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ARTILLERY FIRING

OR

Instructions on Artillery Fire

(Part IV and part of Part V)

Translated from the French
Projet d' Instruction sur le Tir d' Artillerie
Edition November 10, 1917
at
Headquarters American Expeditionary Forces
France
January, 1918

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WAR DEPARTMENT,
WASHINGTON, D. C., February 25, 1918.

The following pamphlet entitled "Artillery Firing," which has been adopted by the American Expeditionary Forces as the provisional standard textbook on this subject, is published for the information and guidance of all concerned.

[062.1 A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

JOHN BIDDLE,
Major General, Acting Chief of Staff.

OFFICIAL:

H. P. McCAIN,
The Adjutant General.

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ARTILLERY FIRING.

PART IV AND PART OF PART V.

HEADQUARTERS AMERICAN EXPEDITIONARY FORCES.
FRANCE, January 4, 1918.

The accompanying edited translation of a portion of the French "Projet d'Instruction sur le Tir d'Artillerie," November 10, 1917, is published for the information and guidance of all concerned.

As stated in the French preface, the work embraces matters previously covered by many publications, often obsolete, poorly co-ordinated, and sometimes based on controvertible principles.

The object of this publication is to standardize and co-ordinate as far as possible the methods of the various classes of artillery, and give to each the best developments of the others.

The methods outlined are based on experience in war, and are in no way experimental.

It is obviously important that the American artillery develop along co-ordinated lines, thus avoiding the difficulties which the French have experienced in this regard. This publication affords the means of accomplishing this result.

It is intended to print the entire work as soon as possible. The subject is treated under the following subheads:

Part	I.	Ballistics. Dispersion. Firing tables.
Part	II.	Reconnaissance. Observatories.
Part	III.	Observation.
Part	IV.	Preparation of fire.
Part	V.	Methods of fire.
Part	VI.	Ammunition.
Part	VII.	Effects of fire.
Appendices.		Amplifications of the foregoing.

The portions herewith are published in this form to supply immediate needs, and also to secure comments on the terminology used.

It has been noted that there is already some divergence in the terminology in use at the various centers of instruction for artillery. The terms finally adopted in Artillery Firing will be standard, and the basis for all future editions of works involving them.

In the use of terms in this issue, the following considerations have governed:

Terminology previously adopted in our service has been retained. For those not previously current, endeavor has been made to use terms suggestive of their meaning, short and easily spoken, and not subject to confusion. Preference has been given to those already more or less widely used by our forces in France, where they are not conflicting.

It is desired that early comments and suggestions in regard to this matter be submitted to these Headquarters, with a view to the incorporation of these suggestions if advisable, in the complete printed issue.

By command of General Pershing:

James G. Harbord,
Brigadier General, Chief of Staff.

Official:

Robert C. Davis,
Adjutant General.

ARTILLERY FIRING.

PART IV.

PREPARATION OF FIRE.

CHAPTER I.

DEFINITIONS.

116. The object of the preparation of fire is to open fire under the most favorable possible conditions.

It consists of:

Preliminary topographical operations.

Establishment on the base line.

Determination of the initial elements of fire.

117. Preliminary topographical operations. (Chapter II.)

The object of these operations is to find the topographical elements necessary for the establishment on the base line and the determination of the initial elements of fire.

They are performed partly during the reconnaissance and completed after the position is occupied.

118. Establishment on the base line. (Chapter III.)—This operation is to facilitate and hasten laying for direction on the different objectives which may be subsequently assigned to the battery.

It is carried out for each battery immediately after the occupation of the position and the assignment of a sector.

A battery is said to be *on the base line* (en surveillance)

when the plane of fire of a particular piece (generally the first), called the *base piece* (piéce directrice), is directed on a well-defined point taken as the *base point* (point de surveillance), and when the planes of fire of the pieces are parallel. The planes of fire of the various pieces, taken as a whole, is called the *sheaf* (faisceau).

The line joining the base piece and the base point is called the base line (direction de surveillance).

The base point is a point on the terrain or of the enemy works, and situated within the sector. It is generally shown on the map, and is generally invisible from the battery position. Sometimes it is visible from an observatory (observatoire), from which it is simply designated on the terrain without being laid out on the map.

One base point may be common to several batteries.

A battery can have several base points, in which case they are designated as No. 1, No. 2, etc.

The base point may be the objective itself, if fire must be opened immediately, or if there is but one objective.

119. The battery being on the base line, when an objective is assigned, the initial elements of fire are determined, and the pieces laid for range and direction (Chapter V.)

120. For both light and heavy artillery, it is very necessary that the preparation of fire be as accurate as possible. The battery emplacements are usually defiladed, and the objectives visible only from observatories considerably separated from the battery. Sometimes the objectives are visible only from aeroplanes or balloons. It follows that fire can be prepared accurately only by means of a map giving exactly the location of the pieces, base points, and objectives.

121. When maps are not available, or are not satisfactory, fire must be prepared by improvised methods, depending on the circumstances and based on measurements taken from suitably chosen observatories.

In such cases, the preparation of fire is by the same principles as ordinarily, but with some modifications, as given in Chapter IV.

122. Definitions.—

Battle map (plan directeur).—A large scale map (1/20,000, 1/10,000, 1/5000), showing the enemy works, and, in some cases, our own.

Plane table (planchette topographique).—A board with tripod, on which is mounted a squared sheet, or a battle map, used for topographical operations on the ground.

Firing board (planchette de tir).—A board on which is mounted a squared sheet, or a battle map, showing the orienting line (direction repére), the base piece, the objectives, the witness points (buts témoins), and observatories, used in the accurate measurement of the map elements of fire.

Triangulation system (Canevas d'ensemble).—A diagram of the natural or artificial points or markers whose position is accurately known. It is used for the topographical operations incident to the preparation and observation of artillery fire.

Lambert north, or Y-line.—The direction of the vertical lines of the map squares, from bottom to top (Lambert system of projection).

Azimuth or bearing of a direction (gisement).—The horizontal angle which this direction makes with the Lambert north, or Y-line, measured clockwise from the north, 0 to 6400 mils (or 4000 decigrades).

ORIENTATION AND DECLINATION OF TOPOGRAPHICAL INSTRUMENTS.

1st. *Plane table.*—The plane table is said to be *oriented* when the lines joining plotted points are parallel to the corresponding directions on the ground. The plane table is said to be *declinated* when the declinator is so set that, when the plane table is moved so as to bring the compass needle opposite its index, the plane table is oriented.

2nd. *Goniometer,* or angle-measuring instrument.—The goniometer is said to be *oriented* when the readings of the various points of the terrain are equal to the azimuths of these points (or 6400 minus these azimuths, if the instrument is graduated counterclockwise).

There are two cases in the declination of such instruments:

(*a*) *When the compass is fixed to the upper movement,* such as the compass goniometer. The instrument is said to be declinated when the reading declination is known which must be set off in order that, when the needle is brought opposite its index by the general movement, the instrument will be oriented.

(*b*) *When the compass is independently movable, such as* the Jobin theodolite. The instrument is said to be *declinated* when the compass has been so set that the instrument will be oriented when the needle is brought opposite its index by the general movement.

CHAPTER II.

PRELIMINARY TOPOGRAPHICAL OPERATIONS.

GENERAL REMARKS.

123. The preliminary topographical operations incident to the preparation of fire consists of:

1st. Operations by the battalion orienting officer (officer orienteur pour le groupe).

2nd. Supplementary operations in each battery.

124. In general, the preliminary operations by the orienting officer are:

1st. The establishment near each battery of an *orienting line,* which is a line materialized on the ground. Its azimuth must be determined.

2nd. The location horizontally and vertically of one or more *place marks* (repéres de position) near each battery.

The orienting officer performs these operations as soon as the battalion commander indicates the battery positions, without waiting for the battery commanders to select definitely the positions for the pieces (pars. 127 to 140).

125. The supplementary topographical operations are performed by each battery as soon as the position is occupied or the positions for the pieces fixed. They are:

1st. The location horizontally and vertically of the base piece (par. 139).

2nd. The location of the other pieces with respect to the base piece, usually by the direction of the front of the battery, the distances between the pieces, and sometimes the differences in level of the pieces (par. 140).

126. If the battalion topographical operations are not completed in time, all of the operations necessary for the preparation of fire must be performed by the batteries themselves (par. 141).

Conversely, the orienting officer may have to perform or verify the battery topographical operations.

The battalion commander apportions the topographical operations necessary between the orienting officer and the battery commanders.

BATTALION TOPOGRAPHICAL OPERATIONS.

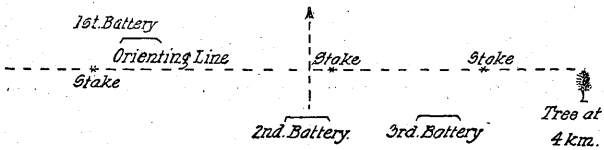
127. Selection of the orienting line.—The orienting line is an origin in laying the pieces for direction.

It should therefore be selected so that, from one or mort points on it, the pieces of the battery will be visible and within calling distance.

Frequently it is best to have it parallel or slightly oblique to the front of the batteries. This is necessary when the pieces must be laid for direction individually, as when the batteries are in woods or casemates.

128. Whenever possible, the same orienting line should be used for all of the batteries of the battalion.

129. The orienting line must be clearly materialized on the ground.



Ordinarily it is staked out by several markers carefully aligned. The number of these should be such that, from all points of the line which must be used, at least two markers can be seen in the same direction. Whenever possible, the line passes through a distant marker consisting of a natural object (tree, bush, spot on the ground), a construction (steeple, chimney), a stake or flag specially placed for this purpose, or even a fictitious point having a real appearance to an observer on the line (intersection of the profiles of two woods or portions of the terrain).

The other markers should be stakes solidly planted and tagged so as to be easily seen and recognized by the personnel of the battalion. These markers should be made in advance by each battalion and carried with the topographical instruments.

The necessary measures should be taken to prevent the markers from being disturbed.

Sometimes an orienting line is found clearly traced on the ground, such as a railroad, canal bank.

130. The determination of the orienting line.—The orienting line is determined by drawing it accurately on the squared sheet or on the battle map, or by finding its azimuth.

The determination is by one of the following methods:

131. (1st) **Use of a declinated instrument.**—Set the instrument over any point of the orienting line, carefully avoiding masses of metal. It should not be nearer to the pieces than 50 meters. The helmet should not be worn.

Orient the instrument by means of the compass.

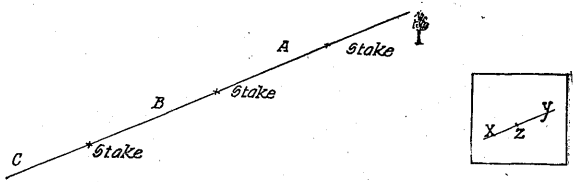
Point on the orienting line.

If the goniometer is used, read the azimuth of the sight taken.

If the plane table is used, draw the sight taken. The direction of this line is defined either by its azimuth read with the protractor or by the measured co-ordinates of two points on it.

The method, by using a declinated instrument, is the most rapid. It is sufficiently accurate for light artillery and for heavy howitzers and mortars[1], provided the instrument is declinated in the locality where it is used.

The first operation may be verified by setting up over a second point of the orienting line not less than 100 meters from the first point used. Take the first station to have been at A and xy the orienting line drawn on the plane table at this station. At the second station B, set any point z of xy over the station. With the plane table oriented, redraw the orienting line through z. The second line should coincide with the first. When using the goniometer, the two azimuths read in this manner should agree within 2 or 3 mils, the mean being taken.

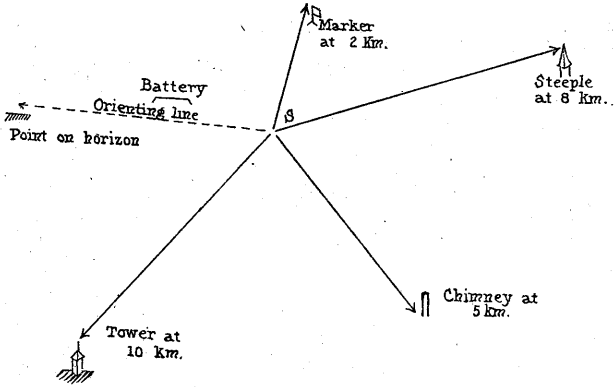


If there is disagreement between the lines drawn at the stations A and B, it is due to local variations in the compass needle. Repeat the operations at other stations C, D, etc. When results are obtained which are in agreement, they will determine the orienting line.

[1] Plane table or compass goniometer, 5 mils. Theodolite, 2 or 3 mils.

132. (2nd) **When the orienting line is tied to an orienting station (station d'orientation).—**

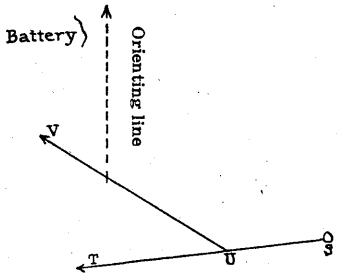
(*a*) If there is a point S, from which it is possible to orient accurately by means of distant known points and from which the battery position can be seen, the orienting line should pass through this point.



Such a point as S is called an *orienting point* (station d'orientation). By simply setting up over it and orienting the instrument, the orienting line can be determined.

(*b*) If the position of the battery cannot be seen from an orienting point, but if it can be reached from this point by a traverse of a few courses, the method is as follows: Set up over S and determine first a line ST, which should

be staked. Then go to any point U of this line, orient on the line ST, and determine another line UV, which should also be staked. Continue in this way until a line is determined which can be used as an orienting line for the pieces.



In the use of the traversing method, stakes on which sights are taken must not be nearer than 100 meters, and the instrument must be set up on the line within 5 cm.

The traversing method must not be used if the number of courses necessary is more than 3 for the plane table or compass goniometer, or 5 for the theodolite. If the number of courses necessary exceeds these limits, it is better simply to transfer the orientation from S to the orienting line directly by means of the compass.

133. (3rd) **Use of astronomical methods.**—For long range firing, requiring great accuracy, the azimuth of the orienting line may be determined astronomically, using the theodolite.

134. (4th) **Use of a distant marker.**—The orienting line may sometimes be directly determined from the known co-ordinates of two points on it, one O near the battery, which might be used also for the base piece, and the other R distant but visible from O.

The two points O and R are plotted on the plane table

by their co-ordinates. The azimuth can then be measured with a protractor. The azimuth can also be calculated directly from the co-ordinates of O and R.

In using this method, the distance OR should be of an order of magnitude comparable with firing ranges. The point R must be accurately known, and O must be capable of accurate determination.

135. Selection and location of place marks.—The place marks located by the orienting officer are to facilitate the location horizontally and vertically of the base pieces. They should be near the battery positions.

Sometimes a single place mark can be used for two nearby batteries.

136. Place marks are indicated by stakes so referred to nearby objects as to enable them to be re-established in case they are disturbed. It is sometimes possible to use existing monuments, trees, or various other clearly defined objects whose permanency is assured.

137. Determination of the co-ordinates of a place mark.—This determination is based on nearby points of the triangulation system, or on details given on the battle map. As a rule, it should be made by a closed traverse. Resection on markers in the vicinity may also be used, verified, if possible, by a traverse.

138. The information and numerical data needed by the batteries in order to utilize the determinations of the orienting officer in the preparation of fire, are reported to them individually, usually in the form of a sketch.

BATTERY TOPOGRAPHICAL OPERATIONS.

139. (*1st Case*) **Using data supplied by the orienting officer.**—The base piece should be located horizontally and vertically by each battery, based on the nearest place mark located by the orienting officer.

To avoid errors, the battery officer who does this should verify his work by means of nearby details given on the battle map.

140. When the base piece has been located, refer the

other pieces to it by determining the length and direction of the lines joining them and the base piece. It is convenient to enter these data on a large scale sketch (such as 1/2000), properly oriented. Such a sketch is very necessary if the pieces are irregularly spaced.

If necessary, measure the difference in level between the pieces.

141. (*2nd Case*) **No data supplied by the orienting officer.**—In this case, each battery must, by suitable topographical operations, determine the orienting line and locate the pieces horizontally and vertically.

142. To this end, the battery officers proceed as described in paragraphs 122 to 137. But, since the instruments at their disposal are generally less accurate and refined than those of the orienting officers, the methods used should be simple. If necessary, accuracy should be sacrificed to a certain extent in order to surely avoid any gross error.

143. For simplification, the orienting line for the battery may be taken through the base piece.

One of the points marking the orienting line is the sight of the base piece, which has the advantage of hastening subsequent operations (par. 155).

This arrangement generally requires that the orienting line be determined by a topographical operation[1].

Moreover certain precautions must be observed in establishing the base piece on the base line (par. 155).

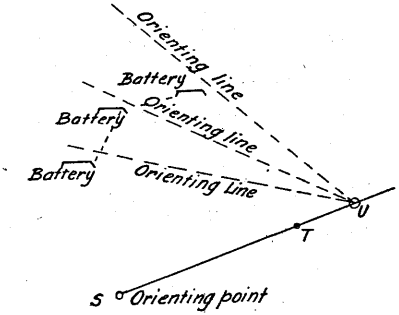
144. The location of the base piece horizontally and vertically should be based on details given on the battle map or the triangulation system. It should be verified by several other topographical operations.

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[1] In general, it is not possible to see from the positions of the pieces, markers fulfilling the double condition of being sufficiently distant and being accurately known (par. 18). Therefore an orienting line passing through the base piece can seldom be determined simply from the known coordinates of the base piece and a distant marker. It is necessary moreover that the base piece be in position. It is not sufficient that its implacement be selected and marked by a stake, since, as a rule, the piece cannot be emplaced with sufficient accuracy to insure that the sight is accurately over the stake.

145. When the battery determinations are not based on data supplied by the orienting officer, they should be checked against each other, in order to obtain the closest possible agreement in the preparation of fire for the battalion as a whole.

For example, if the orienting lines of the batteries are determined by means of a declinated instrument, the same instrument should be used for all batteries.



If they are tied directly to an orienting point in the vicinity, the same point should be used by all of the batteries of the battalion.

The base pieces of the different batteries of the battalion should be tied to each other.

CHAPTER III.

ESTABLISHMENT ON THE BASE LINE.

GENERAL REMARKS. DEFINITIONS.

146. The establishment on the base line consists of:

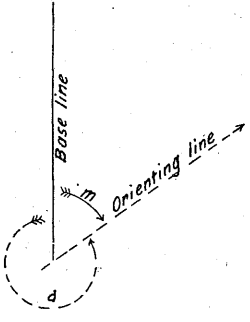
1st. Determining the base angle, or angle between the orienting line and the base line.

2nd. Establishing the base piece on the base line.
3rd. Establishing parallel fire.

The last two operations can be performed successively or simultaneously.

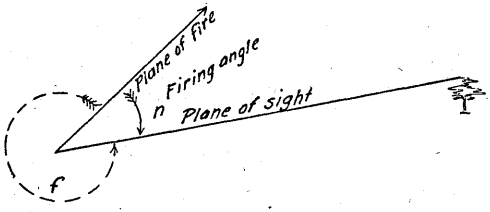
A battery with an extended field of fire sometimes uses several base points. The object of this is, in shifting fire, to avoid the errors incident to measuring large angles. Consequently, if a shift will carry the line of fire past a base point other than the one being used, the pieces should first be established on the new base line.

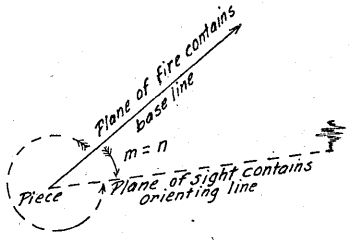
147. The *base angle* (angle de surveillance) is the horizontal angle between the base line and the orienting line, measured from the *base line* in the same direction as the sight graduations.

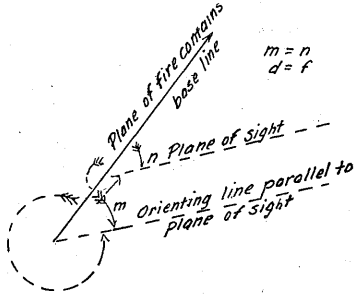


In the figure, the base angle is less than 1600 mils. for materiel with clockwise sights (75 and 155), and greater than 1600 mils. for counterclockwise sights (siege goniometer).

The *firing angle* (angle de direction) is the horizontal angle between the plane of fire and the plane of sight. It


Plane of Fire
Firing angle
n
Plane of sight
f


Plane of fire contains
base line
m = n
Piece
Plane of sight contains
orienting line


Plane of fire contains
base line
m = n
d = f
n Plane of sight
m
Orienting line parallel to
Plane of sight

is measured from the plane of fire in the same direction as the sight graduations.[1]

It follows from these definitions that when the plane of sight is parallel to, or coincides with, the orienting line, and when the firing angle is equal to the base angle, the plane of fire is directed on the base point.

The *deflection* (derive) is the setting on the deflection scale of the sight.

The *deflection constant* (derive normale) is the deflection for which the plane of fire and the plane of sight are parallel. It applies to a particular sight on a particular piece, and is determined during sight adjustment. It is recorded in the section book (carnet de piece).

The deflection constant is about O for materiel equipped with the siege goniometer, 100 for the 75 gun, and 1000 for the Schneider matériels.

To convert the firing angle into deflection:

Add the firing angle to the deflection constant.

If necessary, subtract a certain number of quadrants or a half circle.

1st Example: Siege goniometer.

Firing angle	1930
Deflection constant	+2
Deflection	1932

2nd Example: 75 gun.

Firing angle	5025
Deflection constant	103
Total	5128
Subtract 3 quadrants	4800
Total	328

The deflection is Pl. 2 Dr. 128.

[1] The definitions of the base angle and the firing angle presuppose that the orienting line, base line, plane of sight, and plane of fire, are considered only in one sense and that the siege goniometer is used "au tonnere" during the establishment on the base line.

3rd. Example: 155 Schneider Howitzer.

Firing angle	5025
Deflection constant	998
Total	6023
Subtract a half-circle	3200
Deflection	2823

DETERMINATION OF THE BASE ANGLE.

148. Plot the base point and the base piece on the firing board, by means of their co-ordinates.

Draw the base line by joining these two points.

Plot the orienting line: With the protractor, if it has been determined by its azimuth. By means of the map squares, if it has been determined topographically with the plane table.

Measure the base angle from the base line in the same direction as the sight graduation.

ESTABLISHING THE BASE PIECE ON THE BASE LINE.

149. If the orienting line does not pass through the sight of the base piece, use a goniometer or plane table as a director (instrument directeur), established on the base line.

If the orienting line passes through the sight of the base piece, the orienting line is used directly in laying for direction.

If the orienting line has not been previously established and determined, the base piece is established on the base line by means of a declinated instrument.

150. (*1st Case*)—The orienting line does *not* pass through the sight of the base piece.

Either the goniometer (compass goniometer, theodolite, scissors telescope, observation telescope) or the plane table can be used.

151. Using a goniometer.—Establish the instrument on the base line, that is, point its O in a direction parallel to the base line.

Then lay the base piece parallel to the O of the director by reciprocal laying, taking into consideration the deflection constant.[1]

152. To establish the director on the base line.—Set the director over the orienting line (within at the most a few centimeters), at a point from which the sight of the base piece can be seen.

If the graduations of the director and the sight are in the same direction, set the director at the base angle.

If the graduations of the director are in the opposite direction to those of the sight, set the director at 6400 (or 4000) *less* the base angle.

Using the general motion, point the director on the orienting line. The O of the director is then on a line parallel to the base line.

153. The director being established on the base line, to establish the base piece on the same line.—Lay the piece approximately for direction.

With the upper motion, that is without touching the general motion, point the director at the sight column of the base piece. Let A be the reading of the director so pointed.

If the sight and director are graduated in the same direction, the firing angle to be given the piece is:

A + 3200 mils[2], if A is less than 3200 mils.

A — 3200 mils[3], if A is greater than 3200 mils.[4]

If the sight and director are graduated in opposite directions, the firing angle is:

3200 mils — A[5], if A is less than 3200 mils.

9600 mils — A[6], if A is greater than 3200 mils.

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[1] The base piece must be established on the base line only after the piece is in position. The method of marking the position for the sight by a stake, and measuring the deflection with a goniometer set over this point, before the arrival of the piece, must not be used.

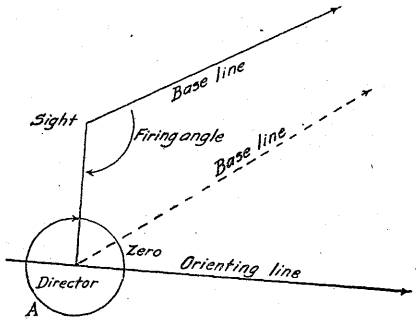
[2] Or A + 2000 decigrades.

[3] Or A — 2000 decigrades.

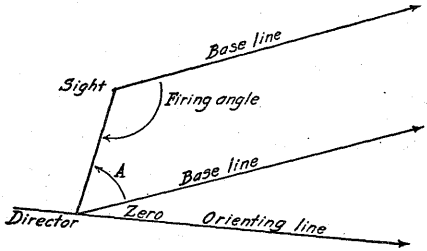
[4] The firing angle is in all cases A + 3200 mils, but if this sum is greater than 6400 mils, it is necessary to subtract 6400, which is equivalent to A — 3200 mils.

[5] Or 2000 — A decigrades.

[6] Or 6000 — A decigrades.



The director and sight are graduated in the same direction (clockwise). The angle A is greater than 3200. The firing angle is A — 3200.



The sight is graduated clockwise and the director counterclockwise. The angle A is less than 3200. The firing angle is 3200 — A.

Having determined the firing angle, convert it into deflection (par. 147).

With this deflection, use the director as an aiming point.

Repeat this operation once or twice, on account of possible movements of the sight during laying.

Refer[1] (repérer) the piece.

Record the deflection (base deflection).

Remark.—In the case of the compass goniometer for the 75 gun, the angle A, when read on the special graduation, gives the deflection directly, without conversion.

154. Using the plane table.—The orienting and base lines should be drawn the full length of the plane table.

Set up the plane table over the orienting line.

Orient it by sighting on a distant point of the orienting line. This must be carefully done so that the orienting line on the plane table will be parallel to the same line on the ground, and over it to within a few centimeters.

With the alidade slope rule (alidade nivelatrice) or eclimeter rule (régle á éclimétre), point on the sight column of the base piece.

Draw this line (V) the full length of the rule.

With the protractor measure the angle between the base line and the line V, from the base line in the same direction as the sight graduations.

This is the firing angle, which is then converted into deflection.

With this deflection, lav the piece for direction, using as an aiming point a pencil held vertically at any point of the line V.

Repeat this operation until the sight no longer moves in laying the piece.

Refer the piece.

Record the base deflection.

155. (*2nd Case*)—The orienting line passes through the sight of the base piece.

[1] "Refer" means to take an auxiliary or individual aiming point by directing the sight on this point without disturbing the laying. When the piece is referred to a distant point, the following method may be substituted: Establish the base piece approximately on the base line. Refer it first to the distant point and then to the director set up and established as described in paragraph 152. From this second reference, the deflection change necessary to establish the piece on the base line can be deduced, and the piece laid for direction in one operation, using the distant aiming point.

The plane of sight is taken coincident with the orienting line, and the firing angle becomes the same as the base angle (par. 147). The firing angle can then be determined as described in paragraph 148.

Convert the firing angle into deflection.

Lay for direction, with this deflection, using the orienting line as an aiming point.

Refer the piece.

Record the base deflection.

When the marker of the orienting line which is used as an aiming point is close, care must be used to insure that the base piece is not thrown off the orienting line while laying for direction. To this end, it is well to establish a supplementary marker on the orienting line near the piece.

156. (*3rd Case*)—Without preliminary determination of the orienting line.

In this case, the *magnetic north* is used as an orienting line. The director is any declinated instrument: compass goniometer, compass theodolite, plane table.

The instrument used must be previously declinated, and set up at least 50 meters from the piece.

157. Using a declinated goniometer.—

(*a*) *When the compass is fixed to the upper movement,* such as the compass goniometer (par. 122).

The method is analogous to that described in paragraphs 151, 152 and 153. The director is established on the base line. The base angle is the angle between the base line and the magnetic north. Let L_M be the declination (par 122, 2nd (*a*)), and V_S the azimuth of the base line measured on the plane table or calculated. If the director is graduated clockwise (compass goniometer), the base angle is then $L_M - V_S$.[1]

Set the director at the value of the base angle. Then, with the general movement, bring the needle opposite its index. This operation establishes the director on the base

[1] Or $6400 + L_M - V_S$, if L_M is less than V_S.

line (par. 151).[1] If the director is graduated counterclockwise, set it $L_M + V_S$, and proceed in the same manner.

The director being established on the base line, the piece is so established, as described in paragraph 153.

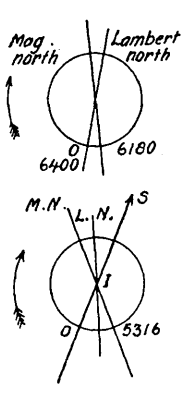
(*b*) ***When the compass is independently movable,*** such as the Jobin theodolite.

Set up the declinated instrument and bring the needle opposite its index by the general movement. It is then oriented (par. 122).

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[1] When the goniometer is oriented (par. 122), the scale is so placed that if the telescope be pointed at the Lambert north, the reading will be O(6400). If the compass needle is brought opposite its index with the upper motion, the reading will be say $L_M = 6180$.

Let IS be parallel to the base line, the azimuth of which is say $V_S = 864$. In order that, when the instrument is pointed in the direction IS, the reading be O(6400), the scale must be turned clockwise 864 mils. When the needle is brought opposite its index with the upper motion, the reading will be $6180 - 864 = 5316$, or in general $L_M - V_S$.



Let L be the reading when the director is pointed at the sight of the base piece.

If the director is graduated clockwise (Jobin theodolite), take the difference $L - V_S$.[1] With this value of the angle A,[2] continue the operations as described in paragraph 153. If the director is graduated counterclockwise, take the angle A as $L + V_S$, and continue in the same manner.

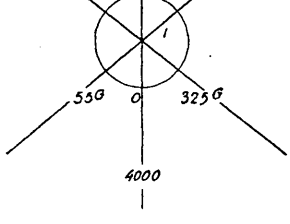
Remark.—This result should be verified by a similar operation at a point about 100 meters from the first, to eliminate local attraction. The two deflections thus obtained should not differ by more than 3 mils.

158. Using the plane table.—Orient the plane table by means of the declinator, and continue as described in paragraph 154.

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[1] Or $6400 + L - V_S$, if L is less than V_S.

[2] In general, when the Jobin theodolite has been oriented, if it is set say at $V_S = 55$ grades, the telescope is parallel to the base line. Let L, the reading on the sight column of the piece, be 325 grades for example. The angle A is stated in paragraph 153 as being the angle between the base line and the direction of the sight of the piece, measured from the base line in the direction of the graduation of the instrument. In this case then, the angle A is $325 - 55 = 270$ grades, or in general, $L - V_S$.



ESTABLISHMENT OF PARALLEL FIRE.

159. Parallel fire may be established by:

1st. Establishing each piece on the base line by means of the director.

2nd. Use of a common aiming point.

3rd. Reciprocal laying on the base piece.

160. Parallel fire using the director.—It is best to use a director established on the base line by means of the orienting line. The director should be used, if possible, from one point for all pieces, both on account of rapidity and accuracy. When conditions make this impossible (woods, casemates), and several positions of the director are necessary, use particular care in setting up the instrument accurately over the orienting line.

A declinated director should only be used when the pieces can be established on the base line from a single point. Its use from more than one point should be resorted to only when all other methods are impracticable.

It should be remembered that the establishment of a battery on the base line depends only on the orienting line and the base line (as marked by the base piece). The operation is independent of the position of the other pieces and the director.

161. Parallel fire by using a common aiming point.—The aiming point may be either

The marker on the orienting line used as an aiming point by the base piece in establishing itself on the base line, when the orienting line passes through the sight of the base piece.

Any aiming point to which the base piece may be referred after establishment on the base line, or which may be used in this establishment (footnote at bottom of page 25).

All pieces use the common aiming point.

The deflection of a given piece is that of the base piece corrected for the parallax of the aiming point for the front base piece—given piece.

If the pieces are on line and equally spaced, the deflection difference is constant. This deflection difference is

the parallax of the aiming point for the front of the battery divided by one less than the number of pieces, that is, the number of intervals between the pieces (see par. 1187 *et seq.*, U. S. F. A. D. R.)

162. The sign of the deflection difference depends on the position of the aiming point (front or rear), and on the direction of graduation of the sights.

To avoid mistakes in the sign of the deflection difference, remember that an O deflection difference gives an *open* sheaf with a *rear* aiming point, and a *converged* sheaf with a *front* aiming point.

The deflection difference for parallel fire must then close the sheaf if the aiming point is in rear, and open it if the aiming point is in front.

163. The methods of determining the parallax are:

Calculation;

Measurement on the map;

Measurement on the ground.

164. Calculation of the parallax.—Let d be the distance in meters from a given piece to the plane of sight of the base piece.

Let D be the distance in kilometers from the battery to the aiming point.

Then the parallax is:

In mils: $\frac{d}{D}$.

In decigrades: $\frac{d}{1.57 \times D}$, or approximately $\frac{d}{1.5 \times D}$,

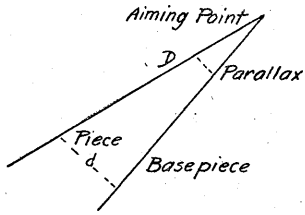
d is measured perpendicular to the plane of sight, either by pacing, or by measurement on the large scale map (par. 140), if one has been made.

The range D is measured on the map, or if there is no other means, estimated.

When d i s paced and counted in strides of about 1m.5, and n is the number of strides, the following formulas give the parallax directly:

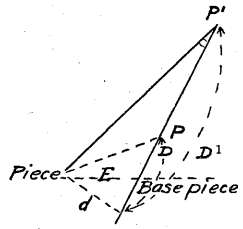
Mils: $1.5 \frac{n}{D}$

Decigrades: $\frac{n}{D}$



REMARKS ON THE VARIATION OF THE PARALLAX.

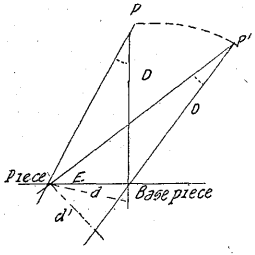
Let E be the interval between a given piece and the base piece, and P the aiming point:

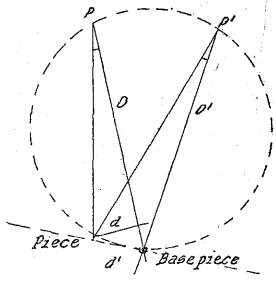


1st. As the aiming point recedes along the line base piece—aiming point, the parallax decreases.

2nd. As the aiming point approaches the battery front, but remains at the same distance from the base piece, the parallax decreases.

3rd. As the aiming point both approaches the battery and recedes from the base piece, the parallax decreases the more rapidly.





4th. The parallax remains constant if the aiming point approaches the battery front, but remains on the circumference through the aiming point and tangent to the battery front.

5th. The parallax is O when the aiming point is on the line of the front of the battery.

165. Measurement of the parallax on the map.—This method is especially appropriate when the pieces are irregularly spaced.

Use a large scale map or diagram of the battery and the parallax protractor. (Appendix II. Use of the parallax protractor.)

166. Measurement of the parallax on the ground.—This is the best method when the aiming point is close.

Set up a goniometer at the aiming point itself, and measure the parallax directly.

167. Parallel fire by reciprocal laying on the base piece.—This method is described in the drill regulations. It is the least satisfactory of all.

168. Referring—Recording the base deflections.—The battery being on the base line, each piece is referred, either to a mirror or a reference point (point de reper-

age), which is used during firing. In the latter case, take two reference points, one distant for use in the daytime, and the other close for use at night. The distance of the night reference point should not be less than 150 meters.[1]

CHAPTER IV.

THE PREPARATION OF FIRE WITHOUT MAPS.

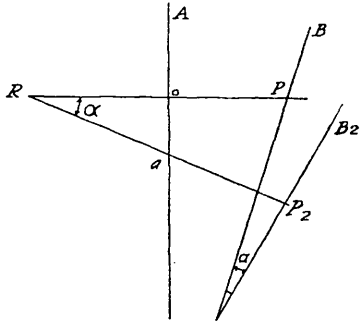
169. When the topographical preparation of fire is effected without maps, it is necessary to resort to improvised methods based on the base points and objectives being directly visible.

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[1] In batteries not equipped with mirrors (recent matériel), very near reference points are sometimes necessary.

Under these conditions, when the sight is displaced, errors in direction as great as 5 mils or more may occur. This may be corrected in the following manner:

Let R be a reference close to the sight P. The piece is laid in the direction PB. A graduated rule is placed at A perpendicular to PR, with its O on PR, at a distance such that its graduations will be mils from R. If the sight is displaced to P_2 and the piece relaid, it will be in the direction P_2B_2. An error in laying thus results which is equal to α. The gunner reads this angle directly on the rule for the position of the sight, and himself makes an appropriate deflection correction.



170. In open warfare, or in position warfare for the pieces assigned to close defense, the objectives may be visible from the battery positions or from points nearby. This is particularly true for light artillery. In such cases, the objectives are usually mobile or reflecting. Fire must be opened as rapidly as possible. Direct laying is used for direction, or if this is not possible, reciprocal laying using a director (compass goniometer, observation telescope) established on the objective. The range is estimated or preferably measured by range finder.

In this case the preparation of fire is practically immediate.

171. But generally the base points and objectives are visible only from observatories separated from the batteries. Moreover the fire should be carefully prepared so as to enable fire to be opened under favorable conditions on any objective, fixed or mobile, which may appear in the sector.

The principles used in the preparation of fire under these conditions are the same as for firing from the map.

By preliminary topographical operations, the relative positions of the observatory, base point, and base piece are plotted on a firing board. The orienting line is determined with respect to the plotted points. The base angle can then be measured with the protractor.

The establishment of the battery on the base line is then accomplished by the usual methods.

172. An observatory is first chosen, from which the objectives and base point are visible. The orienting line is taken through this observatory and the immediate vicinity of the battery. From the observatory, angles are measured with respect to the orienting line and distances are measured or estimated, which will fix the relative positions of the battery, base point and objectives.

173. If the battery position is visible from the observatory, the orienting line is staked from the observatory to the base piece or its vicinity.

When the plane table is used, draw through the point O, representing the observatory, a line OS to the base point,

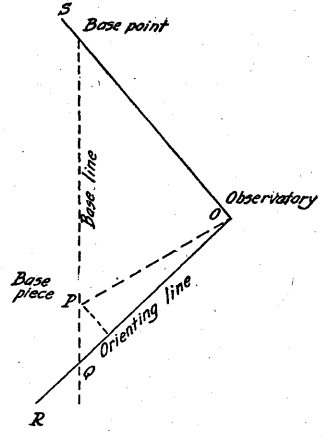
a line OP to the base piece, and the orienting line, if it differs from OP.

Locate the piece P by measuring its distance from the observatory, verifying if necessary by measuring its distance from the orienting line.[1]

Join S and P, and measure the base angle SQO on the plane table in the appropriate direction (par. 147).

If a goniometer is used, measure at O the angles SOP, and if necessary SOR. Plot them and proceed as just described.

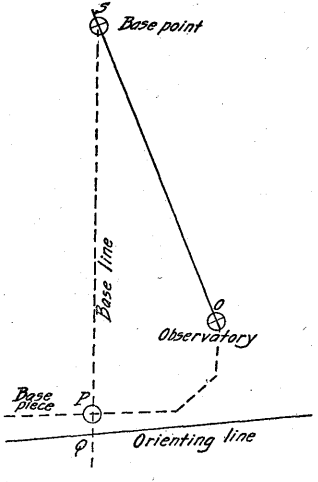
174. If the battery position is not visible from the observatory, the orienting line cannot be taken through the observatory. It must in this case be established near the battery independently of the observatory.



[1] Measure OP by range finder, for example, and the distance of P from the orienting line by pacing. The difference in level between the piece and the observatory should also be determined.

For the topographical operations, use a declinated plane table or compass goniometer.

Declinated *plane table.* Set up at the observatory, and orient with the compass. Take any point as O, and locate the base point S by its direction and distance. Locate the base piece by a traverse from O. Join P and S. Set up



on the orienting line and draw its direction on the plane table. With the protractor measure the base angle SQR.

Declinated *compass* goniometer. Use the same method. The orienting line and the line OS are determined by their measured azimuths.

After the necessary graphical constructions, measure the base angle with the protractor.

175. If fire is not opened immediately after the establishment on the base line, continue the preparation of fire

by locating probable objectives, and prominent points on the terrain which will facilitate the location of objective appearing later.

This is accomplished by the measurement of angles, sites, and distances from the observatory with the usual instruments, and plotting them on a *planimeter sketch* (croquis planimetrique).

The planimeter sketch (generally 1/20000) shows the positions of the battery, the observatory, the base points, and the objectives.

176. When the batteries of the battalion are together, the operations pertaining to the preparation of fire are performed by the battalion from the battalion commander's observatory.

In this case, it is sometimes necessary, on account of lack of time or for other reasons, to abbreviate the preparation of fire. This entails trial shots (tir d'accrochage), which should be by a single battery. The corrections found necessary in the base elements are applied to all batteries of the battalion.

177. When time is available, neighboring battalions should tie together the topographical operations affected by each in the preparation of fire, particularly those pertaining to the location of observatories and objectives.

CHAPTER V.

INITIAL FIRING DATA.

178. General Remarks.—*The initial preparation of fire* on a given objective consists of:

(*a*) Measurement of the *topographical characteristics* of the objective:

Angular distance from the base point.
Front and depth.[1]
Range and site.

[1] Examine also the terrain near the objective.

(*b*) Study of *firing conditions:*
Kind of fire (percussion or time).
Projectile and fuse.
Charge.
Angle of incidence suitable for the objective.
Method of fire for effect
Method of observation.
Method of adjustment.

(*c*) *Determination of initial firing data:*
Deflection.—The change in deflection and deflection difference to be given to the battery on the base line in order to shift and distribute the fire on the objective.
Range.—The elevation or range setting.
Height of burst.—The fuse setting or the corrector.

179. The determination of the initial firing data involves:
1st. The map data in regard to the objective.
2nd. The ballistic data of the firing tables.
3rd. The conditions of the moment, such as meteorological data and the characteristics of the powder lots and projectiles used.

180. Since it involves the conditions of the moment, the determination of the initial data can only be completed just before opening fire.

But everything possible should be done beforehand: Determination of map data for all probable objectives, study of firing conditions, and determination of such of the initial data as does not involve the conditions of the moment.

181. The resumption of a previously adjusted fire is based on the data of the first adjustment, *stripped* (depouille) of the conditions of the moment as far as known, that is, corrected to the normal conditions of the firing tables.

182. Map data pertaining to the objective.—These may be measured:
From the firing board and battle map.

From the battle map alone.

Directly on the ground, when the preparation of fire is without a battle map.

183. Use of the firing board and battle map.—Measure on the battle map the co-ordinates of the point A of the objective, on which the base piece is to be adjusted.

Determine the altitude of this point.

Measure the slope of the ground about the objective This slope is taken in the direction of fire and—

Positive (plus) if the ground slopes upward away from the battery (forward slope or counter slope).

Negative (minus) if the ground slopes downward away from the battery (reverse slope).

Measure—

The front of the objective perpendicular to the direction of fire.

The depth of the objective parallel to the direction of fire.[1]

184. Plot A on the firing board and measure its map range from the base piece.

Measure the angle at the base piece between the base point and A.

185. Calculate the site of A for the base piece by means of the range and the difference in altitude between the objective and the base piece, $H^1 - H.$[2]

186. Use of the battle map alone.—The map data may be measured directly from a 1/20000 battle map (generally mounted on a board), or from a 1/50000 map when the base piece has been accurately plotted on it. In such a case, all of the measurements are made as just explained.

It is also possible to use a map showing only the *objective zone* (zone des objectifs). This map, called the *objective map* (plan d'objectif), is generally to a large scale (1/5000 or 1/10000). This is a convenient method of pre-

[1] For precision fire, also note, if necessary, the echelonment of the objective in depth, and the difference in level of parts of the objective with respect to the point A.

[2] In high angle fire, the site is not calculated. Instead, the map range is algebraically increased by one half the difference in altitude (par. 36).

paring fire for a large number of objectives on the same sheet of the map.

The objective map must have angular graduations centered on the base piece and showing the base line. There should also be range circles, centered on the base piece, for each kilometer.[1]

On this map, angular, distances can be read directly and ranges scaled from the kilometer circles.

The other measurements and determinations are made as previously.

187. Determination of map data on the ground, without a battle map.—Use the planimeter sketch (par. 175), made from the observatory.

Measure the angular distance and range from this sketch.

To calculate the site, convert the site measured at the observatory into the difference in level between the observatory and the objective. From this, find the difference in level between the battery and objective, and compute the site.

The slope of the ground near the objective and the depth of the objective are estimated.

188. If the planimeter sketch is not available.—The angular distance of the base point from the objective, measured at the observatory O, is converted to that at the base piece P by a *station correction* (correction de station).

For the line OP, let P_S be the parallax of the base point and Pb that of the objective.

---

[1] $\frac{H^1 - H}{2}$

The base line and range circles are first drawn on a 1/20000 battle map, which includes the battery and the base point. The necessary portions of these lines are then transferred to the objective map by means of the map squares. For long range firing requiring great accuracy, use calculation.

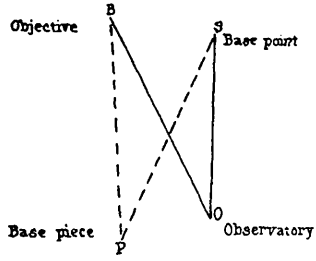
To make the angular graduations, use the parallax protractor on white paper (see appendix XII). Place the map on the protractor, with the base line coincident with the protractor axis. Slide the map along this axis until it is in the proper position as regards range, which can be ascertained by the scale. Fix the map in position, and draw in the graduations on the map from those on the protractor.

The station correction is $P_S - P_b$.

In the figure, if O is the angular distance measured at the observatory, the angular distance P at the base piece is:

$$P = O + P_S - P_b.$$

The sign of the station correction depends on the relative position of the points involved. It is *positive* if P is outside of the circle OBS, and *negative* if it is inside of this circle.



The most rapid method of determining the sign is to move from the observatory toward the battery, without losing sight of S and B, and note whether the angular distance from S to B increases or diminishes. If the former, the station correction is negative; if the latter, it is positive.

The range may be obtained from the objective to the observatory (BO), by range finder or estimation, corrected by the projection of the line battery—observatory (PO) on the line BO.

The site is calculated as in paragraph 187.

These rough methods are admissible only when the battery and observatory are little separated. When this is not the case, the *planimeter sketch must be used.*

189. Study of firing conditions.—The *character of the objective* governs:

The kind of fire (time or percussion).

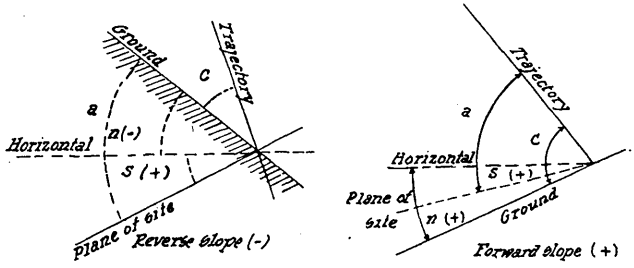
The projectile and fuse.

The conditions to be fulfilled by the angle of incidence (angle between the trajectory and the surface of the ground at the point of fall) will depend on the decision made as to these two elements and on what effect on the objective is desired.

Let C_1 and C_2 be the permissible limits of the angle of incidence.

The angle of fall (angle between the trajectory at the point of fall and the plane of site) must be between:

$$a_1 = C_1 + S - n \text{ and}$$
$$a_2 = C_2 + S - n.$$



The site, S, and the slope of the ground near the objective, n, should be taken with their sign (par. 183). Seek in the firing tables for the range D, the charges which give angles of fall between the limits thus obtained, a_1 and a_2.

If none are found, or if those found leave too small a margin for adjustment, then the fire is impossible under the conditions imposed as to angle of incidence. The fire is entirely impossible if these conditions are based on the form of the terrain.

If several suitable charges are found, as a rule the weakest should be used, in order to avoid useless wear on the matériel. The stronger charge should be used only in the

exceptional case where it gives materially greater accuracy of fire and where this accuracy is essential.

To compare the dispersions of different charges, find the probable error on the slope considered (par. 20).

Having decided upon the charge to be used, make sure that there are no intervening features which prevent the objective from being reached (par. 63).

190. Determine the method of fire for effect, according to the time and means available, and the nature, front, and depth of the objective. Then decide on the methods of adjustment and observation.

191. Determination of the initial firing data.—This includes:

Miscellaneous entries on the *data sheets* (feuilles calculs).

Preliminary calculations, which can be made as soon as the map data in regard to the objective has been obtained and firing conditions decided upon.

Final calculations, which can only be made at the time of firing, when the meteorological data are known.

192. (1st) **Miscellaneous entries and preliminary calculations.**—First enter the following on the data sheets:

(*a*) Co-ordinates and altitude of the battery.

(*b*) Co-ordinates and altitude of the objective (adjusting point of the base piece), difference in level between the objective and the battery, map range, site, and deflection change.

(*c*) Data in regard to ammunition: Kind of projectile, weight of projectile (filled and fused), kind of fuse and powder, designation of powder lot.

193. (*d*) The adjustment co-efficient K_O (or the velocity correction), obtained from previous fire with the powder lot to be used.[1]

[1] The co-efficient K_O for previous firing with a given powder lot is the ratio of the stripped range to the map range (Appendix XIV).

The correction velocity, $V - V_O$, is that which, for the powder lot in question, corresponds to the difference, between the stripped range and the map range (Appendix XIV).

If previous firing with the same powder lot is not available, take K_O as 1, or else as the mean of the values obtained for all lots of the charge used.

Modified range (map range A multiplied by the adjustment co-efficient K_O, or map range modified for the velocity correction, $V - V_O$).

(*e*) Charge to be used. Maximum ordinate for the corrected range.

(*f*) Base deflection for each piece. Deflection corrections from previous adjustments.[1] Correction for drift.[2]

194. (*g*) Distribution corrections.

If the pieces are *regularly spaced* and the distribution to be obtained is *regular,* calculate the change in deflection difference, e.

e is equal to one-fourth of the parallax of the battery for the front of the objective *less* one-third of the parallax of the objective for the front of the battery.

The distribution corrections for the various pieces are +e, +2e, +3e, depending on the direction of the sight graduations and the position of the pieces with respect to the base piece.

If the pieces are *irregularly spaced,* or if the various pieces are to be directed at particular points of the objective, calculate the distribution correction individually for each piece.

The distribution correction for a given piece is the parallax of the battery for the interval between the objective of this piece and that of the base piece *less* the parallax of the objective for the interval between the given piece and the base piece.

(*h*) For each piece, find the algebraic sum, Δ (uncorrected deflection), of the base deflection, deflection change, and distribution correction.

195. (2nd) **Final calculations at the time of firing.**—(*a*) Collect the meteorological data:

Velocity and direction of the wind for the appropriate maximum ordinate. Temperature and barometer for the battery position (weight of a litre of air in milligrams).

---

[1] If there is not previous firing, take these corrections as O.

[2] For high angle fire, this correction cannot be entered until after the corrected initial range has been determined (par. 197).

Date : .....
Hour : .....

DATA SHEET.

Position .....

BATTERY — X = ... Y = ... H = ...

AMMUNITION — Proj. — Kind = ... Weight = ... Fuse, Kind = ... Powder — Kind = ... Lot = ... Charge = ... Temperat. = ...

OBJECTIVE — X' = ... Y' = ... H' = ... Front = ...

H'—H = ...

Total site (S) = ...

Map range (A) = ...

Meteorological Data

BALLISTIC WIND — Maximum ordinate = ... Velocity = ... Direction = ...

AIR — Temperature = ... Barometer = ...

WIND — Long. = ... Cross = ...

Variation of wt. of liter of air = ...

K_o, previous (1) = ...

Deflection correction, previous (δ) (2) = ...

CORRECTIONS.

Range (meters)	Deflection (Decigrades or mils)
Wt. of liter of air =	Cross wind =
Long. wind =	Drift =
Wt. of proj. =	Total =
Powder temp. — Quickness =	
Temperature =	
Total M' =	

CALCULATIONS.

ELEVATIONS.

Map range (A) = ...

Modified Range (K_o x A) = ...

Total Corrections (M') = ...

Total (3) = ...

Elevation (5) = ...

Total site (S) (5) = ...

Quadrant elevation = ...

STRIPPING FOR RANGE. (6)

Adjusted elevation = ...

Site (inverse) (—S) = ...

Total = ...

Corres. Range (4) = ...

Inverse corr. (—M') = ...

Stripped range = ...

New K_o = $\frac{A'}{A}$ = ...

DEFLECTIONS.

	4th Piece	3rd Piece	2nd Piece	1st Piece
Base deflections =				
Deflection shift =				
Distribution =				
Total ($\triangle$) =				
Total correction =				
Previous corr. (δ) (2) =				
Initial deflections =				

STRIPPING FOR DEFLECTION (6)

Adjusted deflections =				
Inv. total correction =				
Stripped deflec. ($\triangle'$) =				
New defl. corr. $\delta = \triangle' - \triangle$				

(1) For the first firing with a powder lot, take $K_o = 1$

(2) For the first firing, take $\delta = 0$.

(3) If a range scale is used, take this as the initial range and neglect entries below.

(4) If a range scale is used, enter here the adjusted range setting. Neglect entries above.

(5) For high angle fire, replace these two lines by : Site correction = $\frac{H' - H}{2}$ .....

Initial range.....

(6) In stripping, calculate anew the total corrections in range and deflection, for the meteorological data and drift at the end of adjustment.

Battery ..... th ..... Art.
Date : .....
Hour : .....

DATA SHEET.

Position .....

TYPE 2 (dV_o)

BATTERY
X = ...
Y = ...
H = ...

OBJECTIVE
X' = ...
Y' = ...
H' = ...
Front = ...

AMMUNITION
Proj.
Kind = ...
Weight = ...
Fuse, Kind = ...
Powder
Kind = ...
Lot = ...
Charge = ...
Temperat. = ...

H'—H = ...
Total site (S) = ...
Map range (A) = ...

Meteorological Data

BALLISTIC WIND
Maximum ordinate = ...
Velocity = ...
Direction = ...

AIR
Temperature = ...
Barometer = ...

WIND
Long. = ...
Cross = ...

Variation of wt. of liter of air = ...

dV_o, previous (1) = ...
Deflection correction, previous (δ) (2) = ...

CORRECTIONS.

Range (meters)	Deflection (Decigrades or mils)
Wt. of liter of air = ...	Cross wind = ...
Long. wind = ...	Drift = ...
Wt. of proj. = ...	Total = ...
Powder temp. Quickness = ...	
Temperature = ...	
Total M' = ...	

CALCULATIONS.

ELEVATIONS.

Map range (A) = ...
Velocity corrections = ...
Modified Range = ...
Total Corrections (M') = ...
Total (3) = ...
Elevation (5) = ...
Total site (S) (5) = ...
Quadrant elevation = ...

STRIPPING FOR RANGE. (6)

Adjusted elevation = ...
Site (inverse) (—S) = ...
Total = ...
Corres. Range (4) = ...
Inverse corr. (—M') = ...
Stripped range = ...

New velocity corr. = V — V_o = dV_o.

DEFLECTIONS.

	4th Piece	3rd Piece	2nd Piece	1st Piece
Base deflections =				
Deflection shift =				
Distribution =				
Total ($\triangle$) =				
Total correction =				
Previous corr. (δ) (2) =				
Initial deflections =				

STRIPPING FOR DEFLECTION (6)

Adjusted deflection =				
Inv. total correction =				
Stripped deflec. ($\triangle'$) =				
New defl. corr. $\delta = \triangle' - \triangle$				

(1) For the first firing with a powder lot, take $dV_o = 0$.
(2) For the first firing, take $\delta = 0$.
(3) If a range scale is used, take this as the initial range and neglect entries below.
(4) If a range scale is used, enter here the adjusted range setting. Neglect entries above.
(5) For high angle fire, replace these two lines by : Site correction $= \frac{H' - H}{2} \ldots \ldots$ Initial range.....
(6) In stripping, calculate anew the total corrections in range and deflection, for the meteorological data and drift at the end of adjustment.

(*b*) Take the powder temperature.

196. (*c*) **Initial deflection.**—Calculate the correction for the cross wind.

Take the algebraic sum of the wind and drift corrections.

Obtain the initial deflection by adding this sum to the uncorrected deflection.

The initial deflection for each piece is obtained in this manner.[1]

197. (*d*) **Initial elevation or range.**—For the *modified range* (par. 193), calculate from the firing table the *corrections* for the:

1st. Variation of the weight of a litre of air.

2nd. Longitudinal wind component.

3rd. Variation of the weight of projectile.

4th. Variation of muzzle velocity due to the powder temperature.

Take the algebraic sum of these corrections, which is the total correction, M^1.

The modified range corrected by M^1 gives the *corrected range* A_C.

For high angle fire, also add the site correction:

$$\frac{H^1 - H}{2}. \qquad \text{(par. 36).}$$

to obtain the corrected initial range.

198. (*1st Case*) **Laying by quadrant.**—*Initial quadrant elevation.* For direct and curved fire, take from the firing tables, for the charge and projectile used, the elevation for the range A_C.

Increase the elevation algebraically by the total site correction,[2] thus obtaining the initial quadrant elevation for the base piece.

For high angle fire, take the tabular elevation for the range A_C, and neglect the site.

199. (*2nd Case*) **Laying by a range scale.**—Generally the site and range settings are taken as follows:

[1] The chiefs of section take into consideration the individual sight errors (Appendix XIII).

[2] The site modified by the complementary site correction.

SITE.—That of the objective, modified by the complementary site correction.

RANGE.—The setting corresponding to the corrected range Ac of the base piece.

200. (*3rd Case*).—If the correct site is not set on the site scale, find the difference d:

d = corrected site—site used.

In the firing tables, find the variation in range which, for the range Ac, corresponds to d. Give it the same sign as d. Add this variation algebraically to the range Ac, and take out the corresponding range setting.

201. Remark.—Sometimes it is necessary to determine range elements for pieces other than the base piece, in order to take into consideration:

1st. Differences in map ranges caused by the obliquity of the battery or the objective to the planes of fire.

2nd. Differences in altitude among the pieces of the battery or within the objective. Let dh be the difference in level of a piece with respect to the base piece, dh^1 the difference in level between the objective of this piece and that of the base piece, and c the angle of fall. The range correction is then:

$$\frac{dh^1 - dh}{\tan c}.$$

These individual corrections are converted into angles, and given to the chiefs of section. The latter add to them the corrections for:

1st. The error of the quadrant.

2nd. The Calibration of the pieces (Appendix XIII).

A total correction is thus obtained for each piece by which the elevation (or site) announced by the battery commander must be modified.

202. (*e*) **Initial fuse setting.—**

1st. *Fuse punch or fuse setter graduated in time.* For the charge and projectile used, take from the firing tables the fuse setting for the initial elevation modified by the site with changed sign.[1]

[1] The site only, and not the total site correction (par. 50), if the site is great.

Modify this setting for the altitude or barometer, by means of the data in the firing tables.

If the time fire is preceded by percussion ranging fire, use the adjusted elevation for the fuse setting, instead of the initial elevation.

2nd. *Fuse setter graduated in range.* Use the same range setting for the fuse setter as for the piece.

If appropriate, modify the normal corrector (corrector normal):

1st. As indicated by the firing tables.

2nd. To offset the error in the site used.

Correct site—site used algebraically).[1]

3rd. For the altitude or barometer.[2]

203. The methods explained in the preceding chapters are for the deliberate preparation of fire.

Generally, it is better to devote a little more time to the preparation of fire and have the first salvos close to the objective, thus saving ammunition, and facilitating and hastening the adjustment.

However, in certain cases and often for considerations of morale, the preparation of fire must be reduced to the minimum. The error resulting from the rapid determination of the elements of fire will then be corrected by the firing itself.

The time necessary for the preparation of fire and its accuracy depends largely on the skill and experience of the battery commander.[3]

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[1] See paragraph 200. Complementary site correction not included.

[2] When this correction is large, the firing tables prescribe that a part should be made by changing the site. This change should not enter into the calculation of the site error.

[3] It is indispensable that all artillery officers, particularly those of light artillery, be frequently practised in the rapid preparation of fire.

PART V.

PRINCIPLES AND METHODS OF FIRE.

CHAPTER I.

GENERAL REMARKS AND DEFINITIONS.

206. General remarks.—The essential aim of artillery in war is to *destroy* the enemy.

Destruction being impossible, the artillery will attempt to *neutralize* the enemy by causing a cessation or at least an abatement of his activity.

In addition, the artillery affords *moral support* to friendly troops by *diverting* the attention and blows of the enemy.

Its accuracy and rapidity of fire enable a maximum of effect to be obtained with the minimum expenditure of time and ammunition.

207. Effects of neutralization, moral support, and diversion result from the known efficacy of artillery. They are none the less tangible, in spite of the fact that they can be produced by a fire whose real efficacy is little or nothing. These effects should be borne in mind when it is a question of hastening or delaying the opening of fire, increasing or diminishing its intensity, or suspending or resuming the fire.

The result sought will be the more surely obtained when it is supported by a real effect as great as possible.

208. Destruction of the enemy can be expected only as a result of precision fire.

However, zone fire, delivered by surprise and in sufficient density upon an exposed animated objective (infantry, artillery, cavalry), may cause very serious losses, or even temporary annihilation.

209. In general, all fire consists of *fire for adjustment* (tir de reglage) and fire for effect (tir d'efficacite).

Fire for adjustment is to determine the data to be used in fire for effect.

210. Fire for adjustment consists, as a rule, of *trial fire* and *improvement fire* (tir d'essai, tir d'amelioration). This applies to precision or complete adjustment (reglage de precision). Trial fire places the zone of dispersion of a single elevation so as to include the objective. Improvement fire places the center of this zone at or near the objective.

In certain cases, fire for adjustment is carried only to the point of obtaining a bracket, which is called a *bracket adjustment* (reglage d'encadrement).

211. Fire for effect is classified as *precision* or *zone.*

In precision fire for effect, the object is to keep the center for each piece in the immediate vicinity of its particular objective.

Laying for range is always by quadrant.

In zone fire for effect, the object is to distribute the shots in a more or less regular manner over a zone which includes the objective. *Fire at a single range* is a special case of zone fire.

212. A *salvo* is a series of one shot per piece fired at regular intervals from one flank to the other of a unit of artillery.

A *volley* is a series of one or more rounds per piece fired as rapidly as the matériel permits. Each piece is served independently of the others.

Volleys or salvos at successive ranges may be used in zone fire.

CHAPTER II.

FIRE FOR ADJUSTMENT.

214. This will be taken up under the following headings:

Percussion precision adjustment.
Percussion bracket adjustment.
Time fire adjustment.

Percussion Precision Adjustment.

215. Conduct of the adjustment.—Each piece is adjusted in deflection and range on the particular adjusting point assigned to it.

If the observation is aerial and the front of the objective does not exceed 10 mils (normal case for counter-battery work), the adjusting point is taken for all pieces at the center of the objective.

Each piece is separately adjusted. Fire may be by piece or battery salvo.

The time interval for salvos is generally 5 seconds, but may be modified to suit the observer.

216. Deflection adjustment.—Bold deflection changes should be made at first to rapidly obtain a deflection bracket. The deflection changes are then measured.

When the deflection displacement of a shot is not more than 4 probable errors,[1] the deflection is not changed until several successive and concordant shots show it to be advisable. In this case, make a change equal to the mean of the several displacements observed.

217. If the first deflection is seriously in error, make a change for the battery to bring the sheaf on the objective. Then proceed by individual corrections.

218. If the observer does not see the shots, time fire may be used to place the sheaf in direction, the bursts being raised to a suitable height by the quadrant or corrector.

219. Range adjustment.—For terrestrial observation, the range adjustment is begun as soon as the deflection is sufficiently adjusted to permit observation for range. From this time on, the two adjustments are conducted simultaneously. If the line of observation is very oblique with respect to the plane of fire, it may be necessary to proceed in the inverse order, the range being first adjusted (par. 101 *et seq.*).

---

[1] Except for trench mortars and high power guns, 3 mils or 2 decigrades may be taken as a sufficiently accurate value for 4 deflection probable errors.

220. If the visibility is poor, it may be necessary to fire the first salvos rapidly or even to use volleys. With rapid fire material (75 or 105), the volleys may be of two or three rounds each. Later salvos at the normal cadence may be resumed.

221. Verifying an elevation.—During trial fire, the sense of an elevation is verified by obtaining at least two successive observations at this elevation.

Two observations in the same sense establish the sense of the elevation used.

If two observations are opposite in sense, the elevation is *bracketing*. This requires two more observations at the same elevation. If these observations are in the same sense, the elevation is taken in this sense. If they are again opposite in sense, the elevation is tentatively taken as correct.

222. If a shot is observed at the objective (target shot), the elevation should be considered as bracketing, and verified as just described.

223. Trial fire.—The object is to *bracket* the target between two *verified* elevations differing by *one fork* (6 proving ground probable errors or 4 field probable errors), one of the elevations being short and the other over; or to find a *verified bracketing range*.

The mean of the bracketing elevations or the bracketing elevation is called the *trial elevation* (angle d'essai). The zone of dispersion of the trial elevation includes the objective with a high degree of certainty.

To obtain the bracket, begin with the elevation calculated in the preparation of fire, and proceed by changes of one fork.[1]

Verify the limits of the bracket or the bracketing elevation.

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[1] If the objective is very close to the friendly lines, begin with an elevation which is surely over, and proceed by changes of a fraction of a fork.

For certain mortars, the first shot, called the *drying shot* (coup de flambage), should be disregarded except for deflection.

224. If the preparation of fire has been rapid, and if the first shots are clearly distant from the objective, the first elevation changes should be two or four forks, so as to rapidly bracket the objective.

The bracket is then reduced to one fork, and the limits verified as explained in paragraph 221.

225. If as many as two shots at the same elevation are not observed, and this is apparently due to the terrain, bold elevation changes should be made to rapidly secure observations. After a bracket is obtained, it should be reduced to one fork, if not already of this size.

226. When it is possible to measure the range displacement of shots (observation by aeroplanes or topographically), the first elevation is corrected to measure. Then proceed by changes of one fork.

227. Improvement fire.—The object is to find an elevation giving substantially as many observations short as over.

With the trial elevation, fire twelve shots per piece. If there is not, for each piece, an equality of shorts and overs, modify the elevation by as many twelfths of a fork as there are shots to be changed in sense to obtain this equality.

The elevation thus obtained is called the *adjusted elevation* (angle de reglage).

228. If only a limited time is available for adjustment (as in observation by aeroplane), the number of observations in improvement fire may be less than twelve, but not less than six, per piece.[1]

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[1] With aeroplane observation, when the objectives of the various pieces are well separated, and when rapid fire matériel is used, it is often best to deliver the improvement fire by piece. This is especially applicable when the individual pieces require a very accurate adjustment in direction.

Each piece fires two series of four shots each at the signal of the observer. After each series, the observer reports the displacement of the deflection center, and the number of shorts, overs, and targets for range.

If the battery commander makes considerable corrections as a result of the first series, he calls for the observation of a second series like the first.

This modification is made necessary by the fact that a series of more than four consecutive shots cannot be properly observed.

The changes in the trial elevation are then made by sixths, eighths, etc., of a fork.

229. With trench artillery, on account of its slow rate of fire, six shots per piece are habitually used in improvement fire.

230. If in an improvement fire of twelve shots per piece, the first six are in the same sense, the elevation is changed by a half fork and six more shots fired. The series of twelve shots is taken as having been fired with the mean of the two elevations used, and the correction is referred to this mean elevation.

If the last six shots are in the same sense as the first six, the adjustment is begun anew.

231. In curved fire, the charge is chosen to give an angle of incidence greater than a certain determined minimum. After the trial elevation has been determined, it must be examined to insure that it has a suitable angle of incidence.

If the charge used is found to give too small an angle of incidence, it is necessary to pass at once to the next lower charge, and begin the adjustment anew. The initial elevation with the new charge should be that corresponding to the adjusted elevation with the old charge. The deflection must also be changed to take into account changes which result from the altered charge and elevation.

232. If the adjustment yields an observation short with an elevation of 36° for curved fire, or of 50° for high angle fire, pass to the next higher charge and begin the adjustment anew.

233. Change in the firing conditions.—If, during the fire, the powder lot is changed[1], begin the adjustment anew.

234. If, during firing, the projectile is changed without changing the powder lot, the elevation and deflection

[1] If the new powder lot has not been used in recent previous adjustments.

should be corrected from the firing tables, and *verified* by firing.

This verification consists of firing two rounds with the new data. If they are of the same sense, the trial fire should be begun anew, using changes of a half fork. After a verified bracket is obtained, pass to improvement fire.

A single piece may be used, for it gives a correction to be applied to the tabular elements, which is applicable to all the pieces.

235. If the kind of fuse is changed during firing, proceed as explained in the preceding paragraph.

236. Adjustment by means of the measured displacements of the shots.—If the means of observation permit the displacement of the shots to be accurately measured by plotting them on a photograph or squared map (observation by aeroplane or topography), the following method may be used:

Correct each round by the observed displacement, *divided* by the serial number of the round.

The first two shots are numbered 1.[1] Those not observed are not numbered.

The fire is considered adjusted when three times in succession the range correction[2] is less than one sixth of a fork, and the deflection correction less than one probable error.

This method of adjustment should be used only when the rate of fire is sufficiently rapid to insure the series being fired under the same atmospheric conditions.

Moreover, the rule "divide the displacement by the shot number" is only applicable up to a limited number, six for example. If after seven shots (the first included), the adjustment has not been secured, a new series of numbers should be begun, applying the rule as before.

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[1] The adjustment properly speaking begins only with the second shot. The first shot simply gives measurements by which those following can be placed close to the objective, where the displacements can be accurately measured.

[2] It is a question of the correction and not of the displacement on which it is based.

Percussion Bracket Adjustment.

237. This method is used when the time or means for a precision adjustment are not available, or when the objective is moving or transient.

It is immediately followed by zone fire for effect (par. 265 et seq.). The depth of the beaten zone depends on the objective, and on the time and means of observation available.

The method is as follows:

238. Deflection adjustment.—In general the fire is distributed over the front of the objective, assigning to each piece an appropriate portion.

If the front of the individual piece is not larger than can be effectively covered, using a single deflection, each piece is laid on the center of its portion.

In the contrary case, each piece is laid on the right element of its portion.

The deflection changes necessary to effectively cover the individual portions are made during fire for effect.

239. With terrestrial observation, the adjustment should from the first be on the visible portions of the objective.

But in all cases care must be used to avoid crossing or confusing the sheaf, so that, in passing to fire for effect, only a simple change in deflection difference will be necessary.

240. With aerial observation, the right of the sheaf should be directed on the right of the objective. The sheaf is then opened or closed to secure proper distribution.

241. Range adjustment.—The adjustment is made for the battery as a whole, it being assumed that the pieces are calibrated. The chief of section corrects the commands he receives for the individual errors of his piece (par. 201).

The firing is by salvos.

242. Method of adjustment.—Begin with the initial range setting or elevation corresponding to the range de-

termined[1], taken in even hundreds of meters or tens of minutes.

Proceed by successive equal changes in elevation until a bracket is obtained.

The size of the bracket is generally two forks.[2]

When the objective has little depth and is clearly visible, the bracket may be decreased to one fork.

243. When the objectives in a locality are numerous and it is feared that the observations made during adjustment for zone fire may be erroneous, due to confusion with fire for effect on nearby objectives, the bracket is narrowed to a half fork.

244. A single observation is a sufficient basis for changing the elevation. But an elevation should be taken as the limit of a bracket only when based on two or more like observations in the same or different salvos.

245. If a bracketing battery salvo is observed (2 shorts and 2 overs), the adjustment should be considered as terminated. If one short and one over are observed in a salvo, the range is bracketing, but should be verified by another salvo at the same elevation. If two or more observations in the same sense are obtained with this salvo, the elevation is taken in this sense. If the salvo yields both shorts and overs, the elevation is accepted as that corresponding to the objective.

246. A target shot should be treated in the same manner as two observations, one short and one over.

Time Fire Adjustment.

Time fire may be:

(*a*) With shrapnel.

(*b*) With H.E. shell.

247. Time shrapnel adjustment.—Shrapnel time fire is

[1] Increase this range for safety if the objective is close to friendly troops.

[2] When the objective is close to friendly troops, the elevation change must be decreased to avoid endangering these troops.

always a zone fire, and the adjustment is a bracket adjustment (par. 237 *et seq.*).

The fuse setting is said to be adjusted when a battery salvo gives two bursts above and two below the normal height of burst.

248. The following are taken as the normal heights of burst. They are referred to the plane of site, taken through the base of the objective.[1]

Muzzle Velocity Meters.	Normal Height of Burst, Mils.
Over 500	2
500 to 400	3
400 to 300	4 to 8
300 to 200	8 to 12

249. Method of adjustment.—If the observation is terrestrial and percussion bursts are visible, first adjust the range and direction by percussion fire, as described under bracket adjustment (par. 237). (See also par. 253.)

250. Then take from the firing tables the initial fuse setting, in seconds and tenths, corresponding to the short limit of the adjusted bracket.

For fuse setters graduated in range (or time), use the normal corrector[2] and the range setting of the short limit of the bracket (or the fuse setting for an O height of burst, diminished by as many *tenths* of seconds as there are *mils* in the normal height of burst).[3]

251. Using the initial fuse setting thus determined, begin with battery salvos in time fire, with 1 or 2 seconds between shots.

252. If the first salvos give only air bursts, estimate the height of burst center, and correct the fuse setting

---

[1] When the objective is defiladed, the height of burst adjustment must be made with respect to the covering crest, and the normal height modified to take into account the defilade of the objective.

[2] When necessary, take into account differences, for the charge and projectile used, between the gun ranges and the fuse setter ranges. The normal corrector is that which gives a normal height of burst.

[3] Matériel not provided with fuse setters.

for the displacement with respect to the normal height of burst.

If the first salvo is all on graze, decrease the fuse setting 4 tenths or raise the corrector 4 points. Double this change if the next salvo is still on graze, in order to obtain air bursts as rapidly as possible.

When a salvo yields two air bursts and two on graze, the most probable position of the height of burst center is O. It is 1 mil above the ground when 3 air and 1 graze bursts are obtained, and 1 mil below the ground when 3 graze and 1 air bursts are obtained. Corrections to obtain the normal height of bursts can be made accordingly.

During fire for effect, the adjusted fuse setting previously obtained should be modified only when this is shown to be necessary by a greater number of rounds than that on which the adjusted setting was based.

253. With aerial observation, or when the battery and the terrestrial observatory are at different distances and altitudes with respect to the objective, or when percussion bursts are not easily observable, or when a rapid adjustment is necessary—use time fire from the beginning.

Use an initial fuse setting determined to give a 1-mil height of burst.[1]

Fire battery salvos at 1 or 2 seconds interval.

Raise or lower the bursts so as to obtain a height of 1 mil, which can be judged by the proportion of air to graze bursts, stated in paragraph 252.

Adjust the deflection and the range, so as to obtain the desired bracket.

Then raise the bursts to the normal height.

If during the adjustment, a salvo in air gives *Bursts* short and *bursts* over, the elevation may be taken as over but near the objective. The next change in elevation may be a half fork.

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[1] With aerial observation, use a fuse setting which will surely give air bursts.

254. The method of the preceding paragraph is applicable to time fire against a wood.

Use bursts at the top of the trees. In passing to fire for effect, modify the height of bursts by a suitable amount.

255. Time shell adjustment.—Time shells are especially effective when the bursts are about 20 meters above the ground.

They are effective against personnel in trenches, but in this case a precision adjustment is necessary.

256. Method of adjustment.—The adjustment of time shell differs materially from that of percussion shell and time shrapnel. It consists of placing the burst above the target, and then raising it to the most effective height.

257. The operations are as follows:

1. Deflection adjustment.
2. Range of burst adjustment.
3. Height of burst adjustment by raising the trajectory.

258. The deflection and range of bursts are adjusted when the burst center is directly over the adjusting point.

This is accomplished by the observation of low air bursts, by the observation of the effect on the ground of high air bursts, by aerial observation, or by bilateral observation.

259. The height of burst is adjusted with respect to the adjusting point, by changing the elevation without changing the fuse setting.[1]

With matériel where the site is set separately, the height of burst may be adjusted by site changes. The proper height in mils is given by $\frac{20}{P}$, where P is the range in kilometers.

For other matériels, the quadrant elevation must be

[1] It is sometimes impossible to use low air bursts in adjusting the height of burst, because of the difficulty of distinguishing ricochets from air bursts. In this case, the adjustment should begin with high air bursts, with subsequent modification of the height of burst by changing the elevation.

changed, the amount in minutes for a height of 20 meters being obtained from the firing tables.

260. Practical methods.—From the firing tables for the charge and projectile used, take the fuse setting for the map range. Correct it for the atmospheric conditions and the altitude, by means of data in the firing tables.

Start with an elevation which is surely over, in order to obtain air bursts. The height of burst can then be corrected to a convenient height, depending on the method of adjustment used, by changing the elevation.

Bracket by changes in fuse setting corresponding in range to the values of the fork given in the firing tables.

CHAPTER III.

FIRE FOR EFFECT.

261. General remarks.—Fire for effect may be classed as:

Percussion precision fire for effect.
Percussion zone fire for effect.
Time fire for effect.

Percussion precision fire for effect is always preceded by a precision adjustment.

The adjusted elevation is only approximate. Fire for effect must therefore be observed for a sufficient number of rounds to surely determine the *elevation for the objective* (angle du but), which gives an equal number of observations short and over.

Moreover, the elevation for the objective is constantly subject to change on account of the heating of the pieces, so that practically constant observation during fire for effect is necessary.

Percussion zone and time fire for effect are based either on:

A precision adjustment on an auxiliary point and a shift of fire (par. 288 *et seq.*), when the objective is not

clearly defined or is of great extent, or, a bracket adjustment (par. 237 *et seq.*), when the time is short, as in firing on a moving objective.

Percussion Precision Fire for Effect.

262. The ammunition is H.E. shell.

Observation must as far as practicable be continuous throughout precision fire for effect.

Battery salvos from the right or left,[1] with 1 or 2 seconds interval, should be used.

The firing is by series of 24 or 48 rounds. During the fire, the observer notes the sense of each round, and at the end of the series reports the result as a whole.

Based on this report, corrections are made if necessary to obtain an equal number of shorts and overs.

Individual corrections are made only when the number of shots observed is at least equal to the number observed during improvement fire.

263. With aerial observation when, as a result of the first series of 24 shots, the battery commander is satisfied with the adjustment, he may pass to a continuous fire, to save time. Aerial observation is continued.

If the firing becomes faulty, adjustment by salvos is resumed at the request of the observer.

In this kind of fire, it is very important that accuracy, and with it effect, be not sacrificed for speed.

264. When firing becomes faulty, the observer makes a point of ascertaining whether a particular piece is responsible, or whether it is due to the battery as a whole.

In the former case, he reports the piece which is out, and if possible, the sense and amount. The elevation of this piece is then corrected, and fire by series resumed.

If the piece cannot be corrected, it ceases firing, and fire for effect is continued with the rest of the battery.

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[1] With terrestrial observation, if the wind comes from the left, fire should be from the right.

If the fault is due to the battery as a whole, the adjustment must be begun anew.

Percussion Zone Fire for Effect. Method of Fire.

265. The ammunition is H.E. shell. The object is to deliver as rapidly as possible a fire whose mean density (number of shots per hectare[1] of objective) is not less than:

80 ..... for the 75 or 90.
45 ..... for the 105 or 120.
30 ..... for the 145 or 155.

The fuses, depending on the range, the ground, and the nature of the objective, should be instantaneous, without delay, or with short delay.

266. The front to be covered is divided into as many portions as there are pieces available.

The planes of fire are directed initially as explained in paragraph 238.

Each piece fires two[2] shots at each range for the first deflection. The deflection is then changed by the proper amount (par. 268), and the fire repeated.

This sweeping is continued until the portion assigned each piece has been completely covered.

The fire is begun at the elevation corresponding to the short limit of the bracket. The elevation is changed progressively by amounts corresponding to 25 meters for the 75, or 50 meters for the 105 or 155.

The fire is by the command: "Zone fire," followed by commands giving the limiting elevations, the elevation change, and the deflection change.

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[1] A hectare is 10,000 square meters, equal to a square 100 meters on a side.

[2] This number should be increased if the ground at the objective slopes downward in the same direction as the trajectory (reverse slope). (Par. 20.)

267. The values of the deflection changes in mils are given in the following table:

Range	Mils[1] 75	105	155	Remarks
2000	5	6	10	
3000	3	4	7	
4000	2	3	5	
5000	2	2	4	
6000	1	2	3	
7000	1	2	3	
8000	1	1½	2½	
9000	1	1½	2	
10000	1	1	2	

[1]These values may be converted into turns of the traversing handwheel.

When the deflections are in decigrades, the following table is applicable:

Range	Decigrades 90	120	155
2000	3	3	6
3000	2	3	4
4000	1	2	3
5000	1	2	2
6000	1	1	2
7000		1	2
8000		1	1
9000			1
10000			1

269. Systematic fire (tir systematique).—Systematic fire is zone fire without preliminary adjustment.

The elevation for the objective is taken as the map range, corrected for the conditions of the moment as far as these are known.

The deflection for the objective is similarly obtained.

Systematic fire for effect. The depth and width of the zone to be covered varies with the accuracy of determination of the firing data.

The depth should be not less than two forks.

Time Fire for Effect.

270. (1) **Shrapnel.**—Time shrapnel fire, when over by as little as a half fork, has little or no effect.

Against unsheltered personnel, such fire, when short by a half fork, is still effective.

When the height of burst is above the normal, much of the effect is lost.

Against sheltered personnel, time shrapnel fire has only a neutralizing effect.

Percussion shrapnel fire is always a zone fire.

271. Method.—The distribution is made as explained in paragraph 238.

Each piece fires two rounds at each range and each deflection. The deflection change used in covering the front is given by the following table:

Range	Mils
2000	7
4000	5
6000	3
8000	2
10000	1

The elevation change is taken uniformly at that corresponding to 100 meters.[1]

The fire is begun at the short limit of the bracket.

With the fuse setter, the fire may be executed at the command: "Zone fire," followed by commands for the corrector, the limiting elevations, the range and fuse setting change, and the deflection change.

272. (2) **H. E. shell.**—The method explained for time

[1] The change should be increased when the objective is on a forward slope.

shrapnel fire is applicable to time shell fire for effect, but, because of the greater dispersion, the elevation change is that corresponding to 50 meters for all calibers and 3 rounds should be fired at each elevation and deflection for the 75.

273. Time fire behind crests.—To cover ground behind a crest, it is desirable to displace the bursts parallel to the slope.

Determine the increments of elevation and decrements of corrector (or increments of fuse setting), so that the bursts will be displaced in a regular manner and parallel to the ground. Use for this purpose the slope charts for air bursts (abaque des pentes des eclatements fusants, from which the following can be read directly: The elevation change, the corrector or fuse setting change, and the actual change on the ground. The arguments are the range of the crest and the reverse slope (Appendix XV).

274. With shrapnel, seek a 100 meter bracket on the crest, with percussion fire.

Then adjust the height of burst at O, using the long limit of the bracket.

With time shell, bracket the crest in time fire. Then raise the trajectory to obtain the proper height of burst, without changing the fuse setting.[1]

275. Search the reverse slope, beginning with the data thus obtained, modified successively according to the chart.

Fire at each elevation and deflection, as described in paragraphs 270 to 272, but with:

For shrapnel, 2 or 3 rounds, depending on whether the range change on the ground is less or greater than 100 meters.

For shell, 3, 4, or 6 rounds, depending on whether the range change on the ground is 50, 75, or 100 meters.[2]

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[1] For the 75, increase the elevation beyond the long limit by 75 or 50 meters, depending on whether the range is less or greater than 4000 meters. For shrapnel, raise the corrector 3 mils.

[2] Time fire on a forward slope is executed in a similar manner, using appropriate charts.

276. Remark.—If, for considerations of safety, it is not possible to adjust on the crest, select a suitable point in the zone to be searched, and adjust on it. Then, by using the chart, determine suitable data for the short limit of the zone. Verify these data by approaching the short limit with due caution by successive changes. The fire for effect is then executed as previously described.

277. With the *75* and a battle map giving the value of the slope, proceed as follows:

For shrapnel, use elevation increments of 50 meters and corrector decrements of 2, if the slope is small (60 mils). If the slope is considerable (90 mils), use elevation increments of 25 meters and corrector decrements of 3.

For shell, use elevation increments of 50 meters and corrector decrements of 1.

278. General remark on fire for effect.—The methods of zone fire for effect set forth in the preceding paragraphs contemplate searching an area with maximum rapidity. But they must not be considered as applicable in all cases. In some cases (for example, interdiction fire and harassing fire), equal or greater efficacy will be obtained by a slow fire (salvos, volleys, or single shots), distributed irregularly so as to baffle the enemy.

Moreover, in general, surprise is an important element of effect on personnel. It is therefore advantageous to have a greater or less interval between fire for adjustment and fire for effect. Fire for effect may well be delivered in several installments, separated by irregular intervals.

279. Fire on a moving or transient objective.—Use zone fire (par. 265).

The adjustment must be made with all possible rapidity.

The adjustment may often be much abbreviated by a knowledge of the terrain and by previous firing.

In position warfare, a battery can nearly always begin fire for effect at once on an objective reported in movement within its normal zone of action.

The adjustment is as for zone fire. But the bracket should be accepted only when the limit last determined is ahead of the objective. When the direction of movement of the objective is not known, the limit last determined should be the short one.

If the objective is obliged to follow a certain route, it is well for all or part of the battery to lay down a barrage on points which must be passed.

Against *tanks* advancing to the attack, the barrage is a suitable method. The fire is as rapid as possible. As soon as shots are observed short but not far from the objective, fire is continued at this elevation. When two overs have been observed, an elevation change is made to again obtain shorts, after which the process is repeated.

Moving objectives reported by aeroplanes are generally attacked with systematic fire. The aeroplane observes the fire. and at his signal, if necessary, the fire is begun anew after suitable correction of the initial data.

In this way it is possible to avoid the delays inherent to adjustment by aerial observation. Due to these delays, the success of zone fire which is preceded by an adjustment would be doubtful.