
Travel correction for uncompleted part of interval;
Fictitious part of range correction, i.e., correction for wind, velocity, tide,atmosphere, and adjustment for ce center of impact.

OBSERVER.

I Definitions C.A.D.R.

See questions indicated in"OBSERVER "column in appendix A.

Elementry gunnery definitions are illustrated on Elementry Gunnery and Warships diagram under Plotter IV Elementry Gunnery (a) Explanation of the several corrections to be applied to the observed range to obtain the corrected range,facing page 122.

OBSERVER.

II Fire-control systen.

(a) Detailed description of that in use at the battery.

For this subject, see the same subject under Plotter II (a), page [illegible]

Observer.

II Fire-control system.

(b) Indication and identification of targets.

For this subject, see the same subject under ~~Plotter~~ Plotter II (b), page 55

OBSERVER.

II Fire-control system.

(c) Emergency system and salvo points.

For this subject, see the same subject under Plotter II (d), page 11?

III FIRE CONTROL APPARATUS.

(a) A detailed knowledge of adjustment and use of all observing instruments and range finders in use at the battery.

WARNER & SWASEY AZIMUTH INSTRUMENT.
Models of 1900 and 1900 M.I.

Candidates should not be required to answer questions marked thus * in order to pass. If they elect to answer any or all of such questions, due additional credit should be given.

1.Q. Name all of the parts that an azimuth instrument chest should contain? Point them out.

A. Azimuth instrument, plumb bob and cord, pin wrench and screw-driver.

2.Q. How should a tripod be set up on a floor or concrete surface?

A. The legs should be set in cracks of the floor, small holes in the concrete or pressed into a wooden floor to give them a hold against slipping. The legs should not be spread too much because that increases the tendency to slip. When set up on the ground the legs should be thrust into the soil individually until a firm bearing is secured. Otherwise the instrument will be shifted by the operator stepping too close to the legs. The tripod head must be approximately level before the instrument is placed on it.

3.Q. How should an instrument be grasped when removing or returning it to the chest? What precautions are necessary in securing the instrument to the tripod or pier mount? In repacking it in the chest? Illustrate.

A. Place the hands under-neath the platen. The telescope is not intended as a handle. Its use for that purpose will injure its adjustment. When screwing the instrument on or off the tripod, it must be supported by the hands while giving the base the necessary motion. The base should not be set up too securely, lest there be difficulty in removing it. Before replacing the instrument in the box, care should be taken that all screws be firmly clamped, to avoid damage in transit. The telescope should be placed lengthwise of the box, eye piece to the left when facing the chest.

4.Q.Level the instrument? Describe the process?.

A.See that all levelling screws are bearing snugly. Disengage the worm by means of the worm box eccentric crank. Set the telescope parallel with any two diametrically opposite levelling screws. Grasp two diametrically opposite levelling screws between a thumb and fore finger. *Turn both screws inward or outward, that is, in opposite directions; never in the same direction. Turn the left thumb in the way the bubble should go until the bubble comes to the center.* Adjust the other pair of levelling screws. If the two levels are in adjustment with each other and with the vertical axis of the instrument, the instrument is now levelled. The adjustment of the levels should always be tested as indicated in Question six below unless it has been very recently tested.

See foot note.

5.Q.Describe the joint between the spindle and the base and the reason for this construction?

A.This joint is of the ball and socket type permitting movement in any direction except radially. The bearing surface of the spindle is spherical and fits in a spherical surfaced socket in the base. See Class 36 Division 22 Drawing 25 in Ordnance Pamphlet No.1657.

6.Q.When the levels are out of adjustment, how are they adjusted?

A.To test the levels to determine whether or not they are out of adjustment proceed as follows: Select one level. Bring the bubble to the center of the bubble tube by means of the levelling screws. Turn the telescope in azimuth 180 degrees. If bubble remains in the center, the bubble axis and vertical axis are perpendicular to each other. *If the bubble does not stay in the center, correct one half by means of the levelling screws and one half by the level holder screws.* Repeat until bubble remains stationary. *With the same level*, repeat over the other pair of screws until satisfactory. The vertical axis and one level are now perpendicular to each other.

To bring the other level into adjustment, adjust it by comparison with the level first selected. *Make the full correction on the level holder screws.*

Note:- To printer; one under line means for that part to go in italics.

7.Q.Why do you correct for one-half of the error in one place and half in another in adjusting the first level and correct all of the error in one place on the second level?

A.See sketch,"Adjustment of Level Bubbles". Much of the difficulty in grasping this principle will be removed when it is recognized that neither level or vertical axis can be in its proper position when the other is out. In other words the bubble can stand in the center of the curved bubble tube only when both the level and the vertical axis are in adjustment,or both out by the same amount. The error of one exactly counteracts the other in the position A B,while both errors combine to give an apparent error of double the real amount when in the position A'B'.

The first level having been put in adjustment with the vertical axis,the second level must receive the full correction or the first adjustment would be disturbed. This having been done,the two levels and the vertical axis will all be in adjustment with each other.

8.Q.What is the name of this instrument?

A.Azimuth Instrument,Model of 1900 (or Model of 1900 M I.) made by Warner & Swasey.

9.Q.What is the difference between the Model of 1900 and Model of 1900 M.I.

A.

Model	Prisms	Focusing Part	Lamp Bracket	Dew Cap
1900	Brashear Hastings.	Objective	Fixed	No
1900 M.I.	Porro	Cross-wires	Movable	Yes

Model	Objective aperature inches	Focal length inches	Power	Field of view Degrees
1900	1.5	11	6	4
1900 M.I.	1.5	11	8	4

10.Q.What does a pier mount look like and when is it used?

A.See part 100 on Class 33 Division 22 Drawing 35 in Ordnance Pamphlet No.1657. The pyramidal shaped bolt is sunk in soft concrete. The base is laid over the bolt after the pier is hard and then secured in place by screwing the nut on to the bolt.
It is used where a permanent and stable mount is especially desired,and in observing stations and emergency stations where the azimuth instrument is a permanent part of the equipment.

11.Q.Draw an outline of a set Brashear-Hastings prisms?

A.SeeFig.___ (Take from Coast Artillery School Pamphlet on Optics figure ________)

12.Q.Draw an outline of a set of Porro prisms?

A.SeeFig.___ (Take from Coast Artillery School Pamphlet on Optics figure ________)

13.Trace the path of a ray of light thru each kind of prism. Show how the image is erected?

A.See Figures ______ and ______(Take fromCoast Artillery School Pamphlet on Optics figure _______).

14.Q.Which type is the most difficult to make? Why?

A.Brashear-Hastings. Because the roof angle of the prism must be so accurately and finely cut that the roof will reflect up to the very ridge;otherwise the ridge line will be visible right across the center of the image. The edges of the Porro prisms are not used to form the image.

15.Q.Which type absorbs the most light? Which have the best angle of reflection?

A.The Porro prisms absorb probably about 3 o/o more. The reflection in the Brashear-Hastings prisms is probably somewhat more efficient due to the first and last reflections being at an angle of incidence of 60 degrees instead of 45 degrees.

16.Q.Which type would suffer most from rough handling?

A.The Brashear-Hastings. The surfaces cemented together with balsam may be cracked apart or the delicate roof angle nicked so that it may become visible,while the central areas of the reflective surfaces of the Porro prisms are no more liable to injury from scratching than are similar areas on the Brashear Hastings prisms.

17.Q.Why does C.A.D.R.837 prohibit the taking apart of telescopes or the making of adjustments other than those described in descriptive pamphlets?

A.Because of the strong probability of injury to lenses or prisms from dropping or from scratching and of disturbance of the careful adjustment of optical parts after test by the makers. It is next to impossible to make perfect optical parts but it is practical and customary to eliminate the greatest part of the results of defects by neutralizing one with another,by adjustment so that the defect is on the outer edge of the field,and by other devices known to the skilled optician. If his arrangement is destroyed,the instrument may be found almost valueless until readjusted after slow and expensive experimentation.

18.Q.What is meant by the critical angles of prisms?

A.The limiting angle of incidence which separates the totally reflected ray from those which (at least partially) escape into the air-Century Dictionary.

The angle of incidence in this case is the same as in Definitions, C.A.D.R.27 and under Plotter,IV Elementary Gunnery,which see. When a light ray strikes the water or plain glass normally (perpendicularly) it passes into the new medium (water or glass As its angle of impact decreases and the angle of incidence increases from zero a smaller and smaller quantity will enter the medium. When all of the light is reflected the critical angle has been reached.

Similarly,with the light entering the medium,after traversing it with more or less loss by absorption,the balance strikes the opposite limiting surface. If its angle of incidence is small (path of ray not far from perpedicular to this second surface) most of the light will escape into the air or medium beyond. A greater and greater quantity of the light,as the angle of incidence increases,will be reflected back thru the medium into the air on the same side as its origin. When none passes out into the air on the side opposite its origin,the critical angle has been reached. For glass and water this angle is in the vicinity of 40 degrees.

This explains the dazzling sun spots on the water in early morning and late afternoons,also window reflections so noticeable at these periods of the day.

19.Q.Why does the surface of a prism through which you can see, reflect light when in its place in a telescope tube?

A.Because the surface opposite the point of entrance of the ray is so placed as to give an angle of incidence greater than the critical angle.

Printer:- Insert sketch "Refraction and Reflection in a prism" herewith. Add underneath the following explanation:

A ray of light from the right strikes the prism at D and passes through the prism to E where it is reflected in the direction F and finally passes into the air again in the direction s F. It is refracted (bent) at D and F because of the difference in density of air and glass. See explanation of the principle of refraction on page ____. It is reflected at E because its angle of incidence, D E C, is greater than the critical angle. The other lines and letters indicate an exact method of determining the path of the ray which is too complex for the purposes of this book.

20.Q.How many lenses are there in this instrument?

A.Three.

21.Q.What are their names?

A.The objective lense which is a compound lense, the field lense and the eye lense, the last two being simple lenses.

* 22.Q.What are their shapes? The name given to each shape?

A.Objective, consisting of a double convex and a convexo-concave; field lense, plano convex; eye lense, plano-convex.

See Figures ___ and ___, showing the several types of lenses.

23.Q.What is meant by a compound lense?

A.A lense made in two parts held together in such a manner that the parts in most respects act as one lense.

* 24.Q.What is the object of compounding?

A.To neutralize chromatic aberration principally. Opticians also use this combination for neutralizing other defects as explained under Question 17.

* 25.Q.What is meant by aberration? by achromatic?

A.Aberration means wandering away, hence in this case the wandering away in different directions of the several colored rays obtained from white light.

Achromatic means without color, for instance a lense from which chromatic aberration has been removed by compounding.

See Figure three (3) below.

(Printer: Insert here Figures 1,2,and 3 from article on Defects in telescopes pages 30,31,and 32,Journal of the U.S. Artillery-January and February 1912. Renumber figures in accordance with numbers in this book,making necessary changes in Figure numbers in text).

Figure 1.

A ray of white light from A striking at B is dispersed into the seven colors; violet,indigo,blue,green,yellow,orange,and red in the order named,because the ray did not strike the plate perpendicularly.

Figure 2.

The ray striking the lenses perpendicularly at the point of impact does not suffer color dispersion. All other rays are dispersed as indicated. Each color of ray passing thru the positive lense has a different focus. If a ground glass were placed any where between F_1 and F_2,an indistinct image having fringes of color around it would be obtained. This is chromatic aberration or color wandering. Note that the positive and negative lenses diperse the colors in opposite directions.

Figure 3.

This shows the type of objective mentioned in Question 22. Note that the compounding of this lense has neutralized the color dispersion of each part.

26.Q.Why are the parts of a compound lense separated?

A.Because it is not practicable to grind the parts of the lense so that one will fit the other perfectly. An air bubble between would increase the amount of light absorbed, reflected,and otherwise lost,and would make it easy for dust to collect between the parts. The spots of contact would look different than the areas of no contact. Small pieces of paper are used to separate the parts and can frequently be seen upon close inspection of an objective.

27.Q.With what is the space filled? Why is this substance used?

A.With Canada balsam because it transmits light practically as well as glass and at the same time acts as a hard cement.

28.Q.What deterioration sometimes occurs in this substance? How do you detect it?

A.It is not infrequently found to be cracked after a heavy shock. It then looks similar to a spalled or split piece of glass but one can usually be distinguished from the other by the whitish or yellow coloring of the balsam.

29.Q.What does greenish spots on lenses indicate?

A.The formation of "patina" on the surface of the lense due to the action of water,the acids in moisture from the hand, collections of moist dust and oil.

30.Q.What do brown spots on lenses indicate?

A.The decomposition of the lead in the glass.These spots are known as lead spots. This occurs on both exterior and interior surfaces.

31.Q.What kind of treatment hasten the development of these spots?

A.Failure to keep lenses clean. Failure touse soft,clean cloths o paper for cleaning.
Use of water or saliva instead of alchol or either,for cleaning.
Handling lenses with the fingers.

* 32.Q.What is meant by the power of a telescope? the field of a telescope? how can you measure each?

A.The power of a lense is the ratio of the diameter of the object as seen thru it. The field is measured by the number of degrees,measuring from the eye of the observer,which the whole image covers. It is also expressed in yards by the extent of the image visible at 1000 yards.

33.Q.Why is there but one wire in this instrument?

A.Is supplied with a vertical wire only because it is intended only for reading azimuths. No waterlining is necessary.

34.Q.How is a broken wire repaired? in an emergency what material may be used?

A.Make a small mark on both the adapter and tube to aid in securing the correct position in reassembling. Remove the adapter from the telescope tube. Remove the broken wire. Insert a new one under the clamps,winding the ends around the clamps and using a drop of shellac to hold the wire more securely. See that the face of the wireholdaracross which the wire is stretched is assembled toward the eye end. Assemble so that the spring attached to the wire holder is placed opposite the lamp bracket. Then insert adjusting screws and adjust for correct position of collimating wire.
In emergency a freshly spun thread from a spider may be used.

35.Q.Who ordinarily replaces broken cross wires?

A.The resident ordnance machinist. Under service conditions however gun pointers and observers would have to replace wires for themselves frequently.

36.Q.What does "collimation" mean? How do you adjust the telescope for collimation? What is the purpose of this adjustment?

A.Collimation means, the accurate adjustment of the line of sight of a telescope so that when it is rotated about its horizontal trunnions the line of sight will remain in a vertical/~~line~~ plane.

Focus and direct the telescope on an object. Reverse the telescope in its bearings. Traverse the instrument 180 degrees. If it is now on the object, the wire is in collimation. If it is not, correct for one half the error by moving the collimation wire holder and half the error by traversing the telescope. Repeat until the error is eliminated.

37.Q?Why should the precaution described in question 34 be observed when removing the eyepiece adapter?

A.Because if the wire holder is assembled with the wrong face to the rear it will be impossible to remove parallax and at the same time obtain a clear image.

38.Q.What is parallax?

A.The change of place of an objectwhen viewed from different points. If, when looking through a telescope, the image "dances" on the cross wires when the eye views it from differ-points in the field as a result of moving the head back and forth and up and down, parallax exists.

39.Q.How is it removed?

A.By focusing the objective until the the image is exactly upon the crosswires. If the image is in front of the crosswires, the image moves in the same direction as the head in relation to the crosswires. If the image is behind the crosswires, the movement will be opposite to that of the head, and will therefore cease when the image and the crosswires coincide.

40.Q.Is the removal of parallax important?

A.It is very important since no dependable results can be obtained from a telescope until it has been removed.

41 Insert from page 147.

43.Q.Orient the instrument upon a designated point?

A.Set up the tripod with one leg pointing in the general direction of the line which would bisect the angle through which it will be necessary to traverse the instrument.This will give the minimum of interference of the legs of the tripod with the movements of the observer and will lessen the chances of his movements disturbing the setting of the instrument.

Screw the instrument to the tripod head; level it as described under question 4; set the index on the platen to read the known azimuth of some point to the nearest whole degree; turn the knob with readings increasing or decreasing as the general direction of the motion of the telescope may

For page 149, see next page.

Screw the instrument to the tripod head; level it as described under question 4: set the index on the platen to read the azimuth of the known point to the whole degree just short, in the direction of motion, of the exact azimuth; turn the knob so that the motion of the index on the platen shall be in the same direction as that used for the whole degree setting until the proper hundredth of a degree is obtained; note whether or not index on platen now indicates approximately the azimuth of the known point; bring eye end of telescope over center of worm box by unclamping slow motion arm clamp, moving the desired amount and again clamping (this to place the window just to the right of the eye end of the telescope to facilitate reading azimuth); shift the spindle and all parts attached thereto on the base, the leveling screws being loosened for this purpose, until the telescope is pointing in the direction of the known point; level carefully, adjusting if necessary by the method outlined under questions 6 and 7 above; adjust for parallax and focus the telescope; bisect the known point coming up from the same direction of motion of platen index as before; test by coming up from the opposite direction; eliminate the error, if any, (called back lash) as explained under questions 48 to 51 below. The instrument is now oriented.

42. Q. What is the advantage of setting the instrument approximately before leveling?

A. Unless the base happens to be exactly parallel to the plane of the level bubbles, the shift in azimuth by moving the leveling screws on the base will compel relevelling. The initial azimuth can be disturbed for the purpose of levelling without materiel disadvantage by simply turning the worm box eccentric crank to the unclamped position.

43. Q. Point out the following parts on the sectional view of the azimuth instrument.

No.	Part.	No.	Part.
1.	Ball and socket joint.		
2.	Cup Washers.	6	Platen (vernier plate)
3.	Spindle.	7.	Yoke.
4	Disk on spindle head (graduated limb)	8.	Azimuth clamp shoe.
5.	Worm Gear.	9.	Slow motion arm.
		10.	Yoke retaining washer.

A. Numbers on section indicate the above parts, number for number.

44. Q. Point out the bearing surfaces when telescope, yoke and shield revolve around the graduated limb.

A. Between the spindle and yoke retaining washer on the one hand and the yoke on the other.

The following are to be inserted after question 40 on preceeding page. Questions 41 to 61 inclusive should be renumbered to agree, i.e 41 on preceeding page becomes 43.

41.Q. What is the first adjustment to be made on a telescope? Why?

A. The adjustment for parallax because if the objective is focused first it will be placed so that its image is correctly picked up by the eye piece but in all probability the latter is not focussed on the cross wires. The cross wires will not be in coincidence with the image of the objective. The cross wire cannot be moved longitudinally, therefore the adjustment for parallax can only be made by beginning over with that adjustment first.

42.Q. Can you remove all parallax in a two wire instrument theoretically? Practically?

A. Theoretically no, because the cross wires have thickness. When the eye piece is adjusted perfectly, the image may be placed upon the center of either wire but cannot be placed on the center of both.

Unless the diameter of the wire is large, when adjustment is made upon the point of contact of the two wires, the parallax will not be noticed except upon close inspection.

45.Q.Point out the bearing surfaces when telescope and yoke revolve and graduated limb and platen remain stationary?

A.The bearing surfaces are the same as before, except that the platen being stationary, there is movement between part of the yoke and the limb in addition.

46.Q.Can the leveling screws be shifted in azimuth?

A.Yes. Study above drawing and reread answer to question 43.

47.Q.When the azimuth scale index indicates an even degree and the hundredths index indicates say .17 what is the trouble and how do you remedy it?

A.The index pointer is out of adjustment. Loosen the index screw and shift it the necessary amount, first having placed the platen index so that it is set at some even degree mark.

48.Q.How do you remove play or binding between the worm and the worm gear?

A.See drawing 32-1-25, Swasey Depression Position Finder Type A-I, General Construction, Section Thru Worm Box which shows the same mechanism as exists on the azimuth instrument, except that it is reversed, the handle being on the left. The worm box is pivoted on the right (left in above view) so that screwing the worm box adjusting screw in against a lug, cast as a part of the platen, will push the free end of the worm box outward away from the worm wheel. This will remove binding between worm and worm wheel. Screwing the worm box adjusting screw out allows the worm box spring to crowd the worm into closer contact with the worm wheel.

49.Q.How do you remove longitudinal play of the worm?

A.By tightening the worm adjusting screw in the end of the worm shaft.

50.Q.Explain the action of this screw?

A.It draws the worm shaft shoulder against the worm box shoulder by crowding the index disc against the end of the worm box.

51.Q.When the index disc fails to stay set but revolves until the disc crank is down, what would you do?

A.Tighten the worm adjusting screw.

52.Q.Which lamp lights the hundredths of a degree scale? the graduated limb or azimuth circle?

A.The same lamp illuminatesboth . It is the one near the azimuth window.

53.Q.How is the vertical wire illuminated?

A.By the lamp on the right side of the telescope.

54.Q.Name the principal parts of the illuminating circuit.Trace the path of the current thru each part?

A.The azimuth lamp,the vertical wire lamp,the switch,the twoway push button,fuze block,resistance coil.
The current having been brought to the fuze block passes in the following order thru the different parts: resistance coil, snap switch, two way push button,thence to either the vertical wire lamp or the azimuth lamp depending upon the setting of the two way button thence back to the source of power in the reverse order,omitting only the resistance coil.

55.Q.What is the purpose of the two way push button?

A.Ordinarily the circuit is thru the vertical wire lamp,but when it is desired to read the azimuth scales,pressure on the button tip close the circuit to the scale lamp and opens the circuit to the vertical wire lamp.

56.Q.Can the amount of light given by the lamps be changed? How? In both lamps or only one?

A.Yes.The socket in the vertical wire lamp bracket has an adjustment for varying the intensity of illumination of the wire. The azimuth scale lamp socket does not.

57.Q.What does sparking in a lamp indicate?

A.That the filament (the small wire inside which glows to give the light) is broken.

58.Q.How can you determine whether your lamps are dead,the power turned off,or the circuit is broken when the lamps fail to glow?

A.The power is almost always on if other lamps at the station are burning. A usual but not very safe way is to place the fingers across two terminals and "feel" the current. This is dangerous because the line may have been brought into contact with a high potential circuit by accident. Unless standing in a dry place with dry shoes a very uncomfortable shock may be experienced from a 110 volt circuit. Under no circumstances should this method be employed on circuits known to have a higher potential.
The circuit can be tested by putting in good new lamps when the power is known to be on.
Broken filaments can usually be detected by inspection in a strong light.

59.Q.Describe the method of removing and replacing lamps?

A.The lamp socket for the azimuth scale lamp bracket is attached by a bayonet joint bearing against a spring. By pressing it into the bracket and rotating it to the left until it bears against the pin, it may readily be removed.

The vertical wire lamp may be removed by screwing the adjusting sleeve to the right until the socket is ejected. The lamp may then be replaced.

To replace this lamp socket screw the adjusting sleeve until it is about flush with the end of the bracket and the slot in the sleeve coincides with the slot in the bracket. insert the socket with the adjusting pin in both slots, and rotate the sleeve to the left.

60.Q.What kind of oil would you use on this instrument? How much? How often?

A.Clock oil. 1 ounce per year is allowed for each instrument. See O.P.1828-23. The oil should be applied by dropping from the end of the dropper attached to the cork. This will last ordinarily from four to six months. Frequent or excessive oiling will actually do harm, as the excess amount will flow away from the bearings to the surrounding parts and serve to catch dust and ultimately to clog up the parts concerned.

61.Q.In what condition should the levelling screws be left before the instrument is returned to the chest?

A.They should all be bearing snugly, not too tight, in order to prevent the spindle and upper parts from "rocking" under the shock of transportation and handling, to the destruction of the finer adjustments?

(Printer: Add here "Names of parts of azimuth instrument", pages 7 and 8, and drawing 23 - 1 - 3 from O.P. 1657 - (9)

III Fire Control Apparatus.
(b)Use of the telephone.

1.Q.How many telephones are there in a standard battery commander's, B.C.,station? To what places do they run?

A.Two. One to the fire commander,F', and one to the observers at the primary,B', and at the se ondary,B",stations.

2/Q.Can the telephone to F' be used for any other purpose?

A.No.

3.Q.Can the telephone on the observers'line be used for any other purpose? If so what?

A.Yes. See diagram of wiring in B.C.Station labelled B.C.STATION SWITCHES and note,"Switches to cut hand set of observers' line in to fire commander's line, and to enable observers' line to be used as readers' line in emergency."

4.Q.Describe these switches,the parts thru which electricity can pass and the positions in which they are usually set.

A.The B.C.STATION SWITCHES are three double pole,double throw switches," The handles and tops are made of hard rubber or other non-conducting material,hence electricity can pass only thru the brass posts or poles,and from one post to another on the brass blade connecting two posts when the switch is closed."The middle terminals ofthe top switch are connected to the B.C.hand set and the switch is normally open. By closing the switch to right,the B.C.hand set is thrown on to the observers'line. By closing the switch to left,the B.C. hand set is thrown on to the fire commander's line . The middle and bottom switches are normally closed to the left,in which case the B' and B" readers are connected to their respective arm setters in the plotting room (Nos.2 and 3 when THE BASE LINE SWITCH BOX is set for HORIZONTAL BASE SYSTEM.

5.Q.What combinations are possible and what purpose does each serve?

A.The following combinations are possible with these switches:-

1.When BASE LINE SWITCH BOX is set for HORIZONTAL BASE SYSTEM.

(a)Middle switch closed to right and bottom switch to left.No.3 plotting room detail is connected to B" reader.No.2 plotting room detail is connected to B' and B" observer in parallel. This is useful in case of casualty to B'reader's line.

(b)Middle switch to left and bottom switch to right.No.2 plotting room detail is connected to B' reader.No.3 plotting room detail is connected to B' and B" observers in parallel. This is useful in case of casualty to B" reader's line.

(c)Middle and bottom switches both closed to right, Nos.2 and 3 plotting room detail B' and B" observers are all connected in parallel.

This is useful in case of casualty to both B' and B" readers lines. When used Nos. 2 and 3 will hear talk from both B' and B" and must select their data.

(2)When BASE LINE SWITCH BOX is set for VERTICAL BASE SYSTEM, OBSERVATION FROM B'.

In this case the bottom switch of B.C.switches is disconnected from the plotting room.

(a)Middle switch closed to the left. This connects B' reader to Nos. 2 and 3 plotting room detail in parallel.

This is the normal position.

(b)Middle switch closed to the right. This connects Nos.2 and 3 plotting room detail, B' and B" observers all in parallel.

This is useful in case of casualty to B' readers line.

(3)When base line switch box is set for vertical base system, observations from B". In this position the middle switch of B.C.switches is disconnected from the plotting room.

(a)Bottom switch closed to left. This connects B" reader to Nos. 2 and 3 plotting room detail in parallel.

This is the normal position.

(b)Bottom switch closed to right. This connects Nos.2 and 3 plotting room detail, B' and B" observers all in parallel.

This is used in case of casualty to B" readers line.

(4)When both switches in BASE LINE SWITCH BOX are closed to left The connections are the same as for 1 above with Nos.2 and 3 plotting room detail interchanged.

The switch should not be used in this position.

TELEPHONE SERVICE.

6_.Q.How would you procsed by practical test to select operators?

A.The men should be tested as to their ability to distinguish sounds in a telephone. The following method is suggested: Enunciate distinctly through the telephone letters which sound somewhat alike,as B,C,P,T,E,and ascertain whether they can be distinguished readily; enunciatd a number of words beginning with S,such as seven,six,sight,sound; try such words as four,more,score,door,bore.C.A.D.R.728.

After a test of this kind with an instrument in good order,try with an instrument which is not working well.C.A.D.R.729..
After the hearing test,give a number of selected words to be sent through the telephone to test the operator's ability to enunciate distinctly.C.A.D.R.730.

7.Q.What habits of speech and voice tones indicate good material for telephone operators.

A.Other qualifications being equal,men should be selected who are in the habit of speaking slowly and distinctly.A man who raises the pitch of his voice when excited should not be selected.C.A.D.R.731.

8.Q.What kind of defects in his telephone is an operator expected to correct for himself.

A.Operators should have a sufficient knowledge of their instruments to correct minor defects,such as loose or corroded contacts,or bent levers.C.A.D.R.732.

9.Q.Describe the tests made and action taken by each operator when preparing for service.

A.When preparing for service the operators arrange their apparatus for communicating and raise and lower the hook switch.If this operation results in a sharp click in the receiver,the battery is in working order.If no click is heard,the binding post to which the head sets are connected should be examined and tightened.If the hook test indicates that there is no battery on the line,the operator must notify the electrician sergeant.The principal operator on each line calls up all the others on his line and reports to the chief of his station. C.A.D.R.733.

10.Q.What can you say about the necessity for proper care of equipment by each operator?

A.Particular stress should be laid on the importance of training each telephone operator to take an interest in the instrument used by him.If each operator takes proper care of his instrument the efficiency of the system is much enhanced.

11.Q.What action should an operator take when closing station?

A.The talking set should be hung in its proper place at the completion of drill,hook springs should be in place,the cords should be clear of possible interference,and a report should be made promptly of any defect in the talking circuit.

12.Q.What things should be done in the general care of telephone equipment?

A.The nickel plating should be kept polished with chamois; the connections external to the transmitters and receivers should be examined often for possible corrosion and a strip of hard-surfaced paper drawn between platinum contacts to insure their cleanliness. Cords should be examined frequently for wear just behind the tips.

13.Q.With what part of the instrument must the operator not tamper?

A.Transmitter shells must not be opened by the operator under any circumstances.C.A.D.R.737.

14.Q.Upon the discovery of an indication of trouble beyond his power to correct to whom does the operator report and where will this person be found.

A.To the electrician sergeant in charge of that portion of the equipment. Electrician sergeants are given definite stations and portions of the equipment to cover during drills and action. The electrician sergeant's station should be known to every operator.

15.Q.Enumerate the rules to be followed in sending messages:

A.1.Speak into the transmitter holding the head in a natural position,the lips about an inch from the transmitter.

2.Use a moderate tone of voice and speak slowly and distinctly, being careful not to slur the words or syllables,but to enunciate clearly each sound.

3.Never shout or raise the pitch of the voice.

4.Send numerals singly;thus,4370 is sent four,three,seven,zero. Never use the letter O for zero. In sending an azimuth or any number involving a decimal,the decimal point is called point; 246.34 is sent two,four,six,point,three,four. An exact hundred is sent as a hundred;thus 200 is sent as two hundred,4500 is sent forty-five hundred. The same system applies to sending an exact thousand;4000 is sent four thousand.

5.If it is necessary to repeat,use more care as to distinctness but do not raise the voice. A single number not understood may be accentuated by counting up to it and emphasizing it. Thus if the figure four is not understood,say four; one,two,three, four.

18.Q. Enumerate the rules to be followed in receiving messages.

A. 1. Keep the mind on the message; a person can not receive correctly when he is thinking of something else.
2. Keep the receiver close to the ear.
3. Do not interrupt the sender unless absolutely necessary.

Note:- For catechism on construction and purpose of parts of telephone, see Appendix C, page 173.

OBSERVER

IV Observer's test,C.A.D.R.

This subject is intended to be a practical test of the candidates at the battery. The following questions probably will not be asked in the examination but are added for the instruction of the candidate as to the points on which he will be judged by the examining officer during the practical test.

1.Q.What are the qualifications especially to be desired in an observer?

A.Observers are selected on account of their special aptitude,and must understand thoroughly the use of their instruments and have a knowledge of the general features of warships in order to be qualified for their duties.C.A.D.R.326.

2.Q.For what is the observer responsible?

A.Each observer is responsible for the care and adjustment of his instrument and for the security and police of his station at all times,and reports to the range officer deficiencies,defects,or accidental damages as soon as they are known.C.A.D.R.326

3.Q.What is his personal equipment?

A.With the type installation,1909,each observer at the base end stations wears a head receiver and breast transmitter bridged on a line (observer's line) to the B.C.station,for the purpose of communicating with this station while he is observing.C.A.D.R.326.
In the later installations the head receiver and breast transmitter are combined into a head set.

4.Q.How is the practical test conducted?

A.In order to select observers who are to work at the ends of the same horizontal base line,two instruments should be set up as near together as practicable and oriented carefully. The observers,using these instruments,track a moving target. Every fifteen seconds a bell is struck three times or READY,TAKE called,and the readings of the two instruments compared.C.A.D.R.327.
Note:- Hereafter in drill,subcaliber,and service practice with guns,mortars, and mines a 30-second observing interval will be employed. Regulations for the Instruction and Target Practice of Coast Art'y Troops,1912.

5.Q.What comparisons of data are observers required to make frequently in drill,and practice? What is its object?

A.Arrangements should be made so that observers may compare frequently the ranges to moving objects as determined by a horizontal base,with the readings of the D.P.F. This comparison should be made during the progress of the observations by calling aloud both results. If the plotting board is not at the primary station,the H.B.range can be sent there by telephone.C.A.D.R.329.

The object is to teach the observer just what he can accomplish with a carefully adjusted instrument in range finding by vertical base.

6.Q. What is the nature and purpose of the month test of observers? Is it optional or mandatory?

A. At least once a month during the outdoor season D.P.F. observers shall be tested as to their proficiency at ranges within the maximum for height of instrument as above described. The test should be conducted so as to determine the relative ability of various observers to read quickly and accurately ranges to fixed and moving objects. C.A.D.R.330.
It is mandatory.

7.Q. What are the duties of the reader?

A. Each reader reads and transmits the azimuth or azimuth and range to the plotting room. C.A.D.R.331.

8.Q. What are the duties of each member of the fire control section on reaching his station?

A. To examine the instrument or other materiel to which he is assigned, to make the prescribed tests and adjustment, and to report defects, if any, to his chief of detail. See C.A.D.R.333.

OBSERVER.

V Characteristic features of the several classes of war ships, general knowledge of local shipping, of channels leading to the harbor, and of ranges to prominent fixed objects in the field of fire of the battery.

For this subject, see the same subject under Gun Commander and Gun Pointer XI, page 51.

APPENDIX A.

Instructions for printer:

Print the paragraphs from C.A.D.R. definitions indicated below. The check marks as shown in the three columns ,indicate to the candidate which definitions he will be required to know. Print the paragraphs in full as given in C.A.D.R.

Add the following paragraphs from C.A.D.R.:

283
285
326-336
343-353
355
480-504
536-540
545
553-555
576-577
617-620
621-653
659-690
757-779
782-787
793-815
819-822
$823\frac{1}{2}$-828
845
848-849
851-860
862
869-878
880
882
888
899-916
935-950
969-983
997-1004.

APPENDIX.A.

Extracts from Drill regulations

Coast Artillery,1909

DEFINITIONS.

Plotter.	Observer.	
✓	✓	21 Aiming.
		22 Ammunition.
✓	✓	24 Angle of departure.
✓	✓	25 Angle of fall.
✓	✓	26 Angle of impact.
✓	✓	27 Angle of incidence.
✓	✓	28 Angle of position.
		29 Apron.
		30 Approaches.
✓	✓	32 Atmosphere board.
✓	✓	33 Axis of gun.
✓	✓	34 Axis of trunnions.
✓	✓	35 Azimuth of a point.
✓	✓	36 Azimuth difference.
✓	✓	37 Azimuth instrument
✓	✓	39 Base end station.
✓	✓	40 Base line.
		41 Banquette.
✓	✓	42 Battery
✓	✓	43 Battery commander.
✓	✓	44 Battery commander's station.
		45 Battery commander's walk.

✓			46	Battery parade.
✓	✓	✓	47	Battle area.
✓	✓		49	Blending
✓	✓		50	Bore.
✓	✓		51	Bore sighting.
✓	✓	✓	52	Bourrelet.
✓			53	Breech.
✓			54	Breech block.
✓			55	Breech mechanism.
✓			56	Breech recess.
✓			57	Breech reenforce.
✓			58	Bursting charge.
✓	✓		59	Caliber of gun.
✓	✓	✓	60	Calibration.
✓	✓	✓	61	Cannon.
✓			62	Canopy.
✓	✓	✓	62½	Cap.
✓	✓	✓	63	Capital.
✓			64	Carriage or mount.
✓			65	Carriage fixed.
✓			66	Carriage movable (wheeled mount).
✓			67	Carriage coast(A,B,C.)
✓	✓	✓	68	Case I - Case II - Case III.
✓	✓	✓	70	Charge.
✓			71	Chase.
✓			72	Chief of ammunition section.
✓	✓	✓	75	Clinometer.
✓	✓	✓	76	Clinometer rest.

77 Coast artillery fort.

78 Coast artillery garrison.

79 Coast artillery reserves.

80 Coast artillery supports.

81 Communications.

82 Computer.

83 Corrected range.

84 Corridor.

85 Corridor wall.

86 Counterweight.

88 Crane.

89 Danger space.

90 Deflection.

91 Deflection board.

91½ Deflection recorder.

92 Delivery table.

93 Density of loading.

94 Depression position finder.

95 Deviation.

96 Deviation at the target.

97 Deviation absolute.

98 Deviation mean lateral.

99 Deviation mean longitudinal.

100 Deviation range.

101 Directing point.

102 Displacement of any point.

103 Drift.

104 Elevation.

105½ Emergency condition.

106 Emplacement.

107 Emplacement book.

109 Equalizing pipe.

110 Exterior crest.

111 Exterior slope.

112 Field of fire.

113 Fire area.

114 Fire-control

115 Frie-control material.

116 Names of all fire-control stations pertaining to a gun battery and a fire command, their abbreviations and conventional signs.

117 Firing interval.

118 Fixed light.

119 Forcing cone.

120 From battery.

120½ Fuze.

121 Gallery.

122 Gas check.

123 General defense plan.

124 Groove.

125 Gun gommander.

126 Gun company.

127 Gun differences.

128 Gun displacement.

129 Gun platform.

130 Gun pointer

131 Hoist room.

132 Hoop.

133 Identification of a target.

134 Illuminating light.

135 In battery.

136 In commission.

137 Indication of a target.

138 In service.

139 Interior crest.

140 Interior slope.

141 Interior wall.

142 Jacket.

143 Jump angle of.

144 Lands.

146 Laying.

147 Line of departure.

148 Line of direction.

149 Line of impact.

150 Line of shot.

151 Line of sight.

152 Loading platform.

153 Loading position.

154 Loading tray.

155 Location of target.

157 Magazines.

158 Manning party.

159 Manning table.

160 Meterological message.

165 Muzzle.

166 Muzzle velocity.

167 Observer.

168 Observing interval.

169 Observing station.

170 Obturator.

Ogive.

172 Orders of fire.

173 Orientation.

174 Orientation table.

175 Parados.

176 Parade slope.

178 Parapet.

180 Plane of departure.

181 Plane of direction.

182 Plane of sight.

183 Plotter.

184 Plotting board.

185 Plotting room.

186 Pointing Case I, Case II, Case III.

T 187 Point of fall.

188 Point of impact.

189 Position finder:The horizontal base system.
(2)D.P.F.system.
(3)The emergency system.

190 Powder chamber.

191 Powder chute.

192 Powder hoist.

193 Powder hoist well

194 Predicted point.

195 Predicted time.

197 Primary station.

198 Primer.

199 Priming charge.

199½ Projectile.

200 Quadrant.

201 Quadrant elevation.

202 Ramp.

203 Range.

204 Range azimuth table.

205 Range board.

206 Range difference.

207 Range finder.

208 Range recorder.

209 Range Officer.

210 Range setter.

211 Rapid fire.

212 Ready.

213 Rear slope.

214 Receiving table.

215 Recoil.

216 Recoil cylinder.

217 Reference number.

219 Reserve table.

220 Restricted fire.

221 Rifling

222 Rimbases.

222½ Rotating band.

223 Round.

224 Roving light.

225 Salvo.

226 Salvo point.

227 Salvo table.

228 Searchlight area.

229 Searchlight range.

230 Secondary station.

231 Serving table.

232 Set foward point.

233 Shell room.

234 Shell tracer.

235 Shot gallery.

236 Shot hoist.

237 Shot hoist well

238 Sight.

239 Sight elevation.

240 Striking angle.

241 Striking velocity.

242 Superior slope.

243 Supplementery station.

244 Swell of the muzzle.

247 Targ.

248 Target.

249 Telescopic sight.

250 Throttling bar.

251 T-I bell.

252 Time range board.

253 Tracking.

254 Trajectory.

255 Travel of projectile.

256 Travel of target.

257 Traverse.

258 Traversing indicator.

259 Trial shots.

260 Trolley.

261 Truck platform.

262 Truck recess.

263 Trunnions.

264 Trunnion band.

265 Tube.

266 Twist of rifling.

267 Unrestricted fire.

268vVent.

269 Wind component indicator.

270 Draw a diagram showing all the angles and planes required in these definitions.

APPENDIX B.

Data for Guns, Mortars, and their Carriages.

Copy without change from Gunner's Instruction (6 Inch Gun), Appendix B.

APPENDIX C.

Note for printer: Copy Appendix C of Gunners'Instruction, adding circuit diagrams as per inclosed prints in addition to circuit diagram shown in Gunners'Instruction.

APPENDIX D.

List of Ordnance Pamphlets for Reference.

Copy without change from Gunner's Instruction (8 Inch), Appendix D.

APPENDIX E.

Instructions for Loading Projectiles with Explosive D.

Copy without change from Gunner's Instruction,(6 Inch Gun), Appendix E.

APPENDIX-F.

Drill for 6-inch Gun, Disappearing Carriage.

Copy without change from Gunner's Instruction (6 Inch Gun), Appendix F.

APPENDIX G.

Nautical and Naval Definitions.

Printer copy list on pages two and three, Coast Artillery War Game by Major William Chamberlaine, Coast Artillery Corps, U.S.A.

APPENDIX H.

TESTS FOR TELESCOPIC SIGHTS.

Telescopic Sights, Models of 1896 MI, 1897, 1898 and 1898 M.

At a fortification where the facilities are few for making the shop tests, the following methods are outlined for the guidance of the officer conducting them:

The test for the equality of the sight trunnions, the accuracy of the elevation arc and deflection scale, the sensitiveness of the levels, and the horizontal motion of the sliding diaphragm can be dispensed with, since the sights before issue to the service have been tested for these requirements, and from the construction of the sight, it is obvious that these requirements can always be obtained.

A bracket mounted accurately on a horizontal gun trunnion will answer all the purposes of an efficient support for the sight during these tests.

1. Test for the parallelism between the line of sight at zero deflection and elevation, and the axis of revolution:

Test each sight independently by setting it at zero deflection and elevation and laying it on a mark about 3000 yards distant, and revolving the sight about its axis of revolution. If the line of sight is parallel to the axis of revolution, the intersection of the cross wires will remain exactly on the same distant mark. If not, deflect the sliding diaphragm and elevate or depress the telescope until the intersection of the cross wires remains exactly on the distant mark. Note the errors in elevation and deflection. If the error in elevation or deflection exceeds 1' the sight must be readjusted. Select that sight which has the minimum errors as the standard sight.

2. Test for parallelism between the axis of the telescope level and the axis of revolution of the sight:

With all the sights set at the true line of sight for zero deflection and elevation, elevate or depress the gun until the telescopic level reads zero. Revolve the sight about its axis of revolution thru an angle of about 5°. If the axis of the telescopic level is parallel to the axis of revolution, the bubble should not leave the center of the level.

3. Test for the cross level being at right angles to the axis of revolution of the sight:

Level the cross level of each sight. Elevate the gun thru an angle about 20°, when the bubble should remain stationary in the center of the cross level.

4. Test for the cross level being at right angles to the vertical arc:

Lay on a distant mark with the sight set at zero deflection and elevation. Elevate the gun thru an angle of about 15°. Now depress the telescope until the intersection of the cross wires cuts the point aimed at. If it does not do so the level is not at right angles to the arc, and the arc is not vertical.

Select the sights that have fulfilled the preceding tests satisfactorily and set each one at 10° elevation and zero deflection, and lay each one carefully on a distant mark.

The sights should be interchangeable to within 1', and this test will verify all the preceding tests except 2. If the sights show a disagreement in elevation which can not be accounted for in the preceding tests, then set each sight at the zero elevation, and if the disagreement still holds, it is due to the trunnions not being of the same diameter and the trunnions must have been injured.

After a sight has been in use for some time the micrometer of the elevating worm may be found not to agree with the vernier. This is due to a slight wear of the worm rack, and when the vernier and micrometer are made to agree at zero, it will sometimes be found that, owing to uneven wearing of the rack, they cannot be made to agree at other angles of elevation. When the difference is considerable the sight should be provided with a new rack. Pages 52-53, O.P.1952-03.

3 inch Telescopic Sight model of 1904 and 3 inch Telescopic Sight model of 1906.

These sights require none of the above tests. They have no levels nor trunnion~~s~~ axes to test. They are so constructed that the horizontal and vertical axes, about which they move in elevation and azimuth, are rigid with the carriage. These axes are by construction properly adjusted and will remain so until wear or injury alters them.

Pocket has: 22 suppls.

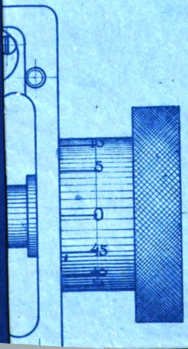
SUPPLEMENTARY
MATERIAL

112
556
THS
Suppl. 7

112
556
THS
Suppl 2

MENTARY
ERIAL

1898 M. Gun Commander and Gun Pointer, VII
(b) The Telescopic Sight..



A. Eye piece cap rem
B. Eye piece cap and diaphram remove
C. Right-hand end level casting, scr removed
D. Front view of fix

Drawing and Tracing
A. Krieg Pvt. 41"