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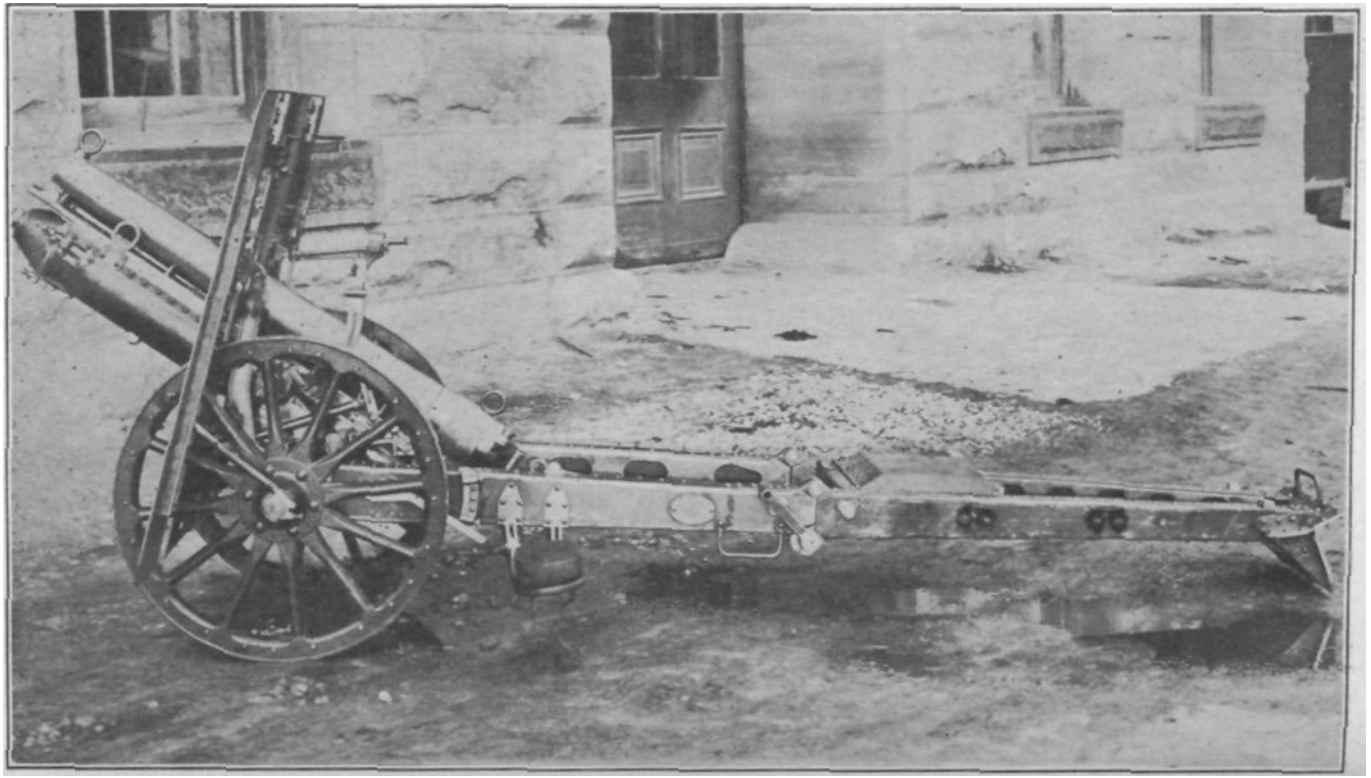


NEW 3-INCH MOUNTAIN HOWITZER AND CARRIAGE.

The Field Artillery Journal

Vol. IV APRIL-JUNE, 1914 No. 2

THE PROBABLE POSITION OF THE TARGET WITHIN A BRACKET AND ITS BEARING UPON THE "DROP BACK."

BY LIEUT. COLONEL ERNEST HINDS, 5TH FIELD ARTILLERY.

In an article by Colonel Potel in the *Journal des Sciences Militaires* for July 15, 1912, the author advocates a "drop back" of from 25 to 100 meters in shrapnel fire. He states that the best ranges against targets in the open are those of the short limit of the bracket decreased by 25 or 50 meters. For the 400-metre bracket, instead of *progressive fire*, he recommends volley fire at five ranges beginning with the range of the short limit of the bracket diminished by 100 metres, "or better still by 50 metres if one does not wish to avoid ranges which are not multiples of 100." For the 200-metre bracket, he says we should always begin with a range 100 metres short. (See pp. 130 to 132, *Journal des Sciences Militaires*, July 15, 1912.) To a certain extent at least, these views appear to be advocated also at the School of Fire at Fort Sill. In the FIELD ARTILLERY JOURNAL for April and June, 1912, pp. 243 to 246, in an article by Captain Burt, 4th Field Artillery, based upon notes made by him while a student officer there, the following statements are made: "It was explained that 'dropping back'—was not to eliminate errors, but to provide for parts of the target not being included in the bracket as in the case of scattered infantry; it is also possible that the center of impact of shots appearing short may be actually over. * * * In time fire it is unwarranted delay to try to get an exact range; after bracketing a 'drop back' of 50 or 100 yards should be made and the 'walk through' begun. Near the target, observation is difficult and the true sense of a shot hard to determine. A bracketing salvo gives a range a trifle too long for effective fire. 'Dropping back' eliminates the effect of faulty observation of shots near the target. * * * When the bracket is 100 yards, a drop back of 50 is usually enough,

NOTE: This study was begun in July of 1913, but the pressure of other work has delayed its completion until the present time—April, 1914.—E. H.

unless there is some reason for doubt; with a 200-yard bracket, 100 yards drop back is better."

In the FIELD ARTILLERY JOURNAL for July-September, 1913, Major Tréguier in a very able article discusses Colonel Potel's views and takes issue with him in regard to the "drop back." Major Tréguier's conclusions are in part as follows: * * * "2d. Against an exposed target, the range of the target is best; therefore fire at a single range should, conformably to the regulations, be executed at the short limit of a 50-metre bracket; * * * 4th. The first range in progressive fire will generally be the short limit of the bracket. With equal expenditure of projectiles, it is better, from an efficiency point, to fire more on a smaller number of ranges, starting always at the short limit instead of that limit decreased by 100 metres." (See Major McNair's translation of Major Tréguier's article, The FIELD ARTILLERY JOURNAL, July-September, 1913, pp. 342, 343.)

It seems that the probable position of the target within the bracket should have considerable weight as a factor in determining the best methods of fire in attacking the target. But so far as the writer is aware no attempt has been made to determine this mathematically. If the premises upon which a mathematical analysis of the problem is based be correct, the conclusions reached by such an analysis should be more reliable and more convincing than those based upon quite extensive experiments even. A reading of the two articles above cited led the writer to a further study of the question. This study has convinced him that the problem may readily be solved mathematically although the work is tedious and quite voluminous, using the methods employed herein; and in view of its importance in determining the advisability of using the "drop back" as well as its bearing upon methods of fire in general, he offers the following discussion:

GENERAL SOLUTION.

It is well known that the points of fall of projectiles fired from the same gun under similar conditions are grouped about the center of impact in accordance with the law of probability of error. This law is known to hold true also for the points of burst of time shrapnel in range, as well as in vertical and lateral distribution.

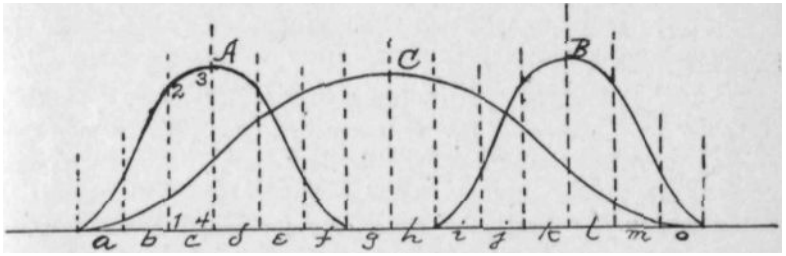


Fig. 1.

In Fig. 1, curves *A* and *B* are the ordinary probability curves, the zones *a, b, c*, etc., being of equal width, and the abscissas being the range deviations of the gun. If a gun be fired a very great number of times under similar conditions at a range *R*, the number of shots falling at any point will be proportional to the ordinate of the curve *A* at the point considered; and the number of shots falling within any particular zone will be proportional to the area under the curve *A* corresponding to that zone. For example the number of shots falling within the zone *c* is proportional to the area 1-2-3-4. This relation holds true for the points of burst of time shrapnel as well as for the points of fall of shell or uncut shrapnel. The areas under the curve are given in the probability tables in works on the Calculus of Probabilities, where the argument is $z = \frac{x}{r}$, *x* being the range deviation and *r* the probable error of the gun in range.

Let p_a, p_b, p_c, etc., represent the probabilities of the shots falling within the zones *a, b, c*, etc., respectively. Let us suppose that by firing two shots at different ranges *R* and *R′* we locate a target within a bracket *RR′*, the shot fired at range *R* falling short of the target, and the one fired at range *R′* falling beyond it. The short range shot may fall at any point under the curve *A,* the long range shot at any point under the curve *B*. The target may therefore be at any point between the short limit of zone *a* and the long limit of zone *o*. The probability that the short range shot will fall within zone *a* is p_a, the long range shot falling somewhere under the curve *B;* similarly the probability that the long range shot will fall within zone *o* is p_o, the short range shot falling somewhere under the curve *A*. The probability that the short range shot will fall within zone *a* and the long range shot within zone *o* is the product of the two separate probabilities, or $p_a p_o$. Now we know that the target is situated

somewhere between the short shot in zone *a* and the long shot in zone *o* and it is just as likely to be in any one zone as in any other in this particular case. Neglecting for the time being the fractional parts of zones *a* and *o* which may be available for the location of the target, and representing by *n* the number of zones between zone *a* and zone *o* we see that the probability that the target is located within any particular zone, as *f* for example, is $\frac{\text{Pa Po}}{\text{n}}$, in case the two shots should fall in zones *a* and *o*. Suppose again that we consider the case of the short range shot falling within zone *d* and the long range shot within zone *k*, the probability that the target is located within any particular zone, as *f* for example, is $\frac{\text{Pd Pk}}{\text{n}'}$, *n′* being the number of zones between zone *d* and zone *k*, If we take all the possible combinations of shots, calculate in like manner the probability that the target is within zone *f* for each combination, and take the sum of these partial probabilities we shall obtain the total probability that the target is within zone *f*. Similarly we may find the probability that the target is located within each of the other zones. By plotting these values we obtain a curve *C* showing the probabilities that the target is located within the various zones, the areas under the curve being the probabilities that the target is located within the corresponding zones.

The same methods are applicable to ranging with more than one gun. In the case of adjustment by platoon the probability that the short range shots will fall within the zones *b* and *e* respectively, shot number 1 falling in zone *b* and shot number 2 within zone *e*, is $p_b p_e$ the probability that long range shot number 3 will fall within zone *k* and long range shot number 4 within zone *m* is $p_k p_m$; the probability that the four shots will fall in those particular zones in the order indicated is therefore the product of the four separate probabilities, or $p_b p_e p_k p_m$. Neglecting fractional parts of zones *e* and *k*, the target must in this particular case be located somewhere in the zones *f* to *j* inclusive. Calling n″ the number of zones available for the location of the target, and P_h the probability that the target is situated within any particular one of these zones, as *h* for example, we have $\text{Ph} = \frac{\text{Pb Pe Pk Pm}}{\text{n}''}$. By taking all possible combinations, calculating the zonal probabilities for each combination and summing the partial probabilities for each zone we obtain the total probability that the target is situated within that zone. In like manner the

probable location of the target may be found when the bracket is determined by battery salvos. But, as will be shown later, if we use a sufficient number of zones to give accurate data for the construction of curve *C*, the calculations become quite voluminous for the two gun problem; and for four guns the amount of work involved in the calculations is almost prohibitive, unless shorter methods than those indicated above be used. Doubtless a mathematician could readily develop such methods.

I.
RANGING WITH ONE GUN.

Let us consider first a bracket determined by one short and one long shot, the difference in the ranges used being for convenience of calculation three times the probable error in range. For the present United States 3-inch field gun this corresponds very closely to the bracket 3000-3100 yards, the *service* probable error in range for the points of burst of the time shrapnel being about 33⅓ yards at those ranges.

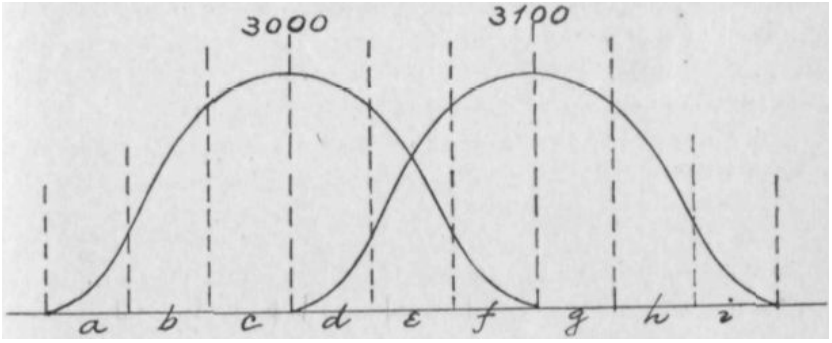


FIG. 2.

In Fig. 2 the zones *a, b, c*, etc., are each equal in width to the service probable error in range for time shrapnel. The points of burst are at one mil height on the axis of abscissas. In order to simplify the work let us consider only those shots falling within a distance from the center of impact of three times the probable range error. Of the shots fired at range 3000, 96% (more accurately 95.8%) fall within the six zones *a* to *f*, 2% falling short of the zone *a*, and 2% beyond the zone *f*. Shots falling outside of zones *a* to *f* are usually regarded as abnormal and are rejected accordingly.

An inspection of the overlapping probability, curves in Fig. 2,

shows that theoretically in the concrete case under consideration, it might occasionally happen that shots fired at the short range bursting beyond the mean point of burst would be observed beyond the target, and shots fired at the long range would be observed short of the target.

But in practice, if a shot fired with a sight range of 3000 yards be observed as an "over" the next shot would be fired at a shorter sight range. And the search for the bracket would probably be continued for several shots before a longer range would be used. In other words the overlapping of *consecutive* shots in fire for adjustment is not ord narily possible. We will therefore call these cases *impossible* combinations and will reject them in our computations.

Attention has already been called to the fact that in addition to the integral zones lying between the two in which we suppose the two shots to burst in any single case under consideration, there will be fractional parts of these two zones available for the location of the target.

Before proceeding to the calculation of the zonal probabilities for the location of the target we have therefore two subsidiary problems to solve:

1st. What percentage of the various zones in which the bursts occur is available for the location of the target?

2nd. What percentage of cases in zones *d*, *e* and *f* will give rise to *impossible* combinations?

PERCENTAGE OF ZONES AVAILABLE FOR LOCATION OF TARGET.

An inspection of the short range curve in Fig. 2 shows that the points of burst will occur more frequently on the far side of zones *a*, *b*, and *c* and on the near side of zones *d*, *e* and *f* than on the opposite sides of those zones. It is evident, therefore, that, considering both the smoke ball and the target, as mathematical points, less than 50% of zones *a*, *b* and *c* will, in the long run, be available for the location of the target when we range with single shots, while more than 50% of zones *d, e* and *f* will be available. On the other hand, for the long range shots, more than 50% of zones *d*, *e* and *f*, and less than 50% of zones *g*, *h* and *i* will be available. Also under this supposition it is evident that the percentages in the two cases are complementary for corresponding zones; that is, if 40% of the short range zone *a* is available for the location of the target, 60% of the short range zone *f* will be available; while for the long range

shots the percentages for the corresponding zones will be reversed, 60% in the long range zone *d* and 40% in zone *i*.

PERCENTAGE FOR ZONE *a*.

If we subdivide zone *a* in Fig. 2 into ten strips of equal width numbered from 1 to 10 from left to right, the probability tables show that the proportion of shots bursting within the various sub-zones will be as follows:

1	2	3	4	5	6	7	8	9	10	Sub-zones.
375	420	485	545	615	685	765	850	945	1030	No. of shots.
90	80	70	60	50	40	30	20	10	0	% of zone *a* available for target, 1st approximation

FIG. 3.

From Fig. 3 we see that as a first approximation, in the case of the 375 shots which burst in sub-zone 1, all of the nine sub-zones 2 to 10 inclusive are available for the location of the target; for the 420 shots in sub-zone 2, 8 of the sub-zones are available; and similarly for the other sub-zones. Multiplying the number of shots in each sub-zone by the percentage of zone *a* available for the target in the various cases and averaging the results, we have as a first approximation, the following:

1st Approximation.

375 ×	.9 =	338
420 ×	.8 =	336
485 ×	.7 =	340
545 ×	.6 =	327
615 ×	.5 =	308
685 ×	.4 =	274
765 ×	.3 =	230
850 ×	.2 =	170
945 ×	.1 =	95
1030 ×	0 =	0
6715		2418

2418 divided by 6715 = 36.01%. So we see that for the shots bursting in sub-zone 1 not only are the 9 sub-zones to the right of (beyond) it available but *approximately* 36% of sub-zone 1; and similarly for

the other sub-zones. Our multipliers should, therefore, have been .93601, .83601, .73601, etc., etc. A second approximation would therefore give us for the sum of the products a number .03601 × 6715 greater than that found by the first approximation; or, 36.01% + 3.601% = 39.611%. A third and fourth approximations would give 36.01 + 3.601 + .3601 + .03601 = 40.007%, practically 40%.

But this calculation was based upon the assumption that the smoke balls are mathematical points, whereas in the case of the *overs* about 10% of the zones should be deducted for the size of the smoke ball, all of which must be beyond the target. For the *shorts* an allowance of that amount at least should be made because, except in the very rare cases in which the burst is immediately over the target, a shrapnel burst at one mil height just short of the target, would produce such visible effect on it that the range of that shot would be taken at once as the range of the target and a bracket would no longer be sought. So the supposition that the 10% sub-zone in which the burst occurs is not available for the location of the target gives results which are approximately correct and the percentage of zone *a* which is available for the location of the target will therefore be assumed to be that given by the 1st approximation, 36.0%.

In a similar manner we obtain the percentages for the other zones, as follows, fractional percentages being rejected:

Percentage of Zones Available for the Target.

Zones	Short range.	Long range.
a	36	.....
b	40	.....
c	43	.....
d	47	54
e	50	50
f	54	47
g	.....	43
h	.....	40
i	.....	36

PERCENTAGE OF POSSIBLE COMBINATIONS.

It is evident from Fig. 2, that all combinations of short range shots in zone *e* with long range shots in zone *d*, and those of short range shots in zone *f* with long range shots in both zone *d* and *e*, are automatically rejected by the methods employed in fire for

adjustment, and for this reason are called *impossible* combinations. It remains to determine the percentage of possible combinations when both the short and the long range shots fall within the same zone *d*, *e*, or *f*.

Zone *d*. From the probability tables it may be seen that 58.34% of the short range shots bursting within zone *d* will be found on the *near* side within a strip whose width is 55.46% of that of zone *d;* and 58.34% of the long range shots bursting in that zone will be found on the *far* side within a strip whose width is 44.53% of that of the zone itself. Therefore 58.34% of the combinations of shots bursting in zone *d* are possible cases.

Zone *e*. Within this zone, 16.135% of short range shots will burst, and the same percentage of long range shots. In the near half of the zone 9.415% of the short range shots will burst, or $\frac{9415}{16135} = 58.35\%$. Similarly 58.35% of the long range shots will burst in the far half of the zone. Therefore 58.35% of the combinations of shots bursting in zone *e* will be possible cases.

Zone *f*. This case is the same as that of zone *d* with the percentages reversed.

In each of these zones therefore about 58⅓% of the combinations are possible cases, the size of smoke ball not being considered. Allowing as before 10% of the zone for both long and short shots we see that 58⅓%–20=38⅓% of the combinations of shots in zones *d*, *e* and *f*, where both long and short shots burst in the same zone, are possible cases; or, for convenience of calculation we may say that 40% of the combinations of shots in zones *d*, *e* and *f*, are possible.

We are now ready to proceed with the calculation of the zonal probabilities for the location of the target when the bracket has been determined with a single gun, one shot bursting short of the target and one beyond it.

The probability factors used are .068 for short range zones *a* and *f* and long range zones *d* and *i;* .161 for short range zones *b* and *e* and long range zones *e* and *h;* and .250 for short range zones *c* and *d* and long range zones *f* and *g*. The probabilities, being always the product of two of these factors, are therefore decimals of the sixth order. The work is shown fully in tabular form in Table I appended hereto. The second column of the table shows all the possible shot combinations, 36 in all; each short range shot may burst in any one

of the six zones *a* to *f* inclusive, and each of the six short range bursts may be combined with any one of the six long range bursts in zones *f* to *i*, thus giving 36 possible combinations. The next column shows the probability of the occurrence of the various combinations in column two. The fourth column shows the number of possible cases; the fifth column shows the number of zones, integral and fractional, which are available in each particular case for the location of the target. The nine columns following show in each case the probability that the target is located in the corresponding zone. These zonal probabilities are obtained by dividing the total probability,—possible cases only,—for the particular case into parts proportional to the number of integral and fractional zones available for the location of the target in that case. The last column shows the number of impossible cases. In the second column the first letter indicates the zone in which the short range shot bursts, and the second that in which the long range shot bursts. Table I shows that in 10,000 cases we may expect the target to be located in the various zones as follows:

Table Showing Probable Location of Target when rangin with a single gun.

Zones,	Times,
a	55
b	338
c	1053
d	2182
e	2744
f	2182
g	1053
h	338
i	55

II.

RANGING WITH TWO GUNS.

In those cases where single shots burst in a zone the percentage of that zone available for the location of the target will be the same as in the case of the ranging with a single gun shown on page 156. Where two short or two long shots fall in the same zone the calculation of the percentage of that zone available for the location of the target is similar to that shown above for the single gun ranging except that the probabilities are the products of two separate probabilities in each case. For example the probability that one short range shot

will fall in sub-zone *1* and the other in sub-zone *5* of zone *a* will be .00375 × .00615. Each shot may burst in any one of the ten subzones and may be combined with the other shot in any one of the ten sub-zones. So there are 100 cases. The number of *different* combinations, however, is but 55, as may be seen by developing the multinomial expression $(a+b+c+d+e+f+g+h+i+k)^2$, the letters representing the probabilities of the shots bursting in the various sub-zones from left to right.

By developing the expression within the parenthesis, substituting the values of the letters, and multiplying each probability by the percentage of zone available for the target in that case we have:

$a^2 \times .9 = .000375^2 \times .9 = .0000001265625$
$2ab \times .8 = 2 \times .000375 \times .000420 \times .8 = .0000002520000$
$2ac \times .7 = 2 \times .000375 \times .000485 \times .7 = .0000002545850$
$2ad \times .6 =$ etc. etc.
etc.

By completing this development we obtain the following:

Table showing percentage of zones available for location of target in ranging by platoon when two long or two short range shots burst within the same zone.

Zones	Short Range Shots	Long range Shots
a	20	.....
b	23	.....
c	27	.....
d	30	39
e	34	34
f	39	30
g	.....	27
h	.....	23
i	.....	20

The calculations are shown in full in Table III.

PERCENTAGE OF POSSIBLE SHOTS IN ZONES D, E AND F.

For the reasons given above under the subject of ranging with a single gun we will reject all combinations of shots in which either of the short range shots bursts beyond the point of burst of either of the long range shots.

We may calculate the percentage of possible combinations as follows:

Zone *d*. Divide this zone into 5 sub-zones, *a*, *b*, *c*, *d*, and *e*. The relative proportion of short range and long range shots falling within these sub-zones is shown in the following diagram, based upon the probability table:

Sub-zones	a	b	c	d	e	Totals
Short range shots	53	53	51	48	45	250
Long range shots	8	11	13	16	20	68
Sub-zones	a′	b′	c′	d′	e′	

1st. Percentage when 2 short and 1 long range shots fall in zone *d*.

The number of different combinations is given by the number of terms in the development of the multinomial expression $(a+b+c+d+e)^2$ $(a'+b'+c'+d'+e')$ and the probabilities of the occurrence of the different combinations are found by substituting in the development the values of a, b, c, d, e and a′, b′, c′, d′ and e′ given in the diagram above. Impossible combinations, corresponding to short range shots ranging beyond the long range shot of the particular combination, are shown in the development by an accented letter occurring in combination with one having no accent and which follows the accented letter in alphabetical order. For example the combinations, a^2b', 2 abc′, 2 bcd′, are all possible cases because the long range shots represented by b′, c′, and d′, all fall in zones farther from the gun than the short range shots represented by a^2, *ab* and *bc*. On the other hand such combinations as b^2a', 2cdb′, 2dec′, are impossible cases because the short range shots represented by the letters with no accent, b^2, cd, and de, fall beyond the long range shots represented by the accented letters a′, b′ and c′, respectively. Also to allow for size of smoke ball, etc., as in the case of ranging with one gun, as previously indicated an allowance of 20% of the zone *d* is made by regarding as impossible those combinations in which a short range shot and a long range shot burst within the same sub-zone, the width of each of the five sub-zones being 20% of that of the zone itself. Such combinations as a^2a', 2abb′, c^2c', etc., are therefore rejected as impossible. The possible combinations are therefore given by the expression $a^2b'+a^2c'+a^2d'+a^2e'+2abc'+2abd'+2abe'+2acd'+2ace'+b^2c'+b^2d'+b^2e'+2bcd'+2bce'+2bde'+c^2e'+2cde'+d^2e'$.

By substituting the values of the letters from the diagram above given and performing the operations indicated we have for the total probability of the occurrence of possible combinations 1411851. The total probability of the occurrence of all the combination of 2 short range shots and 1 long range shot bursting in zone *d* is $250^2 \times 68 = 4250000$ (the probabilities are actually .001411851 and .004250000, respectively, but for convenience the decimals are disregarded as we are considering a ratio only). The percentage of possible cases when 2 short range shots and one long range shot burst in zone *d* is therefore $\frac{1411851}{4250000} = 33.2\%$.

2d. In a similar manner, when 1 short and 2 long range shots burst in zone *d*, we find the percentage of possible cases to be 34.9. The development in this case is given by the expression $(a+b+c+d+e)\ (a'+b'+c'+d'+e')^2$ and we find the ratio of possible combinations is $\frac{403349}{1156000} = 34.9\%$.

3d. Two short and 2 long range shots in zone *d:* We have in this case: $(a+b+c+d+e)^2\ (a'+b'+c'+d'+e')^2$, and the ratio is found to be $\frac{52679275}{289000000} = 18.2\%$

Zone *e*.

1st. When 2 short and 1 long range shots burst in zone *e:*

We have for the realtive proportion of long and short range shots in the various sub-zones in this case the numbers shown in the following diagram:

Sub-zones	a	b	c	d	e	Totals
Short range shots	41	36	32	28	24	161
Long range shots	24	28	32	36	41	161
Sub-zones	a′	b′	c′	d′	e′	

Developing the expression $(a+b+c+d+e)^2\ (a'+b'+c'+d'+e')$ and substituting the values of the letters in the possible combinations, as above indicated, we have $\frac{1434041}{4173281} = 34.4\%$ for the possible combinations.

2d. When 1 short and 2 long range shots are in zone *e* the percentage of possible combinations is the same as in the preceding case, as may

be seen from the diagram, the percentage of shots in the sub-zones being merely reversed in their order.

3d. Two short and two long range shots in zone *e*. The development in this case is similar to that of the 3d case of zone *d*, and gives $\frac{124889313}{671898241} = 18.6\%$.

Zone *f*.

The three cases in this zone are the same as those of zone *d* taken in reversed order:

2 short and 1 long: % = 34.9
1 short and 2 long: % = 33.2
2 short and 2 long: % = 18.2

SUMMARY.

Percentage of possible combinations.

Cases.	Combinations	Zone *d*	Zone *e*	Zone *f*
1	1 short and 1 long shot	40%	40%	40%
2	2 short and 1 long shots	33	34	35
3	1 short and 2 long shots	35	34	33
4	2 short and 2 long shots	18	19	18

For convenience of calculation we may without appreciable error use the percentages 40 for case 1, 33 1-3 for cases 2 and 3, and 20 for case 4 in each of the zones.

Percentage of Zones available for Location of Target in Adjustment by Platoon.

	Short Range Shots.		Long Range Shots.	
Zones	1 shot in zone.	2 shots in zone.	1 shot in zone.	2 shots in zone.
a	36	20	.....	.....
b	40	23	.....	.....
c	43	27	.....	.....
d	47	30	54	39
e	50	34	50	34
f	54	39	47	30
g	.....	.....	43	27
h	.....	.....	40	23
i	.....	.....	36	20

We now have the data necessary for the calculation of the zonal probabilities for the location of the target in the adjustment by platoon. The combinations are given by the development of the

expression $(a+b+c+d+e+f)^2\ (d'+e'+f'+g'+h+i)^2$ in which the letters in the first parenthesis refer to the zones under curve *3000* and those in the second refer to those under curve *3100* in Fig. 2 above. The development shows 441 combinations of which 96 are impossible cases, leaving 345 possible ones.

The calculations are shown in full in Table V. Only the possible combinations are shown. The factors used in the calculation of the probabilities are .250 for the 25% zones, .161 for the next zones and .068 for the outer zones,—*c* and *d*, *b* and *e*, and *a* and *f*, respectively. In the results the last four decimal places are rejected, so that the probabilities are decimals of the 8th order, the decimal points being omitted for the sake of brevity. The results of the calculations are shown in the following:

SUMMARY.

In 10,000 cases the target will be located as follows:

In zone	*a*	3	times;	or, in $\frac{1}{30}$ of 1% of cases.
" "	b	78	"	; or, in ¾ of 1% of cases.
" "	*c*	655	"	; or, in 6½% of cases.
" "	*d*	2432	"	; or, in 24⅓% of cases.
" "	*e*	3664	"	; or, in 36⅔% of cases.
" "	*f*	2432	"	; or, in 24⅓% of cases.
" "	*g*	655	"	; or, in 6½% of cases.
" "	*h*	78	"	; or, in ¾ of 1% of cases.
" "	*i*	3	"	; or, in $\frac{1}{30}$ of 1% of cases.
		10000		

RANGING WITH FOUR GUNS.

The work involved in calculating a 4-gun curve by the methods outlined above is considerable if a sufficient number of zones be used to obtain reliable results. The data for the 4-gun curve using three zones only instead of nine have been calculated. The curve, as well as those for one gun and for two guns, is shown on Plate I. It is not regarded as so reliable as the other two curves, but it is thought that it will give a fairly good idea of the relative values of adjustment by piece, by platoon, and by battery.

From these curves the data shown in Table VI have been taken. The last column under each of the three headings Adjustment by Piece, by Platoon, and by Battery, are the important ones so far as our present discussion is concerned.

THE DROP BACK.

If we could rely upon the target being found within the bracket indicated by the sight ranges used in determining that bracket, it is clear that no drop back would be necessary. But owing to the normal dispersion of the shots in range we know that it may sometimes be considerably short of or beyond the true sight range bracket. The latter case will usually give no trouble because the shrapnel sheaf for the superior limit of the bracket, or even for the mid-range of the bracket will, in nearly all cases, cover it more or less effectively. But if the target be considerably short of the inferior limit of the bracket as indicated by the sight ranges used, we may completely overshoot our target. If this probability be considerable it may be advisable to shorten the range on passing to fire for effect in order to guard against the possibility of obtaining no effect whatever. On the other hand, if such probability is exceedingly small, it is clear that we should take the small chance of overshooting rather than to greatly increase our expenditure of ammunition by dropping back and firing at an additional range when there is slight necessity for it. Moreover, no irreparable mistake will be made if we do occasionally overshoot. The fact that we have done so will be evident immediately—the enemy's actions will tell us. He will continue his fire with unabated zeal, or he will resume his advance. We will shorten the range as soon as we see the necessity therefor. Is it a greater crime to overshoot occasionally than to undershoot frequently? It goes without saying that by dropping back we have a greater factor of certainty that we will obtain effect on the target, but we pay for our insurance in ammunition. The question is: Should we buy such insurance in all cases; if not, when should we? A study of the curves in Plate I and the data of Table VI should enable us to answer this question with a considerable degree of confidence.

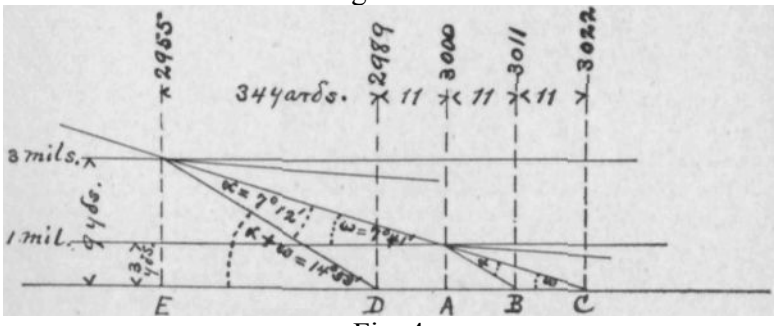


Fig. 4

As a basis for our calculations in the preceding discussion it was assumed that the mean point of burst of the shrapnel for the inferior limit of the bracket is at 3000 yards.* From Fig. 4 it will be seen that in passing to fire for effect with the corrector adjusted for a burst at 3 mils the lowest element of the sheaf is withdrawn from *B* at 3011 yards to *D* at 2989 yards. In other words the mean point of fall of the lowest bullet in the sheaf is at the gun range of 2989 yards from the firing battery. Prone infantry would begin to be hit by the lowest element of the sheaf at 2987; kneeling infantry at 2985; standing infantry at 2982 yards.

From column 7, Table VI, we see that we may expect to find the target short of 2989 yards after adjustment by piece, in 8.62% of cases. So in 8.62% of cases when we adjust by piece we may expect that ½ of the shrapnel of the battery salvo fired at the short range of the bracket will strike entirely beyond a straight line target, such as a straight infantry trench, for example. Only once in 16 salvos should *all* the shrapnel burst beyond the normal point of burst; so only once in $\frac{8.62\%}{16}$ of cases, that is once in 186 cases, should we fail to get *some* effect on a straight trench. Similarly the data shown in tabular form below may be obtained from the data in Table VI.

In fire for effect using battery salvos after an adjustment	One-half of the shrapnel of the battery salvo will strike entirely beyond the target once in			All of the shrapnel of the battery salvo will strike entirely beyond the target once in		
	Target: Prone infantry	Target: Kneeling infantry	Target: Standing infantry	Target: Prone infantry	Target: Kneeling infantry	Target: Standing infantry
	Times	Times	Times	Times	Times	Times
By Piece	12.5	13.5	15.2	200.	217.	243.
By Platoon.....	35.4	40.1	51.0	576.	643.	816.
By Battery	92.1	109.9	156.8	1473.	1758.	2509.

If the bracket is based upon impact shots the points in Fig. 4 will be located as follows:

C at gun range 3000
B at " " 2989
A at " " 2978
D at " " 2967

or at 22 yards short of those given by time bursts at 1 mil height.

---

*Strictly speaking the references to time ranges should be 22 yards less than those given herein,—AC = 22 yds. in Fig. 4. For example, 3000 and 3100 should be 2978 and 3078; but as a matter of convenience they are referred to as 3000 and 3100 yards. The calculations in the tables are the same in any case.

The target will be short of *D*, 2967 yards, after adjustment by piece, in 3.99% of cases. So after adjustment by piece when the inferior limit of the bracket is based upon an impact burst at 3000 yards gun range we may expect that one-half of the shrapnel of the battery salvo with 3 mil height of burst fired at the short limit of the bracket will strike entirely beyond the target in 4% of cases.

If our lower limit of the bracket is based entirely upon impact bursts, the data-shown in tabular form above will be as follows:

In fire for effect using battery salvos, the 100 yard bracket having been determined by impact bursts in an adjustment	One-half of the shrapnel of the battery salvo will strike entirely beyond the target once in			All of the shrapnel of the battery salvo will strike entirely beyond the target once in		
	Target: Prone infantry	Target: Kneeling infantry	Target: Standing infantry	Target: Prone infantry	Target: Kneeling infantry	Target: Standing infantry
	Times	Times	Times	Times	Times	Times
By Piece	27.	30.	35	432.	480.	560.
By Platoon.....	142.	171.	227	2272.	2736.	3632.
By Battery	625.	794.	1111	10000.	12704.	17777.

The last three columns are of little practical interest, however. It is with the first three that we are principally concerned. As a practical proposition we want to know whether the probability of decreased effect from overshooting in some cases will make it advisable to accept in a much greater number of cases the increased expenditure of ammunition with practically a certainty of decreased effect so far as the "drop back" ranges are concerned.

In considering the question, due weight should be given to the elements of time, probability of obtaining effect on the target, importance of the target, the necessity of certainly obtaining effect without loss of time, the value of the moral effect of striking the enemy instantly and with certainty—all these factors should be balanced against the increased expenditure of ammunition required by the "drop back." Individuals will give different weights to these factors; so we need not be surprised when the solutions differ.

CONCLUSIONS.

1. Brackets obtained from adjustment by piece, or what amounts to the same thing, brackets based upon the observation of a single shot, whether percussion or time, are not reliable.

2. Those obtained from adjustment by platoon are fairly reliable, provided both shots for each limit of the bracket are correctly sensed.

3. Those obtained by battery salvos are practically certainties even though one shot of each salvo be not sensed, provided the other three are correctly sensed.

4. Against stationary targets, if the battery commander has established the inferior limit of the bracket by sensing clearly at least two shots, the "drop back" is not justified ordinarily. Cases of course may arise where the target is of such importance as to make it imperative that no chances of overshooting be taken. Certainty of effect is required instantly in such cases and the "drop back" may therefore be justified.

5. Against stationary targets, when the inferior limit of the bracket has been determined by clearly sensing three or four shots, the drop back should never be used.

6. Against moving targets, the question of the employment of the drop back depends upon various factors—the rate of motion of the target, its importance, the certainty and instantaneity of effect required, and psychological factors. The decision in such cases may well be left to the judgment of the battery commander.

7. In case we should be compelled to accept a bracket based upon the observation of a single shot at the inferior limit, a study of Table VI shows that the "drop back" should be 50 yards—not 100. The point *D*, Fig. 4, when we pass to fire for effect in this case will be drawn back to gun range 2939. The lowest element of the various shrapnel cones will be found one-half short of and one-half beyond the point *D*. Table VI shows that only ¾ of 1% of targets will be short of 2939 yards. So in only ¾ of 1% of cases will we have the entire sheaf of more than one-half of the shrapnel falling beyond the target.

Using the data given by Major McNair in the April-June, 1912, FIELD ARTILLERY JOURNAL (Table A, p. 222) the point of maximum effect in this case after dropping back 50 yards will be at about 2960 yards (3022–(50+12)). From Table VI we find that only 2.86% of targets should be found short of 2960. So in only 2.86% of cases will the *maximum effect* of the shrapnel be found beyond the target. (2.6% for prone infantry; 2.3% for kneeling and 2% for standing infantry). If the inferior limit has been established by the correct sensing of two *impact* shots, prone infantry targets will be beyond the point for *maximum effect* with time shrapnel, *using no* "*drop back*," in 96.7% of cases, kneeling infantry in 97.1% of cases. To

the writer this clearly indicates that a 50 yard drop back is sufficient when we are forced to accept a bracket based upon the observation of a single shot at the inferior limit.

8. Similarly we find that when the inferior limit of the bracket has been established by the correct sensing of *two* shots the targets will be short of the range for *maximum effect*, *using no* "*drop back*," only 12.32% of cases—once in 8 cases. For prone infantry it is once in 9; kneeling infantry, once in 10; standing, once in 12 times. In other words using the range of the inferior limit of the bracket when the target is prone infantry, the target will be beyond the point of *maximum effect* in 89% of the cases; kneeling infantry, in 90% of cases; standing infantry, in 91% of cases. For battery adjustment, when all the shots at the short limit are correctly sensed for range, these figures become 92½%, 93½% and 95% respectively for the three infantry targets.

SOME OTHER CONSIDERATIONS.

(a) If it be true, as Table VI indicates, that the target will be found at the center of the bracket in platoon ranging 2.8 times as frequently as it is at the outer limits of the bracket (3.8 as many times in ranging by battery) should not that fact be taken into consideration in our methods of fire?

(b) If the target is outside of the farther limit of the bracket in platoon ranging in 7.36% of cases only, why should we fire at that limit at all when we have a 100-yard bracket? Suppose it is beyond the bracket, a salvo fired at the mid-range of the bracket gives us 40% of the maximum effect at the extreme probable limit. At 3130 yards, beyond which only 1% of targets in platoon ranging will be found, the effect will be 50% of the maximum. (See the Table in Major McNair's article cited above.) If it be between 3050 and 3100, as it should be in 43% of cases, the average effect will be 81% of the maximum. Whereas if we fire at 3100 yards we may expect that two shots will be practically thrown away—we may expect one of these in the long run to burst at a mean range of 3157 where the probability of there being a target is practically *nil;* one at the mean range of 3117, beyond which but 2¾% of targets will be found; one at 3084 beyond which point we may expect to find 16¾% of our targets; the fourth at 3043 as a mean range, beyond which should be found 57% of the targets. Suppose instead of firing at 3100 we fire the salvo at 3050,—the mean points of burst we may expect to

find in the long run at 2993, 3034, 3067 and 3107 with percentages of targets located beyond these points as follows: 95%, 66¾%, 31⅔%, and 5%.

If the bracket has been established by battery, the case against firing at the long limit of the bracket is all the stronger.

(c) Colonel Potel and Captain Burt agree that for the 200-yard bracket we should open the fire for effect at the short limit of the bracket decreased by 100 yards. (See the paragraph at the beginning of this paper.) This study has convinced the writer that the wider the bracket the less reason is there for a drop back.

The area under Curve *C* in Fig. 1 is constant, unity. If we increase the width of the bracket we increase the base of the area under the curve; the mean value of the ordinates must therefore decrease, and it seems evident that the percentage of targets which will be found short of the inferior limit of the bracket will also decrease. There is more space within the bracket for the location of the target; there is just as much tendency for the "overs" at the short range and the "shorts" at the long range to push the target toward the center in the case of the wide bracket as there is in the case of the narrow bracket. So it seems clear to the writer that the percentage of targets found outside of the bracket will be smaller as the width of the bracket is increased.

(d) In discussing the probable effect upon the target, why should we not change our methods of analysis by considering "probable positions of target" instead of "possible" positions? Is not the probable effect of shrapnel fire a function which is dependent upon the probability of the shrapnel bursting at a certain point in range and at a certain height, combined with the probability that the target is located at a certain place, rather than a function of the first probability combined with a mere supposition that the target is at a certain range? In other words, we have heretofore assumed that it is equally probable that the target is anywhere within the bracket, which is not the case.

(e) Does not the data of Table VI indicate a greater necessity of obtaining more reliable data in regard to range than our officers generally realize? Would it not be well to base the short limit of the bracket upon the observation of more than two shots?

It has been urged as an objection to adjustment by battery that the battery commander has too many elements to observe, 4 observations as to range, 4 as to height of burst, and the distribution of the salvo. But is it really necessary for him to observe all these in the

initial adjustment? What is of most importance at that time? Unquestionably the observation of *range*. If the gunners are reasonably well trained, errors in distribution will not amount to much; they can be corrected just as well after we get our range. If we have the correct range our fire will be effective even though the distribution be not exactly what it should be. The battery commander should therefore not necessarily be required to correct errors in distribution until he has found his range bracket. For this purpose it is necessary that the corrector should be such that he will obtain *some* low air bursts and as a corollary thereto *some* impact bursts. Noting the proportion of high, low and impact bursts is not of vital importance for the initial *range* adjustment, it burdens the mind of the battery commander; it would not be done in actual service. Therefore why require it in time of peace? We attach too much importance to the keeping of B. C. records. Only in so far as it may be necessary to secure observable bursts should the adjustment of the corrector be allowed to distract the attention of the battery commander from the *vital* factor, the determination of the *range*. The correct adjustment of the corrector can be attended to later, just as well as the correct adjustment of the distribution.

It is believed that by concentrating his attention principally upon the observation of *range*, the battery commander could easily find the range bracket by battery salvos. And a study of Table VI will show that if we have even three shots of the four correctly sensed as "shorts" we can offer long odds that when we raise the corrector for fire effect we will not overshoot our target, using the range of the near limit of the bracket.

(f) In view of the fact that the self-contained base Range Finders are proving to be very reliable, and of the further fact shown in Table VI that two reliable "overs" will establish with sufficient certainty the superior limit of the bracket, the writer offers as a suggestion to be tried out in practice, the following method of adjustment for range in time shrapnel firing against stationary targets:

Begin with a platoon salvo at a range 100 yards greater than that given by the range finder. This will give the direction as well as a battery salvo, and if we are so fortunate as to observe *both* shots as "overs" the fact that the range used is long will be established with the necessary degree of certainty. Pass then at once to battery salvos. If the first battery salvo fired at a range 200 yards less than

that of the platoon salvo gives us at least *two* certain "shorts" we have at once a reasonably safe 200-yard bracket; if we sense correctly more than two "shorts" we have practically a certainty. The next battery salvo fired at the mid-range should then give us a safe 100-yard bracket provided we correctly sense at least *two* shots; if we sense more than two we can rely upon our bracket with great certainty. The advantage in firing the first platoon salvo at the longer range is obvious, since we are content to base the superior limit of the bracket upon the observation of two shots, whereas we prefer to have more than two sensed for the short limit. Should the first platoon salvo give us two *shorts*, the same method is still applicable, although should the range of the platoon salvo be found to give us the short limit of the bracket we would not have the degree of certainty as to that limit that is considered desirable.

(g) In conclusion, if the theories advanced herein be correct, the writer hopes that some able mathematician will take up the study of the subject and develop formulae which will enable us to solve questions of this nature readily. The methods used in this discussion are long and tedious, and doubtless can be greatly shortened. It is believed, moreover, that there is much in this subject that the writer has not touched upon and that may be studied with profit.

TABLE I.
Ranging With a Single Gun.

Case	Shot Combination	Probability	Possible Cases	Zones Available for Target	Probability that the Target is Located Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
1	a d	4624	4624	.36a + b, c + .54d = 2.90	575	1594	1594	861						
2	a e	10948	10948	.36a + b, c, d + .50e = 3.86	1022	2836	2836	2836	1418					
3	a f	17000	17000	.36a + b, c, d, e + .47f = 4.83	1267	3520	3520	3520	3519	1654				
4	a g	17000	17000	.36a + b, c, d, e, f + .43g = 5.79	1057	2936	2936	2936	2936	2936	1263			
5	a h	10948	10948	.36a + b, c, d, e, f, g + .40h = 6.76	583	1619	1619	1620	1620	1620	1619	648		
6	a i	4624	4624	.36a + b, c, d, e, f, g, h + .36i = 7.72	216	599	599	599	598	599	599	599	216	
7	b d	10948	10948	.40b + c + .54d = 1.94		2257	5644	3047						
8	b e	25921	25921	.40b + c, d + .50e = 2.90		3576	8938	8938	4469					
9	b f	40250	40250	.40b + c, d, e + .47f = 3.87		4161	10400	10400	10400	4889				
10	b g	40250	40250	.40b + c, d, e, f + .43g = 4.83		3333	8333	8333	8334	8333	3584			
11	b h	25921	25921	.40b + c, d, e, f, g + .40h = 5.80		1788	4469	4469	4469	4469	4469	1788		
12	b i	10948	10948	.40b + c, d, e, f, g, h + .36i = 6.76		648	1619	1620	1620	1620	1619	1619	583	
13	c d	17000	17000	.43c, .54d = .97			7537	9463						
14	c e	40250	40250	.43c, d, .50e = 1.93			8968	20855	10427					
15	c f	62500	62500	.43c, d, e, .47f = 2.90			9267	21552	21552	10129				
16	c g	62500	62500	.43c, d, e, f, .43g = 3.86			6962	16192	16192	16192	6962			
17	c h	40250	40250	.43c, d, e, f, g, .40h = 4.83			3584	8333	8334	8333	8333	3333		
18	c i	17000	17000	.43c, d, e, f, g, h, .36i = 5.79			1263	2936	2936	2936	2936	2936	1057	
19	d d	17000 × .4 = 6800		d = 1				6800						10200
20	d e	40250	40250	.47d, .50e = .97				19503	20747					
21	d f	62500	62500	.47d, e, .47f = 1.94				15142	32216	15142				
22	d g	62500	62500	.47d, e, f, .43g = 2.90				10129	21552	21552	9267			
23	d h	40250	40250	.47d, e, f, g, .40h = 3.87				4889	10400	10400	10400	4161		
24	d i	17000	17000	.47d, e, f, g, h, .36i = 4.83				1654	3519	3520	3520	3520	1267	
25	e d	10948 Impossible												10948
26	e e	25921 × .4	10368	e = 1					10368					15553
27	e f	40250	40250	.50e, .47f = .97					20747	19503				
28	e g	40250	40250	.50e, f, .43g = 1.93					10427	20855	8968			
29	e h	25921	25921	.50e, f, g, .40h = 2.90					4469	8938	8938	3576		
30	e i	10948	10948	.50e, f, g, h, .36i = 3.86					1418	2836	2836	2836	1022	
31	f d	4624 Impossible												4624
32	f e	10948 Impossible												10948
33	f f	17000 × .4	6800	f = 1.0						6800				10200
34	f g	17000	17000	.54f, .43g = .97						9463	7537			
35	f h	10948	10948	.54f, g, .40h = 1.94						3047	5644	2257		
36	f i	4624	4624	.54f, g, h, .36i = 2.90						861	1594	1594	575	
		917764	855291		4720	28867	90088	186627	234687	186627	90088	28867	4720	62473

Probability Factors Used:
Zones *a* and *f* short, and *d* and *i* long = .068.
Zones *b* and *e* short, and *e* and *h* long = .161.
Zones *c* and *d* short, and *f* and *g* long = .250.

In 10000 cases the target will be located as follows:

In zone *a*.... 55 times; or, in ½ of 1% of cases.
In zone *b*.... 338 times; or, in 3½% of cases.
In zone *c*....1053 times; or, in 10½% of cases.
In zone *d*....2182 times; or, in 21¾% of cases.
In zone *e*....2744 times; or, in 27½% of cases.
In zone *f*.....2182 times; or, in 21¾% of cases.
In zone *g*....1053 times; or, in 10½% of cases.
In zone *h*.... 338 times; or, in 3½% of cases.
In zone *i*..... 55 times; or, in ½ of 1% of cases.

10000

TABLE II.

Percentage of Zones Available for Location of Target in Adjustment by Piece.

Short Zone *a* and Long Zone *i*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	375	.9	338
2	420	.8	336
3	485	.7	340
4	545	.6	327
5	615	.5	308
6	685	.4	274
7	765	.3	230
8	850	.2	170
9	995	.1	100
10	1030	0	0
.....	6765	.....	2423

2423 ÷ 6765 = .3582

Short Zone *b* and Long Zone *h*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	1135	.9	1022
2	1235	.8	988
3	1340	.7	938
4	1450	.6	870
5	1560	.5	780
6	1665	.4	666
7	1780	.3	534
8	1885	.2	377
9	1990	.1	199
10	2095	0	0
.....	16135	.....	6374

6374 ÷ 16135 = .395

Short Zone *c* and Long Zone *g*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	2190	.9	1971
2	2285	.8	1828
3	2365	.7	1656
4	2445	.6	1467
5	2510	.5	1255
6	2570	.4	1028
7	2615	.3	784
8	2655	.2	530
9	2675	.1	268
10	2690	0	0
.....	25000	.....	10787

10787 ÷ 25000 = .4315

Short Zone *d* and Long Zone *f*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	2690	.9	2421
2	2675	.8	2140
3	2655	.7	1859
4	2615	.6	1569
5	2570	.5	1285
6	2510	.4	1004
7	2445	.3	733
8	2365	.2	473
9	2285	.1	228
10	2190	0	0
.....	25000	.....	11712

11712 ÷ 25000 = .4685

Short Zone *e* and Long Zone *e*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	2095	.9	1886
2	1990	.8	1592
3	1885	.7	1319
4	1780	.6	1068
5	1665	.5	833
6	1560	.4	624
7	1450	.3	435
8	1340	.2	268
9	1235	.1	123
10	1135	0	0
.....	16135	.....	8148

8148 ÷ 16135 = .505

Short Zone *f* and Long Zone *d*

Sub-zones	Probabilities	Part of Zone Available for Target	Products
1	1030	.9	927
2	995	.8	796
3	850	.7	595
4	765	.6	459
5	685	.5	343
6	615	.4	246
7	545	.3	163
8	485	.2	97
9	420	.1	42
10	375	0	0
.....	6765	.....	3668

3668 ÷ 6765 = .5422

Summary

Zones	Short Range	Long Range
a	35.8%	.....
b	39.5%	.....
c	43.2%	.....
d	46.8%	54.2%
e	50.5%	50.5%
f	54.2%	46.8%
g	.....	43.2%
h	.....	39.5%
i	.....	35.8%

TABLE III.
Percentage of Zones Available for Location of Target when 2 Short or 2 Long Range Shots Fall Within the Same Zone.

Short Range Zone *a* and Long Range Zone *i*				Short Range Zone *b* and Long Range Zone *h*			
Combinations	Probabilities	Part of Zone Available	Products	Combinations	Probabilities	Part of Zone Available	Products
a^2	140625	.9	126563	a^2	1288225	.9	1159403
2ab	315000	.8	252000	2ab	2803450	.8	2242760
2ac	363750	.7	254625	2ac	3041800	.7	2129260
2ad	408750	.6	245250	2ad	3291500	.6	1974900
2ae	461250	.5	230625	2ae	3541200	.5	1770600
2af	513750	.4	205500	2af	3779550	.4	1511820
2ag	573750	.3	172125	2ag	4040600	.3	1212180
2ah	637500	.2	127500	2ah	4278950	.2	855790
2ai	746250	.1	74625	2ai	4517300	.1	451730
2ak	772500	0	0	2ak	4755650	0	0
b^2	176400	.8	141120	b^2	1525225	.8	1220180
2bc	407400	.7	285180	2bc	3309800	.7	2316860
2bd	457800	.6	274680	2bd	3581500	.6	2148900
2be	516600	.5	258300	2be	3853200	.5	1926600
2bf	575400	.4	230160	2bf	4112550	.4	1645020
2bg	642600	.3	192780	2bg	4396600	.3	1318980
2bh	714000	.2	142800	2bh	4655950	.2	931190
2bi	835800	.1	83580	2bi	4915300	.1	491530
2bk	865200	0	0	2bk	5174650	0	0
c^2	235225	.7	164657	c^2	1795600	.7	1256920
2cd	528650	.6	317190	2cd	3886000	.6	2331600
2ce	596550	.5	298275	2ce	4180800	.5	2090400
2cf	664450	.4	265780	2cf	4462200	.4	1784880
2cg	742050	.3	222615	2cg	4770400	.3	1431120
2ch	824500	.2	164900	2ch	5051800	.2	1010360
2ci	965150	.1	96515	2ci	5333200	.1	533320
2ck	999100	0	0	2ck	5614600	0	0
d^2	297025	.6	178215	d^2	2102500	.6	1261500
2de	670350	.5	335175	2de	4524000	.5	2262000
2df	746650	.4	298660	2df	4828500	.4	1931400
2dg	833850	.3	250155	2dg	5162000	.3	1548600
2dh	926500	.2	195300	2dh	5466500	.2	1093300
2di	1084550	.1	108455	2di	5771000	.1	577100
2dk	1122700	0	0	2dk	6075500	0	0
e^2	378225	.5	189113	e^2	2433600	.5	1216800
2ef	842550	.4	337020	2ef	5194800	.4	2077920
2eg	940950	.3	282285	2eg	5553600	.3	1666080
2eh	1045500	.2	209100	2eh	5881200	.2	1176240
2ei	1223850	.1	122385	2ei	6208800	.1	620880
2ek	1266900	0	0	2ek	6536400	0	0
f^2	469225	.4	187690	f^2	2772225	.4	1108890
2fg	1048050	.3	314415	2fg	5927400	.3	1778220
2fh	1164500	.2	232900	2fh	6277050	.2	1289340
2fi	1363150	.1	136315	2fi	6626700	.1	662670
2fk	1411100	0	0	2fk	6976350	0	0
g^2	585225	.3	175567	g^2	3168400	.3	949520
2gh	1300500	.2	260100	2gh	6710600	.2	1342120
2gi	1522350	.1	152235	2gi	7084400	.1	708440
2gk	1575900	0	0	2gk	7458200	0	0
h^2	722500	.2	144500	h^2	3553225	.2	710645
2hi	1691500	.1	169150	2hi	7502300	.1	750230
2hk	1751000	0	0	2hk	7898150	0	0
i^2	990025	.1	99003	i^2	3960100	.1	396010
2ik	2049700	0	0	2ik	8338100	0	0
k^2	1060900	0	0	k^2	4389025	0	0
	45765225		9205083		260338225		60840278

$$\frac{9205083}{45765225} = .20114 = 20.1\%$$

$$\frac{60840278}{260338225} = .23376 = 23.4\%$$

TABLE III—Continued.
Percentage of Zones Available for Location of Target When 2 Short or 2 Long Range Shots Fall Within the Same Zone.

Short Range Zone *c* and Long Range Zone *g*				Short Range Zone *d* and Long Range Zone *f*			
Combinations	Probabilities	Part of Zone Available	Products	Combinations	Probabilities	Part of Zone Available	Products
a^2	4796100	.9	4316490	a^2	7236100	.9	6512490
2ab	10008300	.8	8006640	2ab	14391500	.8	11513200
2ac	10358700	.7	7251090	2ac	14283900	.7	9998730
2ad	10709100	.6	6425460	2ad	14068700	.6	8441220
2ae	10993800	.5	5496900	2ae	13826600	.5	6913300
2af	11256600	.4	4502640	2af	13503800	.4	5401520
2ag	11453700	.3	3436110	2ag	13154100	.3	3945230
2ah	11628900	.2	2325780	2ah	12723700	.2	2544740
2ai	11716500	.1	1171650	2ai	12293300	.1	1229330
2ak	11782200	0	0	2ak	11782200	0	0
b^2	5221225	.8	4176980	b^2	7155625	.8	5724500
2bc	10808050	.7	7565635	2bc	14204250	.7	9942975
2bd	11173650	.6	6704190	2bd	13990250	.6	8394150
2be	11470700	.5	5735350	2be	13749500	.5	6874250
2bf	11744900	.4	4697960	2bf	13428500	.4	5371400
2bg	11950550	.3	3585165	2bg	13080750	.3	3924225
2bh	12133350	.2	2426670	2bh	12652750	.2	2530550
2bi	12224750	.1	1222475	2bi	12224750	.1	1222475
2bk	12293300	0	0	2bk	11716500	0	0
c^2	5593225	.7	3915258	c^2	7049025	.7	4934318
2cd	11564850	.6	6938910	2cd	13885650	.6	8331390
2ce	11872300	.5	5936150	2ce	13646700	.5	6823350
2cf	12156100	.4	4862440	2cf	13328100	.4	5331240
2cg	12368950	.3	3710685	2cg	12982950	.3	3894885
2ch	12558150	.2	2511630	2ch	12558150	.2	2511630
2ci	12652750	.1	1265275	2ci	12133350	.1	1213335
2ck	12723700	0	0	2ck	11628900	0	0
d^2	5978025	.6	3586815	d^2	6838225	.6	4102935
2de	12273900	.5	6136950	2de	13441100	.5	6720550
2df	12567300	.4	5026920	2df	13127300	.4	5250920
2dg	12787350	.3	3836205	2dg	12787350	.3	3836205
2dh	12982950	.2	2596590	2dh	12368950	.2	2473790
2di	13080750	.1	1308075	2di	11950550	.1	1195055
2dk	13154100	0	0	2dk	11453700	0	0
e^2	6300100	.5	3150050	e^2	6604900	.5	3302450
2ef	12901400	.4	5160560	2ef	12901400	.4	5160560
2eg	13127300	.3	3938190	2eg	12567300	.3	3770190
2eh	13328100	.2	2665620	2eh	12156100	.2	2431220
2ei	13428500	.1	1342850	2ei	11744900	.1	1174490
2ek	13503800	0	0	2ek	11256600	0	0
f^2	6604900	.4	2641960	f^2	6300100	.4	2520040
2fg	13441100	.3	4032330	2fg	12273900	.3	3682170
2fh	13646700	.2	2729340	2fh	11872300	.2	2374460
2fi	13749500	.1	1374950	2fi	11470700	.1	1147070
2fk	13826600	0	0	2fk	10993800	0	0
g^2	6838225	.3	2051467	g^2	5978025	.3	1793407
2gh	13885650	.2	2777130	2gh	11564850	.2	2312970
2gi	13990250	.1	1399025	2gi	11173650	.1	1117365
2gk	14068700	0	0	2gk	10709100	0	0
h^2	7049025	.2	1409805	h^2	5593225	.2	1118645
2hi	14204250	.1	1420425	2hi	10808050	.1	1080805
2hk	14283900	0	0	2hk	10358700	0	0
i^2	7155625	.1	715563	i^2	5221225	.1	522123
2ik	14391500	0	0	2ik	10008300	0	0
k^2	7236100	0	0	k^2	4796100	0	0
	625000000		167488353		625000000		190611853
$\frac{167488353}{625000000} = .268 = 26.8\%$				$\frac{190611853}{625000000} = .305 = 30.5\%$			

TABLE III—Concluded.

Percentage of Zones Available for Location of Target when 2 Short or 2 Long Range Shots Fall within the Same Zone.

Short Range Zone e and Long Range Zone e				Short Range Zone f and Long Range Zone d			
Combinations	Probabilities	Part of Zone Available	Products	Combinations	Probabilities	Part of Zone Available	Products
a^2	4389025	.9	3950123	a^2	1060900	.9	954810
2ab	8338100	.8	6670480	2ab	2049700	.8	1639760
2ac	7898150	.7	5528705	2ac	1751000	.7	1225700
2ad	7458200	.6	4474920	2ad	1575900	.6	945540
2ae	6976350	.5	3488175	2ae	1411100	.5	705550
2af	6536400	.4	2614560	2af	1266900	.4	506760
2ag	6075500	.3	1822650	2ag	1122700	.3	336810
2ah	5614600	.2	1122920	2ah	999100	.2	199820
2ai	5174650	.1	517465	2ai	865200	.1	86520
2ak	4755650	0	0	2ak	772500	0	0
b^2	3960100	.8	3168080	b^2	990025	.8	792020
2bc	7502300	.7	5251610	2bc	1691500	.7	1184050
2bd	7084400	.6	4250640	2bd	1522350	.6	913410
2be	6626700	.5	3313350	2be	1363150	.5	681575
2bf	6208800	.4	2483520	2bf	1223850	.4	489540
2bg	5771000	.3	1731300	2bg	1084550	.3	325365
2bh	5333200	.2	1066640	2bh	965150	.2	193030
2bi	4915300	.1	491530	2bi	835800	.1	83580
2bk	4517300	0	0	2bk	746250	0	0
c^2	3553225	.7	2487257	c^2	722500	.7	505750
2cd	6710600	.6	4026360	2cd	1300500	.6	780300
2ce	6277050	.5	3138525	2ce	1164500	.5	582250
2cf	5881200	.4	2352480	2cf	1045500	.4	418200
2cg	5466500	.3	1639950	2cg	926500	.3	277950
2ch	5051800	.2	1010360	2ch	824500	.2	164900
2ci	4655950	.1	465595	2ci	714000	.1	71400
2ck	4278950	0	0	2ck	637500	0	0
d^2	3168400	.6	1901040	d^2	585225	.6	351135
2de	5927400	.5	2963700	2de	1048050	.5	524025
2df	5553600	.4	2221440	2df	940950	.4	376380
2dg	5162000	.3	1548600	2dg	833850	.3	250155
2dh	4770400	.2	954080	2dh	742050	.2	148410
2di	4396600	.1	439660	2di	642600	.1	64260
2dk	4040600	0	0	2dk	573750	0	0
e^2	2772225	.5	1386113	e^2	469225	.5	234613
2ef	5194800	.4	2077920	2ef	842550	.4	337020
2eg	4828500	.3	1448550	2eg	746650	.3	223995
2eh	4462200	.2	892440	2eh	664450	.2	132890
2ei	4112550	.1	411255	2ei	575400	.1	57540
2ek	3779550	0	0	2ek	513750	0	0
f^2	2433600	.4	973440	f^2	378225	.4	151290
2fg	4524000	.3	1357200	2fg	670350	.3	201105
2fh	4180800	.2	836160	2fh	596550	.2	119310
2fi	3853200	.1	385320	2fi	516600	.1	51660
2fk	3541200	0	0	2fk	461250	0	0
g^2	2102500	.3	630750	g^2	297025	.3	89107
2gh	3886000	.2	777200	2gh	528650	.2	105730
2gi	3581500	.1	358150	2gi	457800	.1	45780
2gk	3291500	0	0	2gk	408750	0	0
h^2	1795600	.2	359120	h^2	235225	.2	47045
2hi	3309800	.1	330980	2hi	407400	.1	40740
2hk	3041800	0	0	2hk	363750	0	0
i^2	1525225	.1	152522	i^2	176400	.1	17640
2ik	2803450	0	0	2ik	315000	0	0
k^2	1288225	0	0	k^2	140625	0	0
	260338225		89472835		45765225		17634420
$\frac{89472835}{260338225} = .3437 = 34.4\%$				$\frac{17634420}{45765225} = .3853 = 38.5\%$			

Summary

Zones	Short Range	Long Range	Zones	Short Range	Long Range
a	20.1%	.....	f	38.5%	30.5%
b	23.4%	.....	g	.....	26.8%
c	26.8%	.....	h	.....	23.4%
d	30.5%	38.5%	i	.....	20.1%
e	34.4%	34.4%			

TABLE IV.
Percentage of Possible Shots when Ranging by Platoon.

Zone d: 2 Short and 1 Long Range Shots

Combination	Probabilities	Possible Cases
a^2 b'	$53^2 \times 11$	30899
a^2 c'	$53^2 \times 13$	36517
a^2 d'	$53^2 \times 16$	44944
a^2 e'	$53^2 \times 20$	56180
2ab c'	$2 \times 53 \times 53 \times 13$	73034
2ab d'	$2 \times 53 \times 53 \times 16$	89888
2ab e'	$2 \times 53 \times 53 \times 20$	112360
2ac d'	$2 \times 53 \times 51 \times 16$	86496
2ac e'	$2 \times 53 \times 51 \times 20$	198120
2ad e'	$2 \times 53 \times 48 \times 20$	101760
b^2 c'	$53^2 \times 13$	36517
b^2 d'	$53^2 \times 16$	44944
b^2 e'	$53^2 \times 20$	56180
2bc d'	$2 \times 53 \times 51 \times 16$	86496
2bc e'	$2 \times 53 \times 51 \times 20$	108120
2bd e'	$2 \times 53 \times 48 \times 20$	101760
c^2 d'	$51^2 \times 16$	41616
c^2 e'	$51^2 \times 20$	52020
2cd e'	$2 \times 51 \times 48 \times 20$	97920
d^2 e'	$45^2 \times 20$	36080
		1411851

Total probability $= 250^2 \times 68 = 4250000$

$\therefore$ Percentage of possible cases $= \frac{1411851}{4250000} = .3322$

$\therefore$ Percentage $= 33.2$; say $\frac{1}{3}$

Zone d: 1 Short and 2 Long Range Shots

Combinations	Probabilities	Possible Cases
b'^2 a	$11^2 \times 53$	6413
2b'c' a	$2 \times 11 \times 13 \times 53$	15158
2b'd' a	$2 \times 11 \times 16 \times 53$	18656
2b'e' a	$2 \times 11 \times 20 \times 53$	23320
c'^2 a	$13^2 \times 53$	8957
c'^2 b	$13^2 \times 53$	8957
2c'd' a	$2 \times 13 \times 16 \times 53$	22048
2c'd' b	$2 \times 13 \times 16 \times 53$	22048
2c'e' a	$2 \times 13 \times 20 \times 53$	27560
2c'e' b	$2 \times 13 \times 20 \times 53$	27560
d'^2 a	$16^2 \times 53$	13568
d'^2 b	$16^2 \times 53$	13568
d'^2 c	$16^2 \times 51$	13056
2d'e' a	$2 \times 16 \times 20 \times 53$	33920
2d'e' b	$2 \times 16 \times 20 \times 53$	33920
2d'e' c	$2 \times 16 \times 20 \times 51$	32640
e'^2 a	$20^2 \times 53$	21200
e'^2 b	$20^2 \times 53$	21200
e'^2 c	$20^2 \times 51$	20400
e'^2 d	$20^2 \times 48$	19200
		403349

Total probability $= 68^2 \times 250 = 1156000$

$\therefore$ Percentage of possible cases $= \frac{403349}{1156000} = 34.9\%$

Zone d
Probabilities Used:

Short Range Shots	Long Range Shots
$a = 53$	$a' = 8$
$b = 53$	$b' = 11$
$c = 51$	$c' = 13$
$d = 48$	$d' = 16$
$e = 45$	$e' = 20$
250	68

Zone d: 2 Short and 2 Long Range Shots

Combinations	Probabilities	Possible Cases
a^2 b'^2	$53^2 \times 11^2$	339889
a^2 2b'c'	$2 \times 53^2 \times 11 \times 13$	803374
a^2 2b'd'	$2 \times 53^2 \times 11 \times 16$	988768
a^2 2b'e'	$2 \times 53^2 \times 11 \times 20$	1235960
a^2 c'^2	$53^2 \times 13^2$	474721
a^2 2c'd'	$2 \times 53^2 \times 13 \times 16$	1168544
a^2 2c'e'	$2 \times 53^2 \times 13 \times 20$	1460680
a^2 d'^2	$53^2 \times 16^2$	719104
a^2 2d'e'	$2 \times 53^2 \times 13 \times 16$	1797760
a^2 e'^2	$53^2 \times 20^2$	1123600
2ab c'^2	$2 \times 53 \times 53 \times 13^2$	949442
2ab 2c'd'	$4 \times 53 \times 53 \times 13 \times 16$	2337088
2ab 2c'e'	$4 \times 53 \times 53 \times 13 \times 20$	2921360
2ab d'^2	$2 \times 53 \times 53 \times 16^2$	1438208
2ab 2d'e'	$2 \times 53 \times 53 \times 16 \times 20$	3595520
2ab e'^2	$2 \times 53 \times 53 \times 20^2$	2247200
2ac d'^2	$2 \times 53 \times 51 \times 16^2$	1383936
2ac 2d'e'	$4 \times 53 \times 51 \times 16 \times 20$	3459940
2ac e'^2	$2 \times 53 \times 51 \times 20^2$	2162400
2ad e'^2	$2 \times 53 \times 48 \times 20^2$	2035200
b^2 c'^2	$53^2 \times 13^2$	474721
b^2 2c'd'	$2 \times 53^2 \times 13 \times 16$	1168544
b^2 2c'e'	$2 \times 53^2 \times 13 \times 20$	1460680
b^2 d'^2	$53^2 \times 16^2$	719104
b^2 2d'e'	$2 \times 53^2 \times 16 \times 20$	1797760
b^2 e'^2	$53^2 \times 20^2$	1123600
2bc d'^2	$2 \times 53 \times 51 \times 16^2$	1383936
2bc 2d'e'	$4 \times 53 \times 51 \times 16 \times 20$	3459840
2bc e'^2	$2 \times 53 \times 51 \times 16 \times 20^2$	2162400
2bd e'^2	$2 \times 53 \times 48 \times 20^2$	2035200
c^2 d'^2	$51^2 \times 16^2$	665856
c^2 2d'e'	$2 \times 51^2 \times 16 \times 20$	1664640
c^2 e'^2	$51^2 \times 20^2$	1040400
2cd e'^2	$2 \times 51 \times 48 \times 20^2$	1958400
d^2 e'^2	$48^2 \times 20^2$	921600
		52679275

Total probability $= 250^2 \times 68^2 = 289000000$

$\therefore \frac{52679275}{289000000} = 18.23\%$ of shots are possible in zone d when 2 short and 2 long shots fall in that zone.

TABLE IV—Continued.
Percentage of Possible Shots when Ranging by Platoon.

Zone *e*: 2 Short and 1 Long Range Shot

Combinations	Probabilities	Possible Cases
a^2 b'	$41^2 \times 28$	47068
a^2 c'	$41^2 \times 32$	53792
a^2 d'	$41^2 \times 36$	60516
a^2 e'	$41^2 \times 41$	68921
2ab c'	$2 \times 21 \times 36 \times 32$	94464
2ab d'	$2 \times 21 \times 36 \times 36$	106272
2ab e'	$2 \times 21 \times 36 \times 41$	121032
2ac d'	$2 \times 21 \times 32 \times 36$	94464
2ac e'	$2 \times 21 \times 32 \times 41$	107584
2ad e'	$2 \times 21 \times 28 \times 41$	94136
b^2 c'	$36^2 \times 32$	41472
b^2 d'	$36^2 \times 36$	46656
b^2 e'	$36^2 \times 41$	53136
2bc d'	$2 \times 36 \times 32 \times 36$	82944
2bc e'	$2 \times 36 \times 32 \times 41$	94464
2bd e'	$2 \times 36 \times 28 \times 41$	82656
c^2 d'	$32^2 \times 36$	36864
c^2 e'	$32^2 \times 41$	41984
2cd e'	$2 \times 32 \times 28 \times 41$	73472
d^2 e'	$28^2 \times 41$	32144
	Possible cases	1434041

Total cases $= 161^2 \times 161 = 4173281$

$\therefore \frac{1434041}{4173281} = 34.4\%$ of cases are possible.

Zone *e*: The case of 1 short and 2 long range shots is just the same as that of 2 short and 1 long range shots. Therefore there will be 34.4% of possible shots when 1 short and 2 long or 2 short and 1 long range shots fall within zone *e*.

Probabilities Used: Zone *e*

Subzones	Short Range Shots	Long Range Shots
a	41	24
b	36	28
c	32	32
d	28	36
e	24	41
	161	161

Zone *e*: 2 Short and 2 Long Shots Fall Within the Zone

Combinations	Probabilities	Possible Cases
a^2 b'^2	$41^2 \times 28^2$	1317904
a^2 2b'c'	$2 \times 41^2 \times 28 \times 32$	3012352
a^2 2b'd'	$2 \times 41^2 \times 28 \times 36$	3388896
a^2 2b'e'	$2 \times 41^2 \times 28 \times 41$	3859576
a^2 c'^2	$41^2 \times 32^2$	1721344
a^2 2c'd'	$2 \times 41^2 \times 32 \times 36$	3873024
a^2 2c'e'	$2 \times 41^2 \times 32 \times 41$	4410944
a^2 d'^2	$41^2 \times 36^2$	2178576
a^2 2d'e'	$2 \times 41^2 \times 36 \times 41$	4962312
a^2 e'^2	$41^2 \times 41^2$	2825761
2ab c'^2	$2 \times 41 \times 36 \times 32^2$	3022848
2ab 2c'd'	$4 \times 41 \times 36 \times 32 \times 36$	6801408
2ab 2c'e'	$4 \times 41 \times 36 \times 32 \times 41$	7746048
2ab d'^2	$2 \times 41 \times 36 \times 36^2$	3825792
2ab 2d'e'	$4 \times 41 \times 36 \times 36 \times 41$	8714304
2ab e'^2	$2 \times 41 \times 36 \times 41^2$	4962312
2ac d'^2	$2 \times 41 \times 32 \times 36^2$	3400704
2ac 2d'e'	$2 \times 41 \times 32 \times 36 \times 41$	3746048
2ac e'^2	$2 \times 41 \times 32 \times 41^2$	4410944
2ad e'^2	$2 \times 41 \times 28 \times 41^2$	3859576
b^2 c'^2	$36^2 \times 32^2$	1327104
b^2 2c'd'	$2 \times 36^2 \times 32 \times 36$	2985984
b^2 2c'e'	$2 \times 36^2 \times 32 \times 41$	3400704
b^2 d'^2	$36^2 \times 36^2$	1679616
b^2 2d'e'	$2 \times 36^2 \times 36 \times 41$	3825792
b^2 e'^2	$36^2 \times 41^2$	2178576
2bc d'^2	$2 \times 36 \times 32 \times 36^2$	2985984
2bc 2d'e'	$4 \times 36 \times 32 \times 36 \times 41$	6801408
2bc e'^2	$2 \times 36 \times 32 \times 41^2$	3873024
2bd e'^2	$2 \times 36 \times 28 \times 41^2$	3388896
c^2 d'^2	$32^2 \times 36^2$	1327104
c^2 2d'e'	$2 \times 32^2 \times 36 \times 41$	3022848
c^2 e'^2	$32^2 \times 41^2$	1721344
2cd e'^2	$2 \times 32 \times 28 \times 41^2$	3012352
d^2 e'^2	$28^2 \times 41^2$	1317904
	Possible cases	124889313

Total cases $= 161^2 \times 161^2 = 671898241$

$\therefore \frac{124889313}{671898241} = 18.6\%$ of the combinations of shots in zone *e* are possible when 2 short and 2 long range shots fall within the zone.

TABLE V.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
a^2 d'^2	2138	2138	.20a, b, c, .39d = 2.59	2138	165	825	825	323						
a^2 2d'e'	10124	10124	.20a, b, c, .54d = 2.74											
a^2 2d'f'	15722	15722	.20a, b, c, .54d = 2.74											
a^2 2d'g'	15722	15722	.20a, b, c, .54d = 2.74	55968	4085	20426	20426	11031						
a^2 2d'h'	10124	10124	.20a, b, c, .54d = 2.74											
a^2 2d'i	4276	4276	.20a, b, c, .54d = 2.74											
a^2 e'^2	11986	11986	.20a, b, c, d, .34e = 3.54	11986	677	3386	3386	3386	1151					
a^2 2e'f'	36992	36992	.20a, b, c, d, .50e = 3.70											
a^2 2e'g'	36992	36992	.20a, b, c, d, .50e = 3.70	108080	5842	29211	29211	29211	14605					
a^2 2e'h	23972	23972	.20a, b, c, d, .50e = 3.70											
a^2 2e'i	10124	10124	.20a, b, c, d, .50e = 3.70											
a^2 f'^2	28900	28900	.20a, b, c, d, e, .30f = 4.50	28900	1284	6422	6422	6422	6423	1927				
a^2 2f'g	57800	57800	.20a, b, c, d, e, .47f = 4.67											
a^2 2f'h	36992	36992	.20a, b, c, d, e, .47f = 4.67	110514	4733	23664	23664	23664	23666	11123				
a^2 2f'i	15722	15722	.20a, b, c, d, e, .47f = 4.67											
a^2 g^2	28900	28900	.20a, b, c, d, e, f, .27g = 5.47	28900	1057	5283	5283	5283	5284	5283	1427			
a^2 2gh	36992	36992	.20a, b, c, d, e, f, .43g = 5.63	52714	1873	9363	9363	9363	9363	9363	4026			
a^2 2gi	15722	15722	.20a, b, c, d, e, f, .43g = 5.63											
a^2 h^2	11986	11986	.20a, b, c, d, e, f, g, .23h = 6.43	11986	373	1864	1864	1864	1864	1864	1864	429		
a^2 2hi	10124	10124	.20a, b, c, d, e, f, g, .40h = 6.60	10124	307	1534	1534	1534	1534	1534	1534	614		
a^2 i^2	2138	2138	.20a, b, c, d, e, f, g, h, 20i = 7.40	2138	58	289	289	289	288	289	289	289	58	
2ab d^2	10124	10124	.40b, c, .39d = 1.79	10124		2262	5656	2206						
2ab 2d'e'	47944	47944	.40b, c, .54d = 1.94											
2ab 2d'f'	73984	73984	.40b, c, .54d = 1.94											
2ab 2d'g	73984	73984	.40b, c, .54d = 1.94	264104		54454	136136	73514						
2ab 2d'h	47944	47944	.40b, c, .54d = 1.94											
2ab 2d'i	20248	20248	.40b, c, .54d = 1.94											
2ab e'^2	56756	56756	.40b, c, d, .34e = 2.74	56756		8285	20714	20714	7043					
2ab 2e'f'	176264	176264	.40b, c, d, .50e = 2.90											
2ab 2e'g	176264	176264	.40b, c, d, .50e = 2.90											

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2ab 2e′h	113512	113512	.40b, c, d, .50e = 2.90	513984	.....	70894	177236	177236	88618	.....	.....	.....	.....	.....
2ab 2e′i	47944	47944	.40b, c, d, .50e = 2.90		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ab f′²	136850	136850	.40b, c, d, e, .30f = 3.70	136850	.....	14795	36986	36986	36987	11096	.....	.....	.....	.....
2ab 2f′g	273700	273700	.40b, c, d, e, .47f = 3.87		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ab 2f′h	176264	176264	.40b, c, d, e, .47f = 3.87	523948	.....	54155	135387	135387	135387	63632	.....	.....	.....	.....
2ab 2f′i	73984	73984	.40b, c, d, e, .47f = 3.87		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ab g²	136850	136850	.40b, c, d, e, f, .27g = 4.67	136850	.....	11722	29304	29304	29304	29304	7912	.....	.....	.....
2ab 2gh	176264	176264	.40b, c, d, e, f, .43g = 4.83	250248	.....	20725	51811	51811	51811	51811	22279	.....	.....	.....
2ab 2gi	73984	73984	.40b, c, d, e, f, .43g = 4.83		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ab h²	56756	56756	.40b, c, d, e, f, g, .23h = 5.63	56756	.....	4032	10081	10081	10082	10081	10081	2318	.....	.....
2ab 2hi	*47944*	*47944*	*.40b, c, d, e, f, g, .40h = 5.80*	*47944*	.....	*3307*	*8266*	*8266*	*8266*	*8266*	*8266*	*3307*	.....	.....
2ab i²	10124	10124	.40b, c, d, e, f, g, h, .20i = 6.60	10124	.....	614	1534	1534	1533	1534	1534	1534	307	.....
2ac d′²	15722	15722	.43c, .39d = .82	15722	.....	.....	8244	7478	.....	.....	.....	.....	.....	.....
2ac 2d′e′	73984	73984	.43c, .54d = .97		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2d′f′	115600	115600	.43c, .54d = .97		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2d′g′	115600	115600	.43c, .54d = .97	410612	.....	.....	182024	228588	.....	.....	.....	.....	.....	.....
2ac 2dh	73984	73984	.43c, .54d = .97		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2di	31444	31444	.43c, .54d = .97		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac e²	88132	88132	.43c, d, .34e′ = 1.77	88132	.....	.....	21411	49792	16929	.....	.....	.....	.....	.....
2ac 2e′f′	273700	273700	.43c, d, .50e′ = 1.93		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2e′g	273700	273700	.43c, d, .50e′ = 1.93	797648	.....	.....	177714	413289	206645	.....	.....	.....	.....	.....
2ac 2e′h	176264	176264	.43c, d, .50e′ = 1.93		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2e′i	73984	73984	.43c, d, .50e′ = 1.93		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac f′²	212500	212500	.43c, d, e, .30f = 2.73	212500	.....	.....	33471	77839	77839	23351	.....	.....	.....	.....
2ac 2f′g	425000	425000	.43c, d, e, .47f = 2.90		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac 2f′h	273700	273700	.43c, d, e, .47f = 2.90	814300	.....	.....	120741	280793	280793	131973	.....	.....	.....	.....
2ac 2f′i	115600	115600	.43c, d, e, .47f = 2.90		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ac g²	212500	212500	.43c, d, e, f, .27g = 3.70	212500	.....	.....	24696	57432	57433	57432	15507	.....	.....	.....
2ac 2gh	273700	273700	.43c, d, e, f, .43g = 3.86	389300	.....	.....	43368	100855	100854	100855	43368	.....	.....	.....
2ac 2gi	115600	115600	.43c, d, e, f, .43g = 3.86		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2ac h^2	88132	88132	.43c, d, e, f, g, .23h = 4.66 . .	88132	.....	.....	8133	18912	18913	18912	18912	4350	.....	.....
2ac 2hi	73984	73984	.43c, d, e, f, g, .40h = 4.83.....	73984	.....	.....	6586	15318	15317	15318	15318	6127	.....	.....
2ac i^2	15722	15722	.43c, d, e, f, g, h, .20i = 5.63..	15722	.....	.....	1200	2793	2792	2793	2793	2793	558	.....
2ad d'^2	15722 × ⅓ = 5241		d = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2d'e'	73984 × .4 = 29594		d = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2d'f'	115600 × .4 = 46240		d = 1.....	169486	.....	.....	.....	169486	.....	.....	.....	.....	.....	256848
2ad 2d'g	115600 × .4 = 46240		d = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2d'h	73984 × .4 = 29594		d = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2d'i	31444 × .4 = 12577		d = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad e'^2	88132	88132	.47d, 34e = .81.....	88132	.....	.....	.....	36994	51138	.....	.....	.....	.....	.....
2ad 2e'f'	273700	273700	.47d, .50e = .97.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2e'g	273700	273700	.47d, .50e = .97.....	797648	.....	.....	.....	386489	411159	.....	.....	.....	.....	.....
2ad 2e'h	176264	176264	.47d, .50e = .97.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2e'i	73984	73984	.47d, .50e = .97.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad f'^2	212500	212500	.47d, e, .30f = 1.77.....	212500	.....	.....	.....	56426	120057	36017	.....	.....	.....	.....
2ad 2f'g	425000	425000	.47d, e, .47f = 1.94.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad 2f'h	273700	273700	.47d, e, .47f = 1.94.....	814300	.....	.....	.....	197279	419742	197279	.....	.....	.....	.....
2ad 2f'i	115600	115600	.47d, e, .47f = 1.94.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad g^2	212500	212500	.47d, e, f, .27g = 2.74.....	212500	.....	.....	.....	36451	77554	77555	20940	.....	.....	.....
2ad 2gh	273700	273700	.47d, e, f, .43g = 2.90.....	389300	.....	.....	.....	63093	134242	134241	57724	.....	.....	.....
2ad 2gi	115600	115600	.47d, e, f, .43g = 2.90.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ad h^2	88132	88132	47d, e, f, g, .23h = 3.70.....	88132	.....	.....	.....	11195	23819	23820	23820	5478	.....	.....
2ad 2hi	73984	73984	.47d, e, f, g, .40h = 3.87.....	73984	.....	.....	.....	8985	19118	19117	19117	7647	.....	.....
2ad i^2	15722	15722	.47d, e, f, g, h, .20i = 4.67....	15722	.....	.....	.....	1582	3366	3367	3367	3367	673	.....
2ae e'^2	56756 × ⅓ = 18919		e = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ae 2e'f'	176264 × .4 = 70506		e = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ae 2e'g	176264 × .4 = 70506		e = 1.....	224514	.....	.....	.....	.....	224514	.....	.....	.....	.....	346226
2ae 2e'h	113512 × .4 = 45405		e = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ae 2e'i	47944 × .4 = 19178		e = 1.....		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2ae f'^2	136850	136850	.50e, .30f = .8.....	136850	.....	.....	.....	.....	85531	51319	.....	.....	.....	.....

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2ae 2f'g	273700	273700	.50e, .47f = .97											
2ae 2f'h	176264	176264	.50e, .47f = .97	523948					270076	253872				
2ae 2f'i	73984	73984	.50e, .47f = .97											
2ae g^2	136850	136850	.50e, f, .27g = 1.77	136850					38658	77316	20876			
2ae 2gh	176264	176264	.50e, f, .43g = 1.93	250248					64831	129662	55755			
2ae 2gi	73984	73984	.50e, f, .43g = 1.93											
2ae h^2	56756	56756	.50e, f, g, .23h = 2.73	56756					10395	20790	20790	4781		
2ae 2hi	47944	47944	.50e, f, g, .40h = 2.90	47944					*8267*	*16532*	*16532*	*6613*		
2ae i^2	10124	10124	.50e, f, g, h, .20i = 3.70	10124					1369	2736	2736	2736	547	
2af f'^2	57800 × ⅓ = 19267		f = 1											
2af 2f'g	115600 × .4 = 46240		f = 1	107679						107679				171149
2af 2f'h	73984 × .4 = 29594		f = 1											
2af 2f'i	31444 × .4 = 12578		f = 1											
2af g^2	57800	57800	.54f, .27g = .81	57800						38533	19267			
2af 2gh	73984	73984	.54f, .43g = .97	105428						58692	46736			
2af 2gi	31444	31444	.54f, .43g = .97											
2af h^2	23972	23972	.54f, g, .23h = 1.77	23972						7314	13543	3115		
2af 2hi	20248	20248	.54f, g, .40h = 1.94	20248						5636	10437	4175		
2af i^2	4276	4276	.54f, g, h, .20i = 2.74	4276						842	1561	1561	312	
b^2 d'^2	11986	11986	.20b, c, .39d = 1.62	11986		1701	7399	2886						
b^2 2d'e'	56756	56756	.23b, c, .54d = 1.77											
b^2 2d'f'	88132	88132	.23b, c, .54d = 1.77	313748		40769	177259	95720						
b^2 2d'g	88132	88132	.23b, c, .54d = 1.77											
b^2 2d'h	56756	56756	.23b, c, .54d = 1.77											
b^2 2d'i	23972	23972	.23b, c, .54d = 1.77											
b^2 e'^2	67190	67190	.23b, c, d, .34e = 2.57	67190		6013	26144	26144	8889					
b^2 2e'f'	208664	208664	.23b, c, d, .50e = 2.73											
b^2 2e'g	208664	208664	.23b, c, d, .50e = 2.73	608464		51262	222881	222881	111440					
b^2 2e'h	134380	134380	.23b, c, d, .50e = 2.73											
b^2 2e'i	56756	56756	.23b, c, d, .50e = 2.73											

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
b^2 f'^2	162006	162006	.23b, c, d, e, .30f = 3.53	162006	.....	10556	45894	45894	45894	13768	.....	.....	.....	.....
b^2 2f'g	324012	324012	.23b, c, d, e, .47f = 3.70		.....						.....	.....	.....	.....
b^2 2f'h	208664	208664	.23b, c, d, e, .47f = 3.70	620808	.....	38591	167786	167786	167786	78859	.....	.....	.....	.....
b^2 2f'i	88132	88132	.23b, c, d, e, .47f = 3.70		.....						.....	.....	.....	.....
b^2 g^2	162006	162006	.23b, c, d, e, f, .27g = 4.50	162006	.....	8281	36001	36001	36001	36001	9721	.....	.....	.....
b^2 2gh	208664	208664	.23b, c, d, e, f, .43g = 4.66	296796	.....	14649	63690	63690	63690	63690	27387	.....	.....	.....
b^2 2gi	88132	88132	.23b, c, d, e, f, .43g = 4.66		.....							.....	.....	.....
b^2 h^2	67190	67190	.23b, c, d, e, f, g, .23h = 5.46	67190	.....	2830	12306	12306	12306	12306	12306	2830	.....	.....
b^2 2hi	56756	56756	.23b, c, d, e, f, g, .40h = 5.63	56756	.....	2319	10081	10081	10081	10081	10081	4032	.....	.....
b^2 i^2	*11986*	*11986*	*.23b, c, d, e, f, g, h, .20i = 6.43*	11986	.....	429	1864	1864	1864	1864	1864	1864	373	.....
2bc d'^2	36992	36992	.43c, .39d = .82	36992	.....	.....	19398	17594	.....	.....	.....	.....	.....	.....
2bc 2d'e'	176264	176264	.43c, .54d = .97		.....	.....			.....	.....	.....	.....	.....	.....
2bc 2d'f'	273700	273700	.43c, .54d = .97		.....	.....			.....	.....	.....	.....	.....	.....
2bc 2d'g	273700	273700	.43c, .54d = .97	973912	.....	.....	431734	542178	.....	.....	.....	.....	.....	.....
2bc 2d'h	176264	176264	.43c, .54d = .97		.....	.....			.....	.....	.....	.....	.....	.....
2bc 2d'i	73984	73984	.43c, .54d = .97		.....	.....			.....	.....	.....	.....	.....	.....
2bc e'^2	208664	208664	.43c, d, .34e = 1.77	208664	.....	.....	50693	117889	40082	.....	.....	.....	.....	.....
2bc 2e'f'	648024	648024	.43c, d, .50e = 1.93		.....	.....				.....	.....	.....	.....	.....
2bc 2e'g	648024	648024	.43c, d, .50e = 1.93	1889640	.....	.....	421008	979088	489544	.....	.....	.....	.....	.....
2bc 2e'h	417328	417328	.43c, d, .50e = 1.93		.....	.....				.....	.....	.....	.....	.....
2bc 2e'i	176264	176264	.43c, d, .50e = 1.93		.....	.....				.....	.....	.....	.....	.....
2bc f'^2	503126	503126	.43c, d, e, .30f = 2.73	503126	.....	.....	79247	184295	184295	55289	.....	.....	.....	.....
2bc 2f'g	1006252	1006252	.43c, d, e, .47f = 2.90		.....	.....					.....	.....	.....	.....
2bc 2f'h	648024	648024	.43c, d, e, .47f = 2.90	1927976	.....	.....	285872	664819	664820	312465	.....	.....	.....	.....
2bc 2f'i	273700	273700	.43c, d, e, .47f = 2.90		.....	.....					.....	.....	.....	.....
2bc g^2	*503126*	*503126*	*.43c, d, e, f, .27g = 3.70*	503126	.....	.....	58471	135980	135980	135980	36715	.....	.....	.....
2bc 2gh	648024	648024	.43c, d, e, f, .43g = 3.86	921724	.....	.....	102679	*238789*	*238788*	*238789*	*102679*	.....	.....	.....
2bc 2gi	273700	273700	.43c, d, e, f, .43g = 3.86		.....	.....						.....	.....	.....
2bc h^2	208664	208664	.43c, d, e f, g, .23h = 4.66	208664	.....	.....	19254	44778	44777	44778	44778	10299	.....	.....
2bc 2hi	176264	176264	.43c, d, e, f, g, .40h = 4.83	176264	.....	.....	15692	36494	36493	36494	36494	14597	.....	.....

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2bc i^2	36992	36992	.43c, d, e, f, g, h, .20i = 5.63...	36992	.....	.....	2825	6571	6571	6571	6570	6570	1314	.....
2bd d'^2	36992 × ½ = 12331		d = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2d'e'	176264 × .4 = 70506		d = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2d'f'	273700 × .4 = 109480		d = 1.....	401897	.....	.....	.....	401897	.....	.....	.....	.....	.....	609007
2bd 2d'g	273700 × .4 = 109480		d = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2d'h	176264 × .4 = 70506		d = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2d'i	*73984 × .4 = 29594*		d = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd e'^2	208664	208664	.47d, .34e = .81.....	208664	.....	.....	.....	121077	87587	.....	.....	.....	.....	.....
2bd 2e'f'	648024	648024	.47d, .50e = .97.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2e'g	648024	648024	.47d, .50e = .97.....	1889640	.....	.....	.....	915599	974041	.....	.....	.....	.....	.....
2bd 2e'h	417328	417328	.47d, .50e = .97.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2e'i	176264	176264	.47d, .50e = .97.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd f'^2	503126	503126	.47d, e, .30f = 1.77.....	503126	.....	.....	.....	133598	284252	85276	.....	.....	.....	.....
2bd 2f'g	1006252	1006252	.47d, e, .47f = 1.94.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd 2f'h	648024	648024	.47d, e, .47f = 1.94.....	1927976	.....	.....	.....	467087	993802	467087	.....	.....	.....	.....
2bd 2f'i	273700	273700	.47d, e, .47f = 1.94.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd g^2	503126	503126	.47d, e, f, .27g = 2.74.....	503126	.....	.....	.....	86302	183623	183623	49578	.....	.....	.....
2bd 2gh	648024	648024	.47d, e, f, .43g = 2.90.....	921724	.....	.....	.....	149383	317836	317836	136669	.....	.....	.....
2bd 2gi	273700	273700	.47d, e, f, .43g = 2.90.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2bd h^2	208664	208664	.47d, e, f, g, .23h = 3.70.....	208664	.....	.....	.....	26506	56395	56396	56396	12971	.....	.....
2bd 2hi	176264	176264	.47d, e, f, g, .40h = 3.87.....	176264	.....	.....	.....	*21407*	*45546*	*45546*	*45546*	*18219*	.....	.....
2bd i^2	*36992*	*36992*	.47d, e, f, g, h, .20i = 4.67.....	36992	.....	.....	.....	3723	7922	7921	7921	7921	1584	.....
2be e'^2	134380 × ⅓ = 44793		e = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2be 2e'f'	417328 × .4 = 166931		e = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2be 2e'g	417328 × .4 = 166931		e = 1.....	531564	.....	.....	.....	.....	531564	.....	.....	.....	.....	819744
2be 2e'h	268760 × .4 = 107504		e = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2be 2e'i	113512 × .4 = 45405		e = 1.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2be f'^2	324012	324012	.50e, .30f = .80.....	324012	.....	.....	.....	.....	202508	121504	.....	.....	.....	.....
2be 2f'g	648024	648024	.50e, .47f = .97.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2be 2f'h	417328	417328	.50e, .47f = .97.....	1241616	.....	.....	.....	.....	640008	601608	.....	.....	.....	.....

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2be 2f'i	176264	176264	.50e, .47f = .97											
2be g²	324012	324012	.50e, f, .27g = 1.77	324012					*91529*	*183058*	*49425*			
2be 2gh	417328	417328	.50e, f, .43g = 1.93	593592					153780	307561	132251			
2be 2gi	176264	176264	.50e, f, .43g = 1.93											
2be h²	134380	134380	.50e, f, g, .23h = 2.73	134380					24612	49224	49223	11321		
2be 2hi	113512	113512	.50e, f, g, .40h = 2.90	113512					19571	39142	39142	15657		
2be i²	23972	23972	.50e, f, g, h, .20i = 3.70	23972					3239	6479	6479	6479	1296	
2bf f'²	136850 × ⅓ = 45617		f = 1											
2bf 2f'g	273700 × .4 = 109480		f = 1	255197						255197				405601
2bf 2f'h	176264 × .4 = 70506		f = 1											
2bf 2f'i	73984 × .4 = 29594		f = 1											
2bf g²	136850	136850	.54f, .27g = .81	136850						91234	45616			
2bf 2gh	176264	176264	.54f, .43g = .97	250248						139313	110935			
2bf 2gi	73984	73984	.54f, .43g = .97											
2bf h²	56756	56756	.54f, g, .23h = 1.77	56756						17315	32066	7375		
2bf 2hi	47944	47944	.54f, g, .40h = 1.94	47944						13345	24714	9885		
2bf i²	10124	10124	.54f, g, h, .20i = 2.74	10124						*1995*	*3695*	*3695*	*739*	
c² d'²	28900	28900	.27c, .39d = .66	28900			11823	17077						
c² 2d'e'	136850	136850	.27c, .54d = .81											
c² 2d'f'	212500	212500	.27c, .54d = .81											
c² 2d'g	212500	212500	.27c, .54d = .81	756500			252167	504333						
c² 2d'h	136850	136850	.27c, .54d = .81											
c² 2d'i	57800	57800	.27c, .54d = .81											
c² e'²	162006	162006	.27c, d, .34e = 1.61	162006			27169	100625	34212					
c² 2e'f'	503126	503126	.27c, d, .50e = 1.77											
c² 2e'g	503126	503126	.27c, d, .50e = 1.77	1467114			223797	828878	414439					
c² 2e'h	324012	324012	.27c, d, .50e = 1.77											
c² 2e'i	136850	136850	.27c, d, .50e = 1.77											
c² f'²	390625	390625	.27c, d, e, .30f = 2.57	390625			41039	151994	151994	45598				
c² 2f'g	781250	781250	.27c, d, e, .47f = 2.74											

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
c^2 2f'h	503126	503126	.27c, d, e, .47f = 2.74	1496876			147502	546305	546305	256764				
c^2 2i'i	212500	212500	.27c, d, e, .47f = 2.74											
c^2 g^2	390625	390625	.27c, d, e, f, .27g = 3.54	390625			29793	110346	110347	110346	29793			
c^2 2gh	503126	503126	.27c, d, e, f, .43g = 3.70	715626			52222	193412	193412	193412	83168			
c^2 2gi	212500	212500	.27c, d, e, f, .43g = 3.70											
c^2 h^2	162006	162006	.27c, d, e, f, g, .23h = 4.50	162006			9721	36001	36001	36001	36001	8281		
c^2 2hi	136850	136850	.27c, d, e, f, g, .40h = 4.67	136850			7912	29304	29304	29304	29304	11722		
c^2 i^2	28900	28900	.27c, d, e, f, g, h, .20i = 5.47	28900			1427	5283	5284	5283	5283	5283	1057	
2cd d'^2	57800 × ⅓ = 19267		d = 1											
2cd 2d'e'	273700 × .4 = 109480		d = 1											
2cd 2d'f'	425000 × .4 = 170000		d = 1	624467				624467						946333
2cd 2d'g	425000 × .4 = 170000		d = 1											
2cd 2d'h	273700 × .4 = 109480		d = 1											
2cd 2d'i	115600 × .4 = 46240		d = 1											
2cd e'^2	324012	324012	.47d, .34e = .81	324012				188007	136005					
2cd 2e'f'	1006252	1006252	.47d, .50e = .97											
2cd 2e'g	1006252	1006252	.47d, .50e = .97											
2cd 2e'h	628024	648024	.47d, .50e = .97	2934228				1421739	1512489					
2cd 2e'i	273700	273700	.47d, .50e = .97											
2cd f'^2	781250	781250	.47d, e, .30f = 1.77	781250				207451	441384	132415				
2cd 2f'g	1562500	1562500	.47d, e, .47f = 1.94											
2cd 2f'h	1006252	1006252	.47d, e, .47f = 1.94	2993752				725290	1543172	725290				
2cd 2f'i	425000	425000	.47d, e, .47f = 1.94											
2cd g^2	781250	781250	.47d, e, f, .27g = 2.74	781250				134010	285128	285128	76984			
2cd 2gh	1006252	1006252	.47d, e, f, .43g = 2.90	1431252				231962	493535	493535	212220			
2cd 2gi	425000	425000	.47d, e, f, .43g = 2.90											
2cd h^2	324012	324012	.47d, e, f, g, .23h = 3.70	324012				41158	87571	87571	87571	20141		
2cd 2hi	273700	273700	.47d, e, f, g, .40h = 3.87	273700				33240	70724	70723	70724	28289		
2cd i^2	57800	57800	.47d, e, f, g, .20i = 4.67	57800				5817	12377	12377	12377	12377	2475	
2ce e'^2	208664 × ⅓ = 69555		e = 1											

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2ce 2e′f′	648024 × .4=259210		e = 1											
2ce 2e′g	648024 × .4=259210		e = 1	825412					825412					1272892
2ce 2e′h	417328 × .4=166931		e = 1											
2ce 2e′i	176264 × .4=70506		e = 1											
2ce f′²	503126	503126	.50e, .30f = .80	503126					314454	188672				
2ce 2f′g	1006252	1006252	.50e, .47f = .97											
2ce 2f′h	*648024*	*648024*	.50e, .47f = .97	1927976					993802	934174				
2ce 2f′i	273700	273700	.50e, .47f = .97											
2ce g²	503126	503126	.50e, f, .27g = 1.77	503126					142126	284252	76748			
2gh 2ce	648024	648024	.50e, f, .43g = 1.93	921724					238789	477577	205358			
2ce 2gi	273700	273700	.50e, f, .43g = 1.93											
2ce h²	208664	208664	.50e, f, g, .23h = 2.73	208664					38217	76434	76434	17579		
2ce 2hi	176264	176264	.50e, f, g, .40h = 2.90	176264					30390	60781	60781	24312		
2ce i²	36992	36992	.50e, f, g, h, .20i = 3.70	36992					4999	9998	9998	9998	1999	
2cf f′²	212500 × ⅓=70833		f = 1											
2cf 2f′g	425000 × .4=170000		f = 1	396553						396553				630247
2cf 2f′h	273700 × .4=109480		f = 1											
2cf 2f′i	115600 × .4=46240		f = 1											
2cf g²	212500	212500	.54f, .27g = .81	212500						141667	70833			
2cf 2gh	273700	273700	.54f, .43g = .97	389300						216724	172576			
2cf 2gi	115600	115600	.54f, .43g = .97											
2cf h²	88132	88132	.54f, g, .23h = 1.77	88132						26888	49792	11452		
2cf 2hi	73984	73984	.54f, g, .40h = 1.94	73984						20594	38136	15254		
2cf i²	15722	15722	.54f, g, h, .20i = 2.74	15722						3099	5738	5738	1147	
d² d′²	28900 × ⅕=5780		d = 1											
d² 2d′e′	136850 × ⅓=45617		d = 1											
d² 2d′f′	212500 × ⅓=70833		d = 1	257947				257947						527453
d² 2d′g	212500 × ⅓=70833		d = 1											
d² 2d′h	136850 × ⅓=45617		d = 1											
d² 2d′i	57800 × ⅓=19267		d = 1											

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
d^2 e'^2	162006	162006	.30d, .34e = .64	162006				75940	86066					
d^2 2e'f'	503126	503126	.30d, .50e = .80											
d^2 2e'g	503126	503126	.30d, .50e = .80	1467114				550168	916946					
d^2 2e'h	324012	342012	.30d, .50e = .80											
d^2 2e'i	136850	136850	.30d, .50e = .80											
d^2 f'^2	390625	390625	.30d, e, .30f = 1.60	390625				73242	244141	73242				
d^2 2f'g	781250	781250	.30d, e, .47f = 1.77											
d^2 2f'h	503126	503126	.30d, e, .47f = 1.77	1496876				253708	845693	397475				
d^2 2f'i	212500	212500	.30d, e, .47f = 1.77											
d^2 g^2	390625	390625	.30d, e, f, .27g = 2.57	390625				45598	151994	151994	41039			
d^2 2gh	503126	503126	.30d, e, f, .43g = 2.73	715626				78640	262134	262134	112718			
d^2 2gi	212500	212500	.30d, e, f, .43g = 2.73											
d^2 h^2	162006	162006	.30d, e, f, g, .23h = 3.53	162006				13768	45894	45894	45894	10556		
d^2 2hi	136850	136850	.30d, e, f, g, .40h = 3.70	136850				11096	36987	36986	36986	14795		
d^2 i^2	28900	28900	.30d, e, f, g, h, .20i = 4.50	28900				1927	6423	6422	6422	6422	1284	
2de e'^2	208664 × .4=69555		e = 1											
2de 2e'f'	648024 × .4=259210		e = 1											
2de 2e'g	648024 × .4=259210		e = 1	825412					825412					1272892
2de 2e'h	417328 × .4=166931		e = 1											
2de 2e'i	176264 × .4=70506		e = 1											
2de f'^2	503126	503126	.50e, .30f = .80	503126					314454	188672				
2de 2f'g	1006252	1006252	.50e, .47f = .97											
2de 2f'h	648024	648024	.50e, .47f = .97	1927976					993802	934174				
2de 2f'i	273700	273700	.50e, .47f = .97											
2de g^2	503126	503126	.50e, f, .27g = 1.77	503126					142126	284252	76748			
2de 2gh	648024	648024	.50e, f, .43g = 1.93	921724					238789	477577	205358			
2de 2gi	273700	273700	.50e, f, .43g = 1.93											
2de h^2	208664	208664	.50e, f, g, .23h = 2.73	208664					38217	76434	76434	17579		
2de 2hi	176264	176264	.50e, f, g, .40h = 2.90	176264					30390	60781	60781	24312		
2de i^2	36992	36992	.50e, f, g, h, .20i = 3.70	36992					4999	9998	9998	9998	1999	

TABLE V—Continued.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2df f'^2	212500 × 1/3 = 70833		f = 1											
2df 2f′g	425000 × .4 = 170000		f = 1											
2df 2f′h	273700 × .4 = 109480		f = 1	396553						396553				630247
2df 2f′i	115600 × .4 = 46240		f = 1											
2df g^2	212500	212500	.54f, .27g = .81	212500						141667	70833			
2df 2gh	273700	273700	.54f, .43g = .97	389300						216724	172576			
2df 2gi	115600	115600	.54f, .43g = .97											
2df h^2	88132	88132	.54f, g, .23h = 1.77	88132						26888	49792	11452		
2df 2hi	73984	73984	.54f, g, .40h = 1.94	73984						20594	38136	15254		
2df i^2	15722	15722	.54f, g, h, .20i = 2.74	15722						3099	5738	5738	1147	
e^2 e'^2	67190 × 1/5 = 13438		e = 1											
e^2 2e′f′	208664 × 1/3 = 69555		e = 1											
e^2 2e′g	208664 × 1/3 = 69555		e = 1	216260					216260					459394
e^2 2e′h	134380 × 1/3 = 44793		e = 1											
e^2 2e′i	56756 × 1/3 = 18919		e = 1											
e^2 f'^2	162006	162006	.34e, .30f = .64	162006					86066	75940				
e^2 2f′g	324012	324012	.34e, .47f = .81											
e^2 2f′h	208664	208664	.34e, .47f = .81	620808					260586	360222				
e^2 2f′i	88132	88132	.34e, .47f = .81											
e^2 g^2	162006	162006	.34e, f, .27g = 1.61	162006					34212	100625	27169			
e^2 2gh	208664	208664	.34e, f, .43g = 1.77	296796					57012	167681	72103			
e^2 2gi	88132	88132	.34e, f, .43g = 1.77											
e^2 h^2	67190	67190	.34e, f, g, .23h = 2.57	67190					8889	26144	26144	6013		
e^2 2hi	56756	56756	.34e, f, g, .40h = 2.74	56756					7043	20714	20714	8285		
e^2 i^2	11986	11986	.34e, f, g, h, .20i = 3.54	11986					1151	3386	3386	3386	677	
2ef f'^2	136850 × 1/3 = 45617		f = 1											
2ef 2f′g	273700 × .4 = 109480		f = 1	255197						255197				405601
2ef 2f′h	176254 × .4 = 70506		f = 1											
2ef 2f′i	73984 × .4 = 29594		f = 1											
2ef g^2	136850	136850	.54f, .27g = .81	136850						91234	45616			

TABLE V—Concluded.
Ranging by Platoon.

Shot Combinations	Probabilities	Possible Cases	Zones Available for Location of Target	Totals	Probability That Target is Within a Particular Zone									Impossible Cases
					Zone *a*	Zone *b*	Zone *c*	Zone *d*	Zone *e*	Zone *f*	Zone *g*	Zone *h*	Zone *i*	
2ef 2gh	176264	176264	.54f, .43g = .97	250248						139313	110935			
2ef 2gi	73984	73984	.54f, .43g = .97											
2ef h^2	56756	56756	.54f, g, .23h = 1.77	56756						17315	32066	7375		
2ef 2hi	47944	47944	.54f, g, .40h = 1.94	47944						13345	24714	9885		
2ef i^2	*10124*	*10124*	.54f, g, h, 2*o*i = 2.74	10124						1995	3695	3695	739	
f^2 f'^2	28900 × 1/5 = 5780		f = 1											
f^2 2f'g	57800 × 1/3 = 19267		f = 1	42619						42619				96795
f^2 2f'h	36992 × 1/3 = 12331		f = 1											
f^2 2f'i	15722 × 1/3 = 5241		f = 1											
f^2 g^2	28900	28900	.39f, .27g = .66	28900						17077	11823			
f^2 2gh	36992	36992	.39f, .43g = .82	52714						25071	27643			
f^2 2gi	15722	15722	.39f, .43g = .82											
f^2 h^2	11986	11986	.39f, g, .23h = 1.62	11986						2886	7399	1701		
f^2 2hi	10124	10124	.39f, g, .40h = 1.79	10124						2206	5656	2262		
f^2 i^2	2138	2138	.39f, g, h, .20i = 2.59	2138						323	825	825	165	
	76085010	67234581		67234581	*20452*	*524910*	*4405719*	*16346593*	*24639233*	*16346593*	*4405719*	*524910*	*20452*	*8850429*

In 10000 Cases the Target will be Located as Follows:

In zone *a*..... 3 times; or, in 1-30 of 1% of cases.
In zone *b*..... 78 times; or, in ¾ of 1% of cases.
In zone *c*..... 655 times; or, in 6⅓% of cases.
In zone *d*.....2432 times; or, in 24⅓% of cases.
In zone *e*.....3664 times; or, in 36⅔% of cases.
In zone *f*.....2432 times; or, in 24⅓% of cases.
In zone *g*..... 655 times; or, in 6⅓% of cases.
In zone *h*..... 78 times; or, in ¾ of 1% of cases.
In zone *i*..... 3 times; or, in 1-30 of 1% of cases.

10000

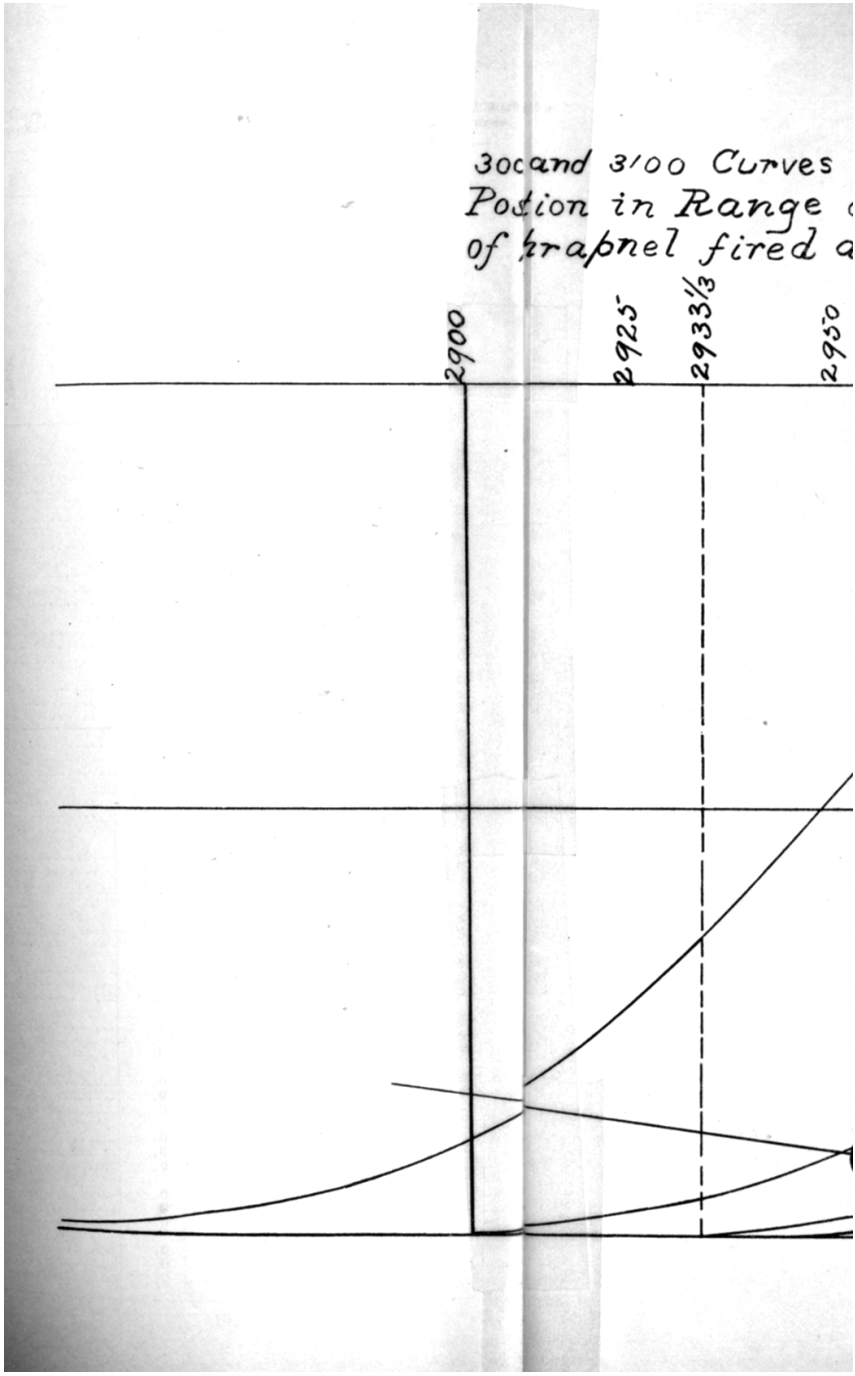
TABLE VI.

Data Relating to Curves Showing Probable Position of a Target When Located Within a 100-yard Bracket, the Probable Error of the Gun in Range Being 33⅓ Yards.

Abscissas measured from center of the bracket—yards.	Adjustment by Piece. Ordinates.	Areas of each zone in order from center of bracket outward.	Total areas from center to outer limit of zone considered.	Percentage of targets within each zone.	Percentage of targets in the area from center to outer limit of zone considered.	Percentage of targets outside of zones considered in preceding column.
0	83.7					
3⅓	83.6	278.83	278.83	2.79	2.79	47.21
6⅔	83.2	278.00	556.83	2.78	5.56	44.44
10	82.3	275.83	832.66	2.76	8.33	41.67
13⅓	81.1	272.33	1104.99	2.72	11.05	38.95
16⅔	79.2	267.17	1372.16	2.67	13.72	36.28
20	77.2	260.67	1632.83	2.61	16.33	33.67
23⅓	75.1	253.83	1886.66	2.54	18.87	31.13
26⅔	72.4	245.83	2132.49	2.46	21.32	28.68
30	69.3	236.17	2368.66	2.36	23.69	26.31
33⅓	66.2	225.83	2594.49	2.26	25.94	24.06
36⅔	62.8	*215.00*	*2809.49*	*2.15*	28.09	21.91
40	59.3	203.50	3012.99	2.04	30.13	19.87
43⅓	55.9	192.00	3204.99	1.92	32.05	17.95
46⅔	52.4	180.50	3385.49	1.80	33.85	16.15
50	48.7	168.50	3553.99	1.69	35.54	14.46
53⅓	45.1	156.33	3710.32	1.56	37.10	12.90
56⅔	41.3	144.00	3854.32	1.44	38.54	11.46
60	37.8	131.83	3986.15	1.32	39.86	10.14
63⅓	34.0	119.67	4105.82	1.20	41.06	8.94
66⅔	30.8	108.00	4213.82	1.08	42.13	7.87
70	27.5	97.17	4310.99	.97	43.11	6.89
73⅓	24.7	87.00	4397.99	.87	43.98	6.02
76⅔	21.9	77.33	4475.32	.77	44.75	5.25
80	19.6	69.17	4544.49	.69	45.44	4.56
83⅓	18.0	62.67	4607.16	.63	46.07	3.93
86⅔	16.0	56.67	4663.83	.57	46.63	3.37
90	14.0	50.00	4713.83	.50	47.14	2.86
93⅓	12.4	44.00	4757.83	.44	47.58	2.42
96⅔	10.9	39.00	4796.83	.39	47.97	2.03
100	9.7	34.33	4831.16	.34	48.31	1.69
103⅓	8.5	30.33	4861.49	.30	48.61	1.39
106⅔	7.3	26.33	4887.82	.26	48.88	1.12
110	6.2	*22.50*	*4910.32*	*.22*	49.10	.90
113⅓	5.1	18.83	4929.15	.19	49.29	.71
116⅔	4.2	15.50	4944.65	.16	49.45	.55
120	3.4	12.67	4957.32	.13	49.57	.43
123⅓	2.8	10.33	4967.65	.10	49.68	.32
126⅔	2.3	8.50	4976.15	.08	49.76	.24
130	1.9	7.00	4983.15	.07	49.83	.17
133⅓	1.5	5.67	4988.82	.06	49.89	.11
136⅔	1.1	4.33	4993.15	.04	49.93	.07
140	.8	3.17	4996.32	.03	49.96	.04
143⅓	.5	2.17	4998.49	.02	49.98	.02
146⅔	.2	1.17	4999.66	.01	*49.99*	*.01*
150	.0	.33	4999.99	.00	50.00	.0

TABLE VI—Continued.
Data Relating to Curves Showing Probable Position of a Target When Located Within a 100-yard Bracket, the Probable Error of the Gun in Range being 33⅓ Yards.

	Adjustment by Platoon.					
Abcissas measured from center of the bracket—yards.	Ordinates.	Areas of each zone in order from center of bracket outward.	Total areas from center to outer limit of zone considered.	Percentage of targets within each zone.	Percentage of targets in the area from center to outer limit of zone considered.	Percentage of targets outside of zones considered in preceding column.
0	113.2					
3⅓	112.8	376.67	376.67	3.77	3.77	46.23
6⅔	111.8	374.33	751.00	3.74	7.51	42.49
10	109.8	369.33	1120.33	3.69	11.20	38.80
13⅓	107.0	361.33	1481.66	3.61	14.82	35.18
16⅔	103.2	350.33	1831.99	3.50	18.32	31.68
20	99.2	337.33	2169.32	3.37	21.69	28.31
23⅓	93.8	321.67	2490.99	3.22	24.91	25.09
26⅔	87.3	301.83	2792.82	3.02	27.93	22.07
30	80.2	279.17	3071.99	2.79	30.72	19.28
33⅓	73.1	255.50	3327.49	2.56	33.27	16.73
36⅔	66.1	232.00	3559.49	2.32	35.59	14.41
40	59.3	209.00	3768.49	2.09	37.68	12.32
43⅓	52.7	186.67	3955.16	1.87	39.55	10.45
46⅔	46.3	165.00	4120.16	1.65	41.20	8.80
50	40.1	144.00	4264.16	1.44	42.64	7.36
53⅓	34.6	124.50	4388.66	1.25	43.89	6.11
56⅔	29.3	106.50	4495.16	1.07	44.95	5.05
60	24.6	89.83	4584.99	.90	45.85	4.15
63⅓	20.7	75.50	4660.49	.76	46.60	3.40
66⅔	17.6	63.83	4724.32	.64	47.24	2.76
70	14.9	54.17	4778.49	.54	47.78	2.22
73⅓	12.5	45.67	4824.16	.46	48.24	1.76
76⅔	10.4	38.17	4862.33	.38	48.62	1.32
80	8.5	31.50	4893.83	.32	48.94	1.06
83⅓	6.8	25.50	4919.33	.26	49.19	.81
86⅔	5.5	20.50	4939.83	.21	49.40	.60
90	4.3	16.33	4956.16	.16	49.56	.44
93⅓	3.4	12.83	4968.99	.13	49.69	.31
96⅔	2.6	10.00	4978.99	.10	49.79	.21
100	1.8	7.33	4986.32	.07	49.86	.14
103⅓	1.0	4.67	4990.99	.05	49.91	.09
106⅔	.6	2.67	4993.66	.03	49.94	.06
110	.4	1.67	4995.33	.02	49.95	.05
113⅓	.3	1.17	4996.50	.01	49.96	.04
116⅔	.2	.83	4997.33	.008	49.97	.03
120	.17	.62	4997.95	.006	49.98	.02
123⅓	.14	.52	4998.47	.005	49.98	.02
126⅔	.11	.42	4998.89	.004	49.99	.01
130	.09	.33	4999.22	.003	49.99	.01
133⅓	.07	.27	4999.49	.003	49.99	.01
136⅔	.05	.20	4999.69	.002	50.00	.0
140	.03	.13	4999.82	.001	50.00	.0
143⅓	.02	.08	4999.90	.001	50.00	.0
146⅔	.01	.05	4999.95	.001	50.00	.0
150	.00	.02	4999.97	.000	50.00	.0


30cand 3100 Curves
Posion in Range
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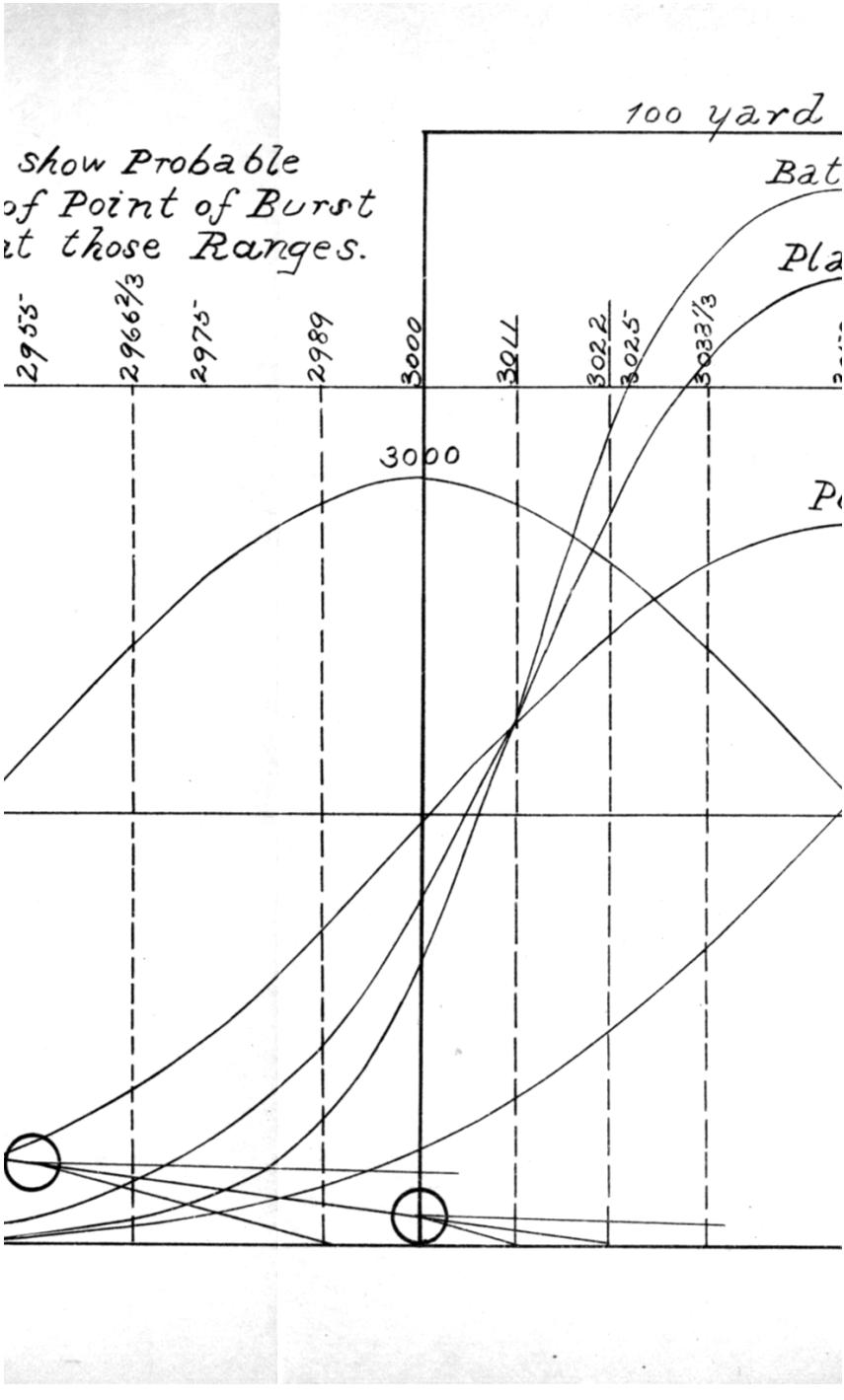
2933⅓
2950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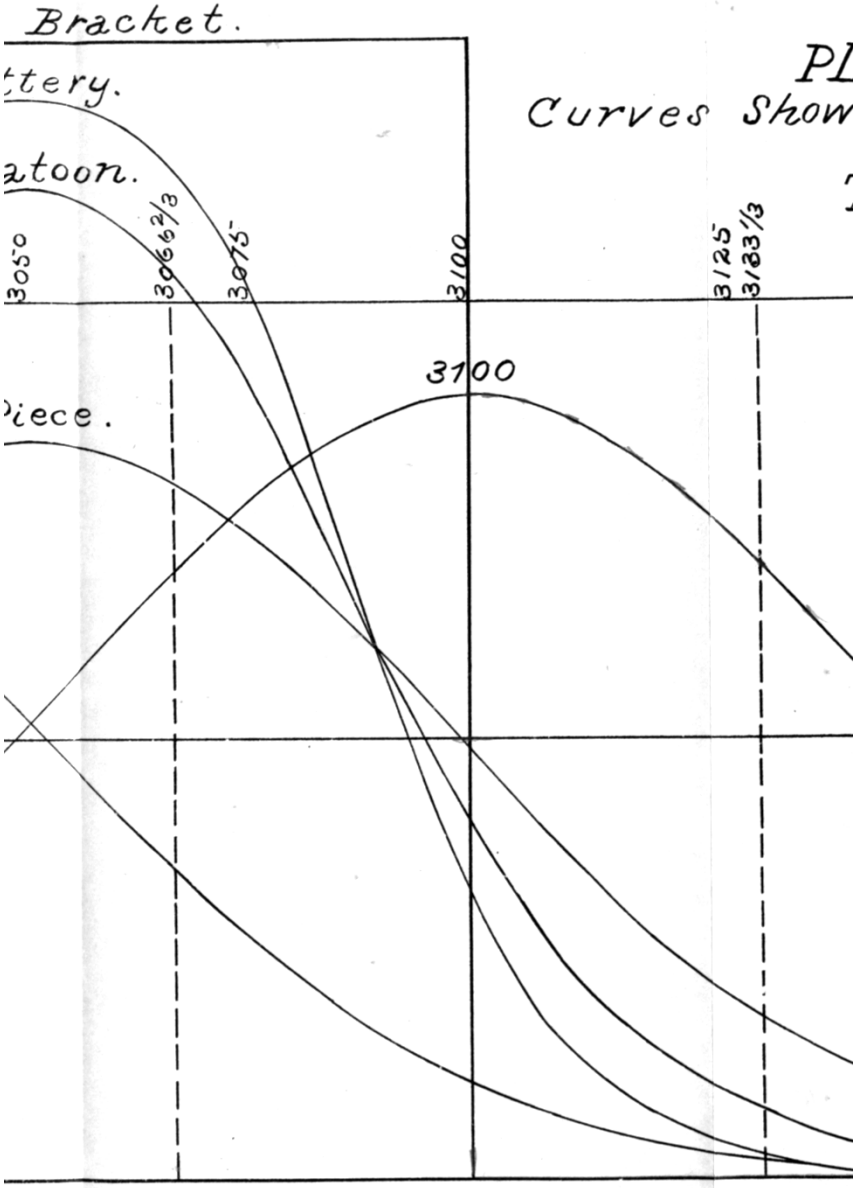
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LATE I.
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Target.

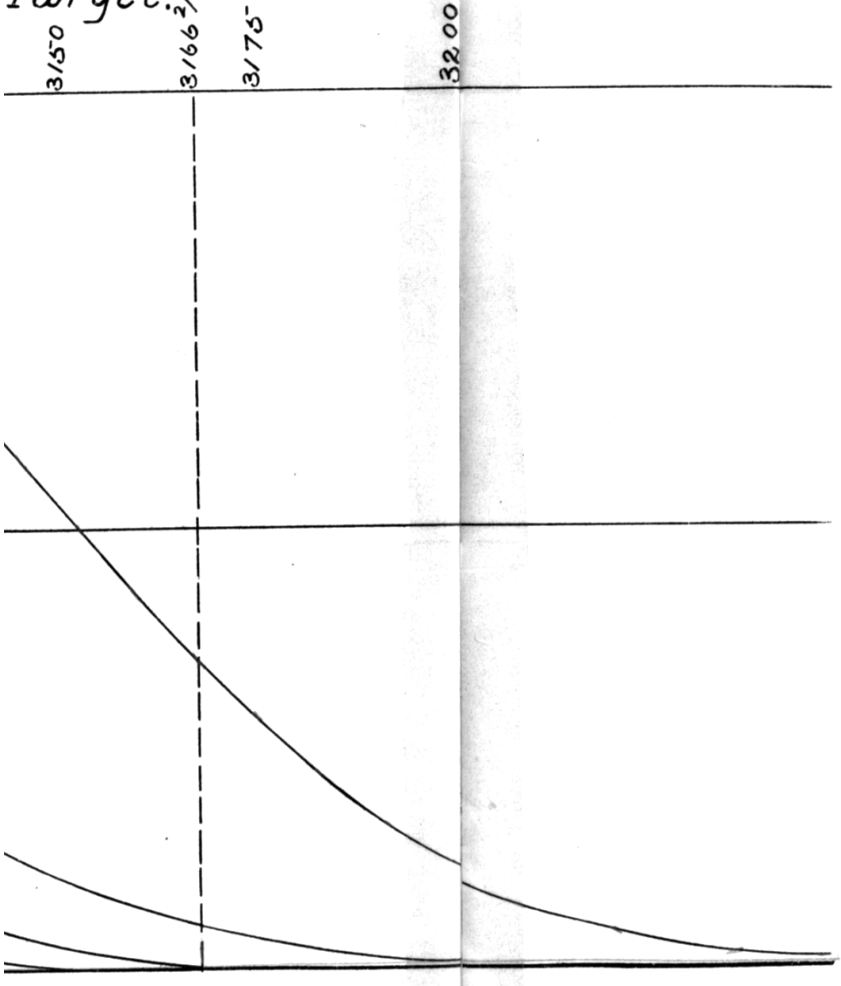


TABLE VI—Concluded.
Data Relating to Curves Showing Probable Position of a Target When Located Within a 100-yard Bracket, the Probable Error of the Gun in Range Being 33⅓ Yards.

		Adjustment by Battery.				
Abscissas measured from center of the bracket—yards.	Ordinates.	Areas of each zone in order from center of bracket outward.	Total areas from center to outer limit of zone considered.	Percentage of targets within each zone.	Percentage of targets in the area from center to outer limit of zone considered.	Percentage of targets outside of zones considered in preceding column.
0	123.2					
3⅓	123.0	410.33	410.33	4.10	4.10	45.90
6⅔	122.4	409.00	819.33	4.09	8.19	41.81
10	121.1	405.83	1225.16	4.06	12.25	37.75
13⅓	118.9	400.00	1625.16	4.00	16.25	33.75
16⅔	115.6	390.83	2015.99	3.91	20.15	29.85
20	110.9	377.50	2393.49	3.78	23.93	26.07
23⅓	104.8	359.50	2752.99	3.60	27.52	22.48
26⅔	97.5	337.17	3090.16	3.37	30.90	19.10
40	88.5	310.00	3400.16	3.10	34.00	16.00
33⅓	78.9	279.00	3679.16	2.79	36.79	13.21
36⅔	68.5	245.67	3924.83	2.45	39.24	10.76
50	58.3	211.33	4136.16	2.11	41.36	8.64
43⅓	48.5	178.00	4314.16	1.78	43.14	6.86
46⅔	39.7	147.00	4461.16	1.47	44.61	5.39
50	32.2	119.83	4580.99	1.20	45.80	4.20
53⅓	25.7	96.50	4677.49	.97	46.77	3.23
56⅔	20.1	76.33	4753.82	.76	47.54	2.46
60	15.5	59.33	4813.15	.59	48.13	1.87
63⅓	12.1	46.00	4859.15	.46	48.59	1.41
66⅔	9.6	36.17	4895.32	.36	48.95	1.05
70	7.4	28.33	4923.65	.28	49.23	.77
73⅓	5.6	21.67	4945.32	.22	49.45	.55
76⅔	4.2	16.33	4961.65	.16	49.61	.39
80	3.0	12.00	4973.65	.12	49.73	.27
83⅓	2.0	8.33	4981.98	.08	49.81	.19
86⅔	1.3	5.33	4987.31	.05	49.87	.13
90	1.0	3.83	4991.14	.04	49.91	.09
93⅓	.75	2.92	4994.06	.03	49.94	.06
96⅔	.55	2.17	4996.23	.02	49.96	.04
100	.38	1.55	4997.78	.02	49.98	.02
103⅓	.25	1.05	4998.83	.01	49.99	.01
106⅔	.13	.63	4999.46	.01	49.99	.01
110	.07	.33	4999.79	.00	50.00	.0
113⅓	.03	.16	4999.95	.00	50.00	.0
116⅔	.0	.05	5000.00	.00	50.00	.0
120	.0					
123⅓	.0					
126⅔	.0					
130	.0					
133⅓	.0					
136⅔	.0					
140	.0					
143⅓	.0					
146⅔	.0					
150	.0					

A CARRYING DEVICE FOR THE FIELD ARTILLERY TELEPHONE.

BY CAPTAIN GUIDO F. VERBECK, *1st Field Artillery, N. G. N. Y.*

A common cause of trouble with the Field Artillery telephone is the shock and jar sustained by the instrument while being transported on the back or the saddle of the operator when moving at increased gaits and when mounting and dismounting.

PLATE I.
SHOWING THE NEW DEVICE FROM THE FRONT, DISMOUNTED. THE MAN'S ARMS ARE FREE.

The carrying device issued with the telephone is so constructed that unless very perfectly adjusted the instrument is apt to strike against the saddle or other objects. Usually it strikes against the back of the man, which is very tiring. In mounting and dismounting it often strikes the saddle. When it is removed from the back

it is apt to fall or strike some object. All this injures the instrument and often puts it out of adjustment. An efficient operator should be able to move rapidly and connect his instrument rapidly. To be constantly nursing it against damage reduces speed.

The issue carrying device is unsatisfactory in its present state for the following reasons: 1. It is difficult to adjust so that it will not strike the back of the man or other objects that will injure it when riding at increased gaits. 2. It cannot be adjusted conveniently so that the telephone can be used without removing it from the body. 3. The movements of the man are hampered with the telephone strapped to his back.

PLATE II.
NEW DEVICE FROM THE REAR. STRAP WILL NOT CUT OR TIRE THE NECK IF PROPERLY ADJUSTED.

To correct these faults it is suggested that another strap be attached to the lower part of the telephone case. To either side of

the bottom of the case rivet a half-inch ring. A strap should be made which is adjustable with buckle, and that is fitted with a snap at both ends. The old device is left unchanged.

The old sling is passed over the head, the telephone being adjusted to hang above the belt and below the breast. The new strap, properly adjusted, is passed around the waist in back of the man and both straps fastened to the rings at the bottom of the case. Both straps should be adjusted so that the instrument does not swing or vibrate, and yet so that it does not press too snugly against the man's breast. In this position the telephone may be carried all day. It can be used instantly without change of position. It will not touch the saddle or roll on the pommel. It is protected from shock and jar. It is not apt to strike against anything. The operator's arms are free. His vital parts are protected. While mounted he may, with one hand, prepare the instrument for use. He can mount and dismount with the receiver and transmitter in the "ready" position. Speed of operation is increased greatly. This method of carrying does not tire the man as much as the old way.

PLATE III.
NEW DEVICE FROM THE SIDE, MOUNTED. ARMS' ARE FREE AND THERE IS NO DANGER OF TELEPHONE STRIKING THE SADDLE OR INJURING THE MAN.

Battery A, 1st Field Artillery, N. G. N. Y., have given this method a thorough test under different conditions, and unhesitatingly pronounce it an improvement over the regular equipment.

The appended photographs show this method of carrying the 'phone.

NOTES ON THE EMPLOYMENT OF FIELD ARTILLERY.

Colonel Potel, of the French Artillery, writing in the *Journal des Sciences Militaires,* makes some timely and pertinent suggestions concerning the employment of field artillery. Extracts from his article are here reproduced.*

CAN A BATTERY WHICH IS UNDER A FIRE FOR NEUTRALIZATION ONLY BE WITHDRAWN FROM ACTION?

For our part, we believe that this may be attempted and that it is possible for it to succeed. This is the method:

A well-placed observer should soon discover the method of fire used by the neutralizing artillery, and should know the direction from which the shots are coming and the interval between them. He may even see the flashes of the guns. He can then warn the personnel of the approach of each projectile in time for them to take shelter behind the shields. Even if he can see nothing, the battery will very quickly get to sense the moment of arrival of a projectile. In the interval the cannoneers work on the guns, and on the guns alone; little by little, these are withdrawn; at first yard by yard, and then, as they get further to the rear, they can be moved with increasing speed and safety, until they are beyond the range of the farthest bursts observed. Then the limbers are brought rapidly up and a firing battery formed from the four guns and six caissons from the reserve. The six caissons of the original firing battery are temporarily abandoned, and the limbers come after them when the enemy sees that he is shooting at nothing and ceases his fire. The ease with which guns can be moved by hand down hill renders this scheme perfectly feasible. If the ground is soft the guns are moved two at a time, all the cannoneers working on them.

CONCERNING DIRECTION OF FIRE BY THE BATTALION COMMANDER AND THE METHODS TO BE FOLLOWED IN BATTALION INSTRUCTION.

The provisional instructions of January 17, 1906, defined fire direction as "the means taken and the methods employed by the battalion commander in indicating, defining and assigning to his

* Translated by 1st Lieutenant Fred T. Cruse, 5th Field Artillery.

batteries such targets as appeared." The regulations of 1910 do not retain the expression or define it, but Chapter VII, of Section IV, under the heading "the battery as part of the battalion," really described fire direction.

It is proper to say here that other officers than majors may have to direct the fire. A captain whose guns are using the same aiming point but attacking different targets, and a lieutenant-colonel of divisional artillery present with the battalion commanders, would be examples of this. So in the definition given above we would have to substitute "commanders of several fractions of artillery called on to fire separately," for "battalion commander." Nevertheless, it is none the less a fact that it is mainly in the battalion that fire direction will be necessary, the battalion being composed of three batteries whose fire can be concentrated or handled by battery by the same methods as are employed by a battery. The dividing of a battery for firing is, however, exceptional, whereas in corps or division artillery, concentrated fire could be obtained only by some explanatory command.

Before the days of aiming points, fire direction consisted in a conference at which the tactical situation was explained; now, it is handled just as we shift the fire in a battery, namely, by the announcement of certain numbers, and it is therefore accurate and instantaneous.

It is the aiming point which enables the fire to be directed in such cases. There is one thing to be watched in using it, however, and that is the difference in the site of the observing station which more or less affects the deflection. The major's station may be at a different height than the captains', and those of the latter will probably be above their directing pieces. It can be shown that this correction for angle of site is negligible if the aiming point is at the height of the target. It should then always be negligible, because the aiming-point can be thus chosen. If the objective is not known the aiming-point must be selected beforehand. But even then an aiming-point 3000 meters away makes the corection negligible for the targets between 2500 and 3500 or even 4000 meters, provided that the distance of the battalion commander from the captains or from them to their directing pieces is not over 200 meters. As the ranges just given are about those at which we would look for artillery, and as the interval between a battalion commander and his captains will

rarely exceed 200 meters, it can be safely said that fire direction by means of announcing deflection is nearly always feasible for counter-battery problems, and this with only one aiming-point. This with the fact that we can correct for angle of site and can use multiple aiming-point enables us to state that fire direction by means of announced deflection is, theoretically, always practicable, and brings us now to certain practical observations.

To begin with, we believe that in a battalion, or a divided battery operating against infantry, real fire direction is not possible. The targets are too numerous and fleeting for the battalion commander to announce them and take it upon himself to attack them. In such a situation the terrain should be divided into zones and in each zone the unit or sub-unit commander be given a free hand.

It is quite different with a battalion in counter-battery. If the target is located, the proper thing is to divide it among the batteries, but if it is not identified and the battalion is in observation only, the cases in which the field of fire would be divided would be very rare.

The battalion commander should be ready for instant action; he should have his three batteries well in hand ready to open fire either successively or simultaneously on any part of the target. This demands a certain skill, complete coolness, a keen eye, and finally the ability to accurate measure deflections. As the properties of the aiming-point and of the basic deflection extend to the battalion, this should be handled as readily as a battery; the commander should concentrate all the moral and physical power of the unit in his own hands, leaving to the captains merely the control of the fire.

With this preface, and the understanding that in a way we often do not what we wish, but what we can, our idea of the handling of a battalion in counter-battery is about as follows:

The following cases present themselves:

First Case.—The batteries are at such a distance from each other that the transmission of orders, even if it were accurately done, would require too much time. (It is assumed there are no telephones, because we believe this instrument would not work in time of war, particularly when it was urgently needed.) This would often be the case with batteries with the advance guard. In this case the battalion commander is in the same situation as his captains, and leaves the direction of fire to them. He assigns the zones to be attacked and exercises general supervision. Nevertheless,

even in this case, the battalion commander uses an aiming-point. By reason of the extent of the zones one will usually not be enough, one for each zone being generally necessary. The aiming-points enable the captains to orient themselves with respect to points in the enemy's terrain, and to execute quickly the orders they receive to open fire.

Second Case.—The batteries, although well separated, are nevertheless close enough to permit of fire direction. For example: three batteries 100 yards apart, with interval between pieces of 25 yards, gives about 400 yards. This situation will often occur in combat of a separate division, where the battalions can and should take plenty of interval.

In this case the battalion commander chooses an aiming-point about 3,000 yards' distant and about in the center of the zone where the targets will probably appear. If possible, he takes his own station between two of the batteries. If the target is located he divides the terrain. If it is not identified, here are some of the methods to follow:

(*a*) Divide the zone into three parts, leave each battery to cover its sector, only interfering when you need their fire.

(*b*) Divide the zone into two parts, assigning one of each of the flank batteries, and hold the center battery to help either of the others or to be used for some specific work.

(*c*) Do not divide the zone, but give the order in which the batteries are to fire, the battery nearest you being last. Be careful to state in the very beginning the maximum front to be covered, 150 yards, for example. Use the battery that is nearest you for covering gaps in the zone, helping the others, etc.

(*d*) Do not divide the zone, but place yourself between two of the batteries and give your commands to their captains, by word of mouth. Have the captain of the third battery stay with you as soon as he has established his battery in position and give him his orders by word of mouth when you are ready for him to open fire. It would probably be wise to give this third captain the first target that appears and keep the other two for situations which will become constantly more urgent.

In the most unfavorable case mentioned, that is, where the battalion commander has to take action on one flank, he has at least one battery in hand ready for instant action. This battery is his

reserve. Each time that he orders one of the other batteries to open fire he can order this one to follow the fire. If the battery firing weakens, this battery can instantly replace it. We will speak further on this in discussing concentration of fire.

If the first battery needs no help, and a new target appears, the command "Deflection for observation: add or subtract so much" puts the battery on the target as easily as if it had been in observation all the time.

Third Case.—The batteries are at about normal interval. This would be the general case, because with the amount of artillery which would be on a battlefield the batteries would rarely be separated very far. In this case there is just one thing to do. The battalion commander himself should have the entire direction of fire, as have been described above in (d). He sends the captains the data for their targets; in a word, he directly handles the sheaf of each battery and shifts it at will, leaving only conduct of fire to the captains.

After reading the above some will remark, "but this is no battalion you are describing, but a twelve-gun battery." Precisely; that is our idea and why have it otherwise? When we have a material that permits the control of several units by one mind why not take advantage of it and let the responsible officer use their combined power in his own way? Why substitute for this single mind the opposing or vaguely coordinated ideas of three captains, and lose the benefit of united action against an objective, which from its very nature (we are speaking of artillery, remember) can be identified and located by a single pair of eyes? Where an arm possesses the methods of fire that the French artillery has, it should not fail to use them, and consequently we can clearly lay down the following: in artillery in counter-battery the battalion should usually be regarded as a battery of twelve pieces, having three distinct sheafs of fire; the battalion commander himself gives the direction and extension of the sheafs, leaving corrector and range to the captains. He does the above by the announcement of numbers.

CONCERNING NEUTRALIZATION AND THE ECONOMY OF FORCES DURING THE BATTLE.—HOW TO KEEP UNITS AVAILABLE FOR ACTION.

It is frequently stated that masked artillery will not be destroyed. We believe this to be an exaggeration, for, either this artillery will

take the offensive in which case it will be near the crest, or it will not act on the offensive and so will take defilade, and stay a long way in rear of the crest. In the first case shell fire will be used and will destroy it, if you get the upper hand instead of letting it get you, as it will try to do. In the second case it has ceased to be dangerous; it is trying to get out as well as it can; it has no idea of playing the part for which it was created, namely, to help the infantry after the artillery duel is ended. It is on the verge of material destruction, just as it is already morally subdued. To destroy it is not absolutely necessary.

Whatever happens, the end of every artillery duel that terminates favorably is either destruction or neutralization. Let us add that destruction alone definitely puts the enemy out of the way. Neutralization may give him a chance to pop up again, but, like a mortally wounded animal, just showing its teeth; it is at this moment that he is most dangerous; yet he cannot escape his destiny. For neutralization we never need all the batteries we have used to get control.

The number of guns to employ in neutralization during the combat depends upon how badly shaken the opening artillery is; it can therefore not be definitely fixed, but, nevertheless, it should generally not exceed half the guns engaged. If it does, it would seem that we did not have any decisive advantage, and we should increase the fire for effect until we undoubtedly had the upper hand. To have some basis for discussion and to consider a rather complex case, let us figure that half of the guns engaged should be used in neutralization. Thus two guns of a battery and six of a battalion would be available for this. The battalion commander, therefore, has three platoons of three different batteries that he can use for other purposes, such as for counter-batteries against other batteries. He can move them forward from their position or even to other positions just as though they were supporting infantry and had therefore taken less defilade, being under the protection of the neutralizing platoons. But this division of each battery into two parts is making poor use of the available strength. It is better to neutralize with one battery and one platoon free. In the battalion, the changes that this grouping would cause are easily made; the officers know the targets, their condition, and the distances or the bracketing ranges for them. Above all, they know how badly

shaken this artillery is, and how it has been firing. The battalion commander can then, by aid of these scraps of information, readjust the sheaf without the risk of striking snags, and as a result can neutralize when necessary certain portions of the target with part of the battery that have not yet been engaged. He can, for example, use for this purpose one whole battery and half of another, and thus leave available the whole third battery and one platoon of the second. In this way he creaters the least possible confusion.

With divisional or corps artillery in counter-battery it would seem that the same should hold true, and that we could thus keep a battalion and a half available, which would interfere the least with the command. But here conditions are not the same. The extent of the front which this artillery has had to counter-bombard is too great for the lieutenant-colonel (the technical commander) to be able to observe the conditions all along its length. In addition, the changes in range, angle of site, and deflection, are too large; a new assignment of targets would cause endless confusion, of which the enemy would take prompt advantage. It would seem wiser to carry the principle of economy of forces no further than each battalion, and then to form in special commands the batteries which are going to remain on the terrain to neutralize and those which will undoubtedly be shifted to other parts of the field of battle.

This forming the temporary commands, grouping batteries and grouping sections to form batteries, is one of the most delicate and least-studied subjects that higher officers have to consider. It should be foreseen and prepared for. Whether in the form given above or in other ways, we can expect, after some hours of fighting, to see divisional artillery and battalions with batteries other than their own. We might even see batteries with pieces belonging to other batteries, because the losses of battle will reduce certain batteries to one or two pieces with no officers left to command them. It is impossible to bring out at school of fire these episodes of the future battle, but they can be studied in the map exercises, and we can endeavor then to solve some of these problems, which are not simple and which deserve mature consideration.

CONCERNING THE INTRINSIC POWER OF THE BATTERY.

The intrinsic power of a battery is generally underestimated, and this is probably one of the reasons why so many officers are opposed

to the principle of economy of forces. Backed up by examples from old wars, where the artillery was feeble both in the projectile and in their explosive power, they cling tenaciously to the mistaken ideas on which the employment of the old artillery was based, and the more they can employ whole units, even against insignificant targets, the better they are satisfied.

It is therefore advisable to figure out the intrinsic power of a battery, that is, the number of shrapnel balls it has ready to fire, and their destructive power. It being impossible to figure out the number of fragments of a bursting shell, we will suppose the battery carries only shrapnel, which will give a conservative estimate, the shell being, all things considered, superior to the shrapnel.

Each shrapnel contains 290 balls weighing 12 grammes each, so that a gun, provided as ours is, with 321 rounds exclusive of those carried in the ammunition column, can fire 90,480 balls, and a four-gun battery can fire 361,290. Now a company of 250 men would have only 36,250 bullets, leaving out, of course, those in the ammunition column. A battery, therefore, carries as many bullets as ten companies or two and a half regiments of 1,000 men each. In time fire at 2,500 metres, the shrapnel balls have a velocity of 320 metres, to which must be added the additional velocity of 90 metres given by the bursting charge; total, 410 metres. This considerable velocity, the fact and extraneous forces do not affect it, furnish another reason, not well understood, of the superiority of our artillery. We can give an idea of the power of the shrapnel ball by stating that at the range considered above it is the velocity of the model M rifle bullet at 350 metres from the muzzle. It is true that the spherical shrapnel ball loses velocity rapidly, which the conicalpointed bullets having the initial movement of rotation do not. This loss of velocity is such that we must admit that the shrapnel ball cannot disable a man beyond 175 metres from the bursting point. Nevertheless, do not rely too strongly on this. At this distance shrapnel balls easily penetrate 42 mm. of soft wood, which is equivalent to penetrating the clothes and tissues of the body in the region of the abdomen.

Here enters rapidity of fire at 16 rounds per piece per minute, which is less than the reality we have for a battery $4\times16\times290=18{,}560$ balls per minute. This is equal to ten companies (of 250 men) firing rapid fire.

Finally, in progressive fire, even without sweeping, the surface covered by this fire is 100×500=50,000 square metres, over which are distributed, not uniformly, but systematically, 9,280 balls, or about one ball to every five square metres. If necessary, a battery could repeat this fire about forty times without drawing ammunition from the column.

The above does not mean that a battery is worth ten companies of infantry, because, in infantry's action, actual fire is only a part, and not even the most important part, while artillery is only good for firing; nevertheless, it gives a good idea of the power of our arm, and may bring reflection to those who would waste our batteries without considering it.

WATER BAGS IN THE FIELD.

BY FIRST LIEUTENANT WILLIAM SHARP, 2D FIELD ARTILLERY.

It has occurred to me that although the water bags shown in the accompanying cuts may be familiar to a great many officers, there may be some who have never seen them and who would profit by a knowledge of how they are made and used.

There is a great advantage in having two or three sets in each organization where transportation is limited to park-animals, and in

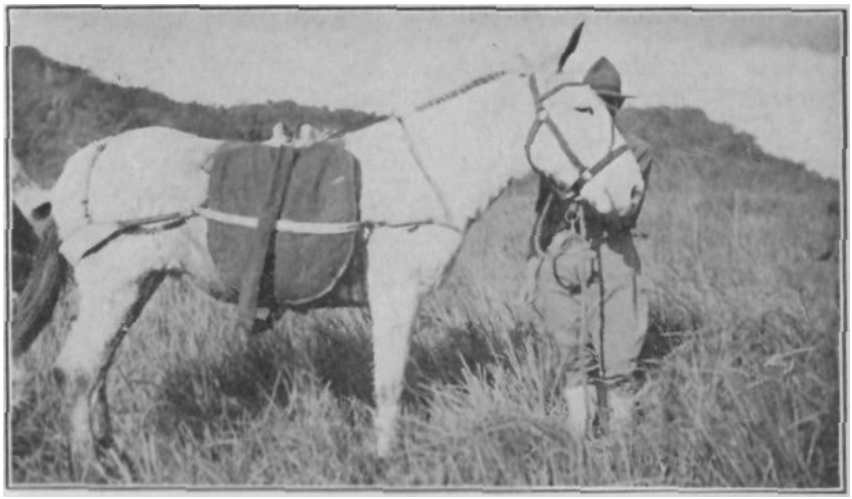
rough country where difficulty is experienced in driving teams from the source of water supply to the kitchens.

During my service with the Mountain Artillery in the Philippines I have found these water bags of the greatest convenience on maneuvers or practice marches, for bringing water from nearby streams to the camp. Organizations equipped with the water bags invariably had their kitchens set up and meals prepared long before those units that depended upon hauling their supply of water with wagons or other means. The wagons would always have to be unloaded and the cans unpacked before the wagons could start for the source of supply; whereas the bags, when they were carried where they could be gotten at quickly, were placed on the first animals unsaddled on arrival in camp, and sent immediately with a water detail to the

designated water supply. With one animal only it was possible to cut off distance and to get in and out of places where it was impossible to drive a team.

Two sets of bags were usually carried with the cooking outfit, for kitchen use only, and one set in the first section of the battery for the use of the chiefs of section and the stable sergeant in caring for the animals and equipment on arrival in camp.

The bags, which can be made by the battery pack-master or the saddler, consist of two pieces of 22-ounce canvas duck, 8 feet long and 3 feet wide, stitched together along the edges with bellows sides



let in and reaching up to within one foot of the shorter center line of the canvas. The upper piece of canvas has an oblong hole cut in the center about 18 inches across the longer axis. A piece of heavy canvas about six inches wide is stitched around the edge of the hole, forming a funnel.

As a means of emptying the bag without removal from the animal's back a piece of canvas hose about four feet long and two inches in diameter is set into the bottom of each bag. When in transit the ends of the hose are attached to rings near the funnel, by means of small snaps on the ends of the hose.

A back strap and breeching of canvas with a breast strap provided with snaps and rings for easy removal are also added to prevent the bags slipping off the animal's back.

A saddle blanket or canvas manta is usually placed on the animal's back before putting on the bags in order to prevent rubbing.

The ordinary ordnance canvas water buckets are used for filling the bags. Two men usually accompany each animal to the source of supply, one holding the animal while the other fills the bags.

It was found that instead of packing large water cans with the kitchen outfit, that weight and bulk could be reduced by using containers made of heavy canvas; these containers are shown in figure.

When on the march they are carried with the kitchen water bags and are made collapsible like the ordnance canvas buckets.

Some difficulty was experienced at first in making the containers stand up when filled with water, but by making a broad base, doubling the canvas, and putting a heavy rope binder on the top they were found to work very satisfactorily. These containers, taken in connection with the Koester Kitchen Pack Outfit, make the cooking paraphernalia for a battery a simple load for one pack animal.

TACTICAL STUDIES.*

BY BREVET CAPTAIN E. DOSSE. FRENCH ARTILLERY.

(*Continued from January-March number*.)

STATIONING OF TROOPS.

Every march ends with a halt of greater or less duration.

At halts as well as on marches a force is divided into two parts. (1) the main body; (2) the service of security (advance guard or outposts).

We shall study each separately.

METHODS OF STATIONING THE MAIN BODY.

The area in which the main body is stationed and the methods for doing this depend in the first place on the mission, then on the time necessary for making the necessary dispositions for combat in case of an attack; that is to say, it depends on: (1) the distance of the enemy, and (2) the strength of the force to be covered.

It also depends on considerations of the welfare and comfort of the troops, especially when far from the enemy, namely: (1) Facilities for cantonment in the region occupied by the force. (2) Temperature.

According to circumstances, the force when halted occupies: (1) Cantonments, (2) Camps, (3), alarm quarters, (4) Bivouacs.

Cantonments afford the greatest comfort to the personnel, but can only be used when they are absolutely safe from surprise. Camps are used if the cantonments are insufficient.

The alarm quarters permit the various units to be assembled more rapidly than in the former cases, but the men are in closer quarters and are less comfortable. This is the only sort of cantonment which may be used when in contact with the enemy.

Bivouacs are fatiguing to men and horses, and permit the strength of the force in question to be determined by aerial observation. They have, however, the great advantage of keeping the troops together and in constant readiness.

There should be no hesitation in putting the troops in bivouac if tactical necessity requires, as in the following cases:

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(1) When the force, at the end of a combat, takes position and maintains contact with the enemy.

(2) When it may expect to be moved at any moment.

(3) When an attack by the enemy is expected.

(4) When there are no cantonments near enough in the zone occupied, etc.

Cantonments or bivouacs of the various units are usually arranged in deep echelon formation, covering one another. Large cavalry units often endeavor to make their halts beyond rivers or bodies of water, where they can find protection and where they only have to hold the bridges.

METHOD OF COVERING THE MAIN BODY.

As soon as the position of the main body is determined, means must be devised by which it may be covered, and allowed to move towards the enemy. On the march the commander of a force marches with the reserve of the advance guard. As soon as he decides to occupy a position, his first care is to use his cavalry in order to prevent the advance posts from being captured. This is a time very favorable for the enemy to make a surprise, and it is now that the cavalry can render the greatest service. The whole of it is usually sent out beyond the probable positions of the outposts. The commander of the force then decides upon the units of security in view of the position to be occupied.

The line to be occupied and the strength of the force necessary for maintaining the security of the main body vary according to circumstances. Nevertheless, they are subject to certain very general rules which must be applied.

Two cases may be distinguished, namely, whether the force is of considerable strength or otherwise.

A Force of Considerable Strength is covered by an advance guard which is pushed forward in the direction of march of the next day, or in the menaced direction.

The position of the advance guard is determined by the commander of the force to be covered, according to the following considerations:

The Advance Guard at the minimum distance:

(1) Must cover the position of the main body, particularly sheltering it from artillery fire. Therefore, it must occupy positions

beyond those from which the enemy might threaten the main body with artillery fire; (2) It must allow the main body the time and space necessary for leaving its position and maneuvering; and (3) It must allow it to move out in the direction determined by the mission; that is to say, the advance guard must go beyond the important and neighboring defiles which a force may have to pass on the following day, so that, after passing these defiles, it may control the adjoining terrain, and make the proper dispositions for combat.

At the maximum distance it must not risk being cut off from the position of the main body, and must hold all the roads leading to it. Therefore, it is necessary to determine the directions by which the enemy might slip in between the advance guard and the main body.

The advance guard, established in a position between this minimum and maximum distance, keeping in view the possibilities for contonment, fulfills its mission merely by the fact that it occupies the zone assigned to it. It remains for it to provide for its own security by outposts, according to the principles explained above.

A Force of Small Strength (less than a brigade) may be considered as being an entire outpost in itself.

The advance guard which we are now considering is placed in this class. Its main body forms the outpost reserve, assuring its mission by the mere fact that it occupies the position fixed by its mission or determined by the decision taken in conformity therewith. In order to be free to act, it guards itself in every menaced direction. Its commander, for this purpose, determines successively:

(1) Its zone of action in case of attack.

(2) The strength of the units of security necessary for covering the zone and forming the first line of resistance.

(3) The distribution of this force in the menaced direction.

ZONE OF ACTION IN CASE OF AN ATTACK.

One may call the zone of action of a force consisting of the three arms, that zone included between the line of resistance of the units of security and the positions to be occupied by the artillery of the main body in case of an attack. The positions to be occupied by the infantry of the main body in case of an attack are included in this zone. They cover the artillery positions and very often coincide with the support, or the positions where the units of security will offer the first resistance.

This expression, "Zone of Action," does not indicate that the main body will remain on the defensive in case of an attack, but that it will keep itself in readiness to fulfill the mission which its commander will assign to it. To determine the zone of action, its elements must be determined. These are:

(1) *Its width*: its extent of front.

(2) *Its depth*: the average distance between the line of supports, where the units of security will offer resistance, and the position of the main body.

Width.—Front to be held. The front of the zone of resistance is included between the two extremities of the menaced directions. Accordingly, at the very beginning, these directions are determined, leaving out of consideration those which are too circuitous. The space included between the right and the left directions limit the width of the zone of action.

Depth.—Average distance between the supports, or line of resistance of the outposts and main body. The line of supports, where the units of security and the main body of the outposts will form their line of resistance, is determined in such a manner as to insure the main body:

I. At a minimum:

(1) Security of its position. Consequently, it must be on or beyond the emplacements from which a hostile artillery might bombard this position.

(2) The employment of all its means of resistance (artillery and infantry). Consequently, at the minimum distance the line of resistance must . . .

(a) Be beyond the first positions from which our artillery may fire on the enemy in case of an attack. These are usually the very positions which may be used by the enemy.

(b) Be beyond or on the line of supports which may be occupied by the infantry of the main body assigned to protect these artillery positions.

(3) There must be sufficient time and space necessary for its participating in the action. The time is that required for moving from position, and maneuvering in order to act in the direction of the attack. The space or zone of maneuver depends on the strength, on the force, and on the terrain.

(4) There must be immediate exits in the direction of the enemy,

and consequently in fulfillment the ultimate mission. The line of supports must hold all the neighboring defiles, woods, and cuts which must be traversed in advancing on the enemy.

II. The maximum distance of line of supports from the main body should be such:

(1) That the units of security which occupy this line may not be cut off from the main body. This consideration makes it necessary that the line of supports shall cross all the roads by which the enemy might attack the main body.

(2) That the main body may occupy its lines of resistance before the units of security are forced to abandon them. Here we must take into account the length of time that the outposts can hold back the enemy and the time required for the main body to reach its positions. Moreover, we shall see that the strength of outposts must be reduced to a minimum. Thus we have seen that the zone of action is limited:

(a) *In width*: Between two directions.

(b) *In depth*: Between a maximum and a minimum.

DETACHED POSTS.

We have only considered the principal menaced directions. The necessity for holding certain directions, notwithstanding their distance, would result in extending the line of resistance over a distance too great to be guarded by the troops available. Therefore, detached or independent posts must be established and placed along these directions.

Partial Reserves: On the other hand, when the line of supports, through tactical considerations, is far from the main body, it is well to establish partial reserves, which are actually advance guards of the main body along menaced directions. These reserves are established at points where they can easily spread out and support the grand guards.

Division of the zone of action into sectors.—To facilitate control and command, the zone of action is divided into sectors:

(1) If it is of great extent.

(2) If the country is covered or broken.

The sectors are marked with the greatest precision. Care must be taken not to leave uncovered between two sectors any important points, such as a village, bridge, defile, center of communication, or a menaced direction.

Each of these sectors has a special commander designated in the order for taking position, and is provided with a reserve.

In the case where outposts are established at night, the terrain can not be used as during the day time. It is not absolutely necessary to hold all the heights, or post the infantry under cover, because of the neutralization of the two opposing artillery forces.

Since in most cases communicating routes alone are used for an attack, outposts are only established along roads and paths. However, in a very open country, or on moonlight nights, it is well also to watch the spaces between the various roads.

Resistance is organized along the approaches and at a distance from the main body, based on the following considerations:

(1) *The minimum distance*:

(a) To allow freedom of action.

(b) To insure the advance troops at the start of their day's march.

(2) *The maximum distance*:

So as not to be cut off from the main body.

Tactical connection by sight no longer existing, distances are closed and circuitous roads are watched. The zone of action is often divided into independent sectors as a result of the difficulty of insuring tactical connection.

If the force is halted in the same zone during the next day, the necessary changes are made in disposition for the night.

FORCE WHICH MUST BE ASSIGNED TO OUTPOSTS, AND FUNCTION OF THE DIFFERENT ARMS.

Cavalry outposts.—Reconnoitering parties and patrols which have gained contact must keep in contact at the end of the march. In case none have been sent out, it is well to do so immediately upon halting.

The main body of cavalry is pushed beyond the line of outposts in order to cover it while it is being established. Later it sends vedettes and patrols to guard the menaced directions beyond the positions of the outposts.

If its strength is not great, cavalry falls back behind the outposts at sunset. However, the commander of outposts may order cossack posts established along the roads or at important points such as cross-roads or defiles too distant to be held by infantry. There posts

serve merely to give warning of the approach of the enemy and form a protected area beyond the outposts.

If a large body of cavalry be employed, and if it becomes necessary to hold a circuitous route so as to protect the main body or facilitate the final mission, cavalry may be left during the entire night beyond the line of outposts. But we must consider whether the result will justify the great fatigue imposed on these troops.

Infantry.—Infantry is the nucleus of the outposts.

Its strength depends:

(1) On the strength of the force to be covered.

(2) On the direction of the enemy.

(3) On the number of menaced directions.

(4) To a certain extent on weather conditions and considerations of comfort.

(5) On the nature of the terrain and the difficulty of holding it.

Its strength, which varies greatly, is always reduced to the smallest possible numbers. Far from the enemy it consists only of a few small units whose duty it is to hold in check hostile cavalry accompanying artillery.

Artillery.—Artillery attached to advance guards in large forces remains, along with the reserve, at the disposal of the commander. However, in very exceptional cases it is posted in observation.

Engineers.—Engineer detachments are divided among the various sectors in order to construct, if necessary, field works for strengthening the line of supports.

III. DISTRIBUTION OF THE UNITS OF SECURITY.

The force assigned to hold the zone of action is divided and sent out along the menaced directions, proportioned according to the importance of these directions. We must, therefore, determine which are the most menaced directions. They are usually those which lead straight towards the enemy.

The proportion of forces is based on the following requirements:

(1) That of confiding to a single unit the task of guarding a well-defined direction or a line of supports.

(2) That of insuring tactical connection between the various units and their commander.

(3) That of placing the whole of the force serving to maintain security in deep echelon formation.

(4) That of establishing a partial reserve in each sector, if the area is so divided.

When the units are small, this distribution is made by the commander himself, who determines:

(1) The sectors, the force assigned to each, their commander, and the line of supports.

(2) The positions of the reserves if no sectors are established, and the direction each one must cover.

The reserves are usually near a line of support which conceals them from view and affords them valuable cover. They should not be posted in villages where they will be dispersed and their power of resistance diminished.

Tactical connection between neighboring units.

All the preceding statements apply to isolated units. However, these may form a section of a line of outposts. In such case it is necessary:

(1) To determine the zone of action in order that it may be along the same front as the neighboring units.

(2) To insure a continuous tactical connection with these units by the aid of small bodies of cavalry or even infantry, established at conveniently fixed posts.

Assembling of outposts. The advance guard is not formed from the units of security. In large units, it is drawn from the outpost reserve; or from the main body in the case of a small force. The reason for this is to allow the outposts to insure the security of the entire force up to the time when the advance guard assumes its normal function of watching, thus avoiding all danger of surprise at the time of setting out on a march.

REVIEW.

In every question relating to outposts, after having estimated the situation and came to a decision, it is necessary:

To determine:

The first position for cavalry,
The position for the main body,
The menaced directions;

To deduce:

The front of the field of action,

The distance of the artillery and infantry positions on the line of resistance from the main body (depth);

Then:

The circuitous routes requiring special detachments,
The position of partial reserves if these are established,
The strength of the outposts,
The distribution of this force,
Then, if necessary,
Designate sectors,
Establish tactical connection with neighboring units.

COMBAT.

Marching and taking up positions are merely the means of bringing a force into a final action, under the conditions foreseen in the decision. This is combat.

The destruction and disorganization of the enemy's forces is always the end to be attained; the means employed to obtain this result must tend to impose upon the enemy one's determination either

(1) To push forward, or
(2) To take up position;

which may result in two sorts of action:

1st. Offensive combat.
2nd. Defensive combat.

Offensive combat alone allows the shattering of the enemy's unity and the arrival at a conclusion. We must fully appreciate this essential principle.

The defense can only be a phase of the combat. Passive defense accomplishes nothing. According to a well-known expression, "To resort to it is suicidal."

Combat in retreat should only be considered in case of absolute necessity. Therefore, combat in its entirety is strictly offensive; but one or more of its phases may be defensive, either through necessity or on account of an order.

We may recall that the decision, derived from the mission, can have but a single objective, the enemy, and that the occupation or capture of a position are only means of increasing the resisting or offensive power of the three arms. This may be the end to be reached at the termination of *a phase,* but under no circumstances may it be regarded as a definite conclusion.

OFFENSIVE COMBAT.

In theory, offensive combat takes place in the following manner:

The advance guard violently attacks the enemy, in order:

(1) To attack him and obtain information.

(2) To cover the main body.

(3) To prepare the way for the main body.

The commander of the force engaged calls for the artillery necessary to support the advance guard, and determines his plan of action.

Then he issues orders:

(1) To the advance guard.

(2) To the main body, which he divides into two parts:

(a) The support (for immediate action).

(b) The reserve (for maneuvering).

He then makes his dispositions for carrying out a general and decisive attack.

In practice, these various phases often are confused and it is impossible to distinguish clearly between them. This takes place especially in a violent attack when all the forces are united and act on a preconceived idea, or in an engagement of a force which up to that time was held in reserve in rear of the forces already engaged.

Nevertheless, the general case is an advance guard action followed as soon as possible, and without being discontinued, by the main engagement.

ADVANCE GUARD ACTION.

The cavalry of the advance guard, as soon as it gains contact, endeavors to determine the strength and composition of the enemy. But usually it is unable to do more than indicate his apparent position; it then holds the front until the arrival of infantry.

At this time its rôle of covering the front of the force is terminated, and it seems to reach the flanks of the enemy which it tries to turn in order to surprise the position of the main body.

If the force of which it forms a part is well covered, the cavalry may be kept towards the flanks and may be drawn in behind the infantry. It may then serve as a very mobile reserve, and in case of necessity may be moved towards a menaced point or accompany the artillery.

Infantry, aided from the very beginning by the advance-guard artillery, if necessary, enters into action as soon as it comes up, so as to fall on the advanced units of the enemy, break through his screen of skirmishers, and push forward as far as possible.

To reconnoiter the enemy's position, the various units of the advance guard must operate with brutality. If the enemy yields, the advance guard continues the march along its normal course. If the enemy resists, it increases its efforts, moving infantry forward to positions to the front (villages, small woods, trenches, etc.).

While attacking, it makes a display, often covering a front entirely out of proportion to its numbers, for the following reasons:

(1) The nearness of the enemy obliges it to protect its flanks, so as to prevent, with every means at its disposal, hostile units from attacking its flanks in order to menace the main body.

(2) The best means for determining the front held by the enemy is to attack at several points.

Finally, it seeks a point suitable for forcing a passage.

The artillery of the advance guard: (1) Supports its infantry immediately, and, as far as it is able, in the attack of the different lines of support. (2) Makes it easy for the artillery of the main body to come into action.

For this purpose, the commander of the advance guard informs the artillery units of his intentions, decides on their positions, and keeps them informed of any new orders he issues.

The commander of the force directs the combat.

The advance guard does not stop its forward movement until it can no longer make material progress. Then only can it be forced for the moment to act on the defensive. It holds the positions it has won, which form a base for the main body in its maneuvering, serving:

(1) To cover the forward movement of reinforcements.

(2) To permit the artillery to take position behind the advance guard. In principle, the commander of the force undertakes the direction of the combat as soon as he feels that the action has become something more than an advance-guard engagement.

He then takes into consideration the information collected:

(1) By his cavalry, if he has any.

(2) By the various units of his advance guard.

(3) By the neighboring troops, if he is well covered and if he has established good tactical connection.

But whether this information is complete or not, whether precise or vague, it is necessary for him to make without delay a plan of action, based on:

(1) His mission.
(2) His personality.
(3) The terrain.
(4) The order of march.

He determines:

(a) The immediate action of the advance guard.
(b) The action of the main body.

(*a*) *Immediate action of the advance guard*.

The commander gives an order to the commander of the advance guard:

(1) Either to attack resolutely in full force,
(2) or to delay by maneuvering,
(3) Or, finally, to occupy an artillery position, where the batteries of the main body may finally take position if necessary. This is a normal and methodical engagement, which, moreover, is in harmony with the two courses first mentioned.

In the first case, which is generally a direct and rapid assault, an attack on an enemy who is seeking to avoid combat, etc., the advance guard continues to push forward from position to position.

In the second case, which occurs if the leader must gain time for reaching the main body when far off, or for maneuvering in conjunction with the main body in a different direction from that previously followed, the advance guard makes a display, moves towards favorable positions, takes position in those already occupied, and holds them in force.

In the third case, which is a typical methodical engagement, the advance guard resorts in succession to each of the above methods of action. It occupies an artillery position designated by the commander, so that the main body may be able to act with all the means at hand. It moves on positions located beyond this position, in order:

(1) To cover it.
(2) To allow the artillery to reach it.
(3) To leave room for the main body to maneuver.

(*b*) *Action of the main body*.

During the engagement of the advance guard the main body continues its march until halted by order of the commander, or until its arrival at the edge of the zone beaten by hostile fire.

The orders received from the commander, arriving at frequent intervals, generally bear as the following points:

(1) Reinforcement of artillery of the advance guard by the whole or a part of the artillery of the main body.

(2) Division of the main body into:

(a) Support, which is to enter the engagement immediately so as to continue the advance.

(b) Reserve, if there is such, which is to enter into the final action.

(3) Designation of objectives for the support.

(4) Strength of units to be assigned to the various supports.

(5) First position for the reserve, if established.

Reinforcement of the advance guard's artillery.

The best means of rapidly supporting the advance guard by increasing its fire action, is to reinforce it with a part of the artillery of the main body, which, on account of its mobility, can come up before the infantry.

The batteries designated for this purpose occupy the position won for them by the advance guard which they then support in its further advance, either by gaining fire superiority over the enemy's artillery, often a necessary course of action, thus preventing it from firing on the advance guard, or by firing on the enemy's infantry to destroy it and prevent it from firing on the infantry of the advance guard. The latter is its constant aim.

The first phase of the combat consists actually in throwing a barrier in front of the enemy, behind which the supports may move towards the objectives chosen; but in reality it often coincides with the main action when the purpose is to bring about a brutal frontal action. Thus it becomes merely a theoretical distinction.

Division of the main body into support and reserve.

The division of the main body into support and reserve depends primarily on the location of the force, which may be

(1) Isolated,
(2) On a flank,
(3) Between other bodies of troops.

When isolated, the force cannot count on the support of anyone; it must act for itself, and therefore it generally holds a certain part in reserve, which is used according to circumstances:

(1) For bringing on the decisive action.
(2) For making an echelon formation behind the flanks in order to ward off flanks attack or to outflank the enemy.
(3) For insuring a successful retreat.

The strength of the reserve depends on the mission and on the general situation.

When posted on a flank, this unit is responsible for the security of the whole force on that flank; therefore, it is well for it to keep a reserve for protection against an unexpected attack on that side. This reserve is formed in echelon in the menaced direction so as to be prepared for a flank attack by the enemy.

If the force is between other bodies of troops, a reserve is often unnecessary, as the flanks are usually guarded by the neighboring units, and behind them the reserves of the main units are charged with bringing on the decisive action or covering the retreat.

As is always the case in tactics, the division of the main body is subject to no definite rules, and is merely dependent on conditions at the time.

But it is well to remember that by establishing too large a reserve offensive power is diminished.

If a rapid advance is necessary, it is best to leave in rear as few troops as possible.

Designation of objectives for the supports.

The commander of the troops decides on the direction in which he will make his first attempt, in order to prolong the action of the advance guard, without delay. He bases his decision on the following considerations:

(1) The mission.
(2) Conformation of terrain and positions occupied by the enemy.
(3) Information obtained.

(4) The limits of action to the right and left, which have been fixed for him in case he is between other bodies of troops.

The objectives designated by him correspond to the following simple ideas:

(1) That of moving well-arranged units on each objective.

(2) That of coordinating the movements of these units so that all of them may move forward avoiding any unusual combinations.

Everything is reduced to the idea of an effort to advance.

Strength of units assigned to the various supports.

The commander of the force distributes the units assigned to each objective according to:

(1) The importance of the objective in its relations to the mission.

(2) Difficulties of terrain.

(3) The strength of the resistance already encountered.

The result of these dispositions is that well-arranged units are designated to march on objectives determined in view of a fixed mission.

Composition of the reserve.

The reserve is generally composed:

(1) Either of units left behind by the supports when they enter into action, which remain under orders of the comander;

(2) Or, of units not engaged in action.

In the first place, in order to avoid confusion among the various units the different groups of the reserves generally receive orders to remain in position behind the units which are engaged and to which they belong.

Operation of the dispositions of the commander after the advance guard action.

Supports.—The order which puts a support in motion is generally framed thus: For example, in the case of a regiment—

The regiment will move towards the village A* in order to—

Its movements will be supported by the artillery B, if necessary.

Then, sometimes—

It will leave (one) battalion at C (in reserve) at the disposal of the commander of the force.

———

*Cut omitted.

March to the combat position.

The colonel leads the two battalions which are to become engaged, moving generally across the terrain in such a way as to conceal them from view and protect them from the enemy's fire as long as possible. He decides on his plan of action, then divides his two battalions into:

(1) The first line.

(2) Supports.

He assigns definite secondary objectives to his various subordinates.

Tactical connection with artillery.

If he knows that the artillery is going to support his attack, he indicates to the artillery commander his disposition and intentions. He sends him the information he has collected, and asks him to support him at such points as are of considerable importance to him.

This information is absolutely necessary, because only the colonel attacking "A"* can indicate to the artillery how and where he intends to carry out his mission, thus allowing the artillery to aid him judiciously. This is "Liaison par le bas."

The engineers attached to an attacking force are generally under the direct orders of the commander of the attacking force, who indicates to them their mission, which is to accompany the units of the first line in order to demolish obstructions.

The commanders of subordinate units act in the same manner as the commander of the attack in dividing their units and in designating objectives.

Method of re-forming and marching the reserves.

The word "re-forming" must not be taken in a strict sense.

Re-forming a force is merely a special way of keeping it ready for rapid action in every direction leading towards the enemy.

The assembly consequently must be:

(*a*) Articulated.

(*b*) Perfectly covered.

Articulation.

The object of articulation in the assembly of a force in position

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*Cut omitted.

or on the march is to form its units in echelon, so that they may move in the desired direction with the least delay. It is carried out so as to have a unit facing in each menaced direction, in readiness to act as an advance guard, the other units being prepared to immediately follow it in the desired direction.

Perfect covering of the units.

The assembling of the units must be carefully covered, although their being united makes them less vulnerable and diminishes the danger inherent in every mixed body of troops. Security is insured by small units which, remaining near at hand, guard the menaced directions and prevent surprises by cavalry or reconnaissances by officers.

This is a precaution often neglected yet very important. No matter how unimportant the assembly may be, it is dangerous unless perfectly covered.

Nature of the preparatory combat.

Along the front of an attacking force there usually are series of partial engagements, in the course of which everyone must use his initiative and act within the limits prescribed to him. Some succeed in advancing and pushing back the enemy. Others cannot advance and are forced to act on the defensive. Others are even thrown back. This gives to the front of the attacking force the character of a discontinuous and irregular line consisting of salients made by offensive and reentering angles made by the defensive. Often for various reasons there are even breaches of continuity.

The decisive action.

The preparatory combat must result in forcing the enemy, under the penalty of disaster, to use his supports and also even a part of his reserves.

Its duration is greater if the enemy's troops are firm, and less if the supports are directed on points judiciously chosen by the commanders.

Sometimes the resistance or the attack of the enemy at certain points along the front may indicate his intentions. The commander must endeavor to make note of this, avoiding, however, drawing too strict deductions from mere chance movements. Good judgment in

such matters requires quick power of perception, coolness, thought, and judgment. The bases for his opinion are furnished him:

(1) By information received from his subordinates from all points on the field of battle.

(2) By reconnaissances which may still be made by cavalry operating on the flank or in rear of the enemy.

(3) By aerial observation.

(4) Finally, if the unit is not very large and covers only a small front, by his personal observation, made at a point conveniently chosen, which permits his observing a large part of the field of action.

Theoretically, he takes into consideration the moral state of the enemy, and he then possesses the elements necessary for making a most grave decision, namely:

To determine the moment when he will order all his reserves into the engagement so as to attain the desired result.

All the skill of a commander rests in this supreme decision.

In practice, the result is often brought about by the initiative of subordinate units vigorously pushed forward or favored by circumstances.

The superior commander then only has to follow it up.

The purpose of the commander is to use every means at his disposal to make resistance by the enemy impossible and to force him to yield.

The means he employs are:

(1) To accumulate the forces still at his disposal at a judiciously chosen point, in order to break the cohesion of the enemy's forces, to demoralize them by making them fear that they will not be able to disengage themselves, and by inflicting on them the greatest possible losses.

(2) To facilitate the accumulation of his force by ordering a general attack along the whole front, so as to attack the enemy and prevent his moving out any troops in order to support those hardest pressed.

(3) To arrange his artillery judiciously, so as to have it support the general attack, and particularly attack the most important points.

The commander must from the first decide upon:

(a) The direction of the attack.

(b) The forces to be used in the attack.

(c) The means to be employed.

DIRECTION OF THE ATTACK.

It is impossible to give a rule for choosing the points of attack which depend:

(1) On the terrain.

(2) On the general impression of the commander.

(3) On the effect produced by the initiative of subordinate units.

Nevertheless, there are two general methods of bringing about a decisive action:

(1) A turning or enveloping movement.

(2) A direct frontal attack.

Turning or enveloping movements.

An attack by a frontal or enveloping movement consists:

(1) Of going beyond one or both of the flanks of the enemy's line with a part of the force.

(2) Of falling upon the enemy, attacking from every side at once.

The purpose of this attack is to force the enemy to double back on himself and to inflict the greatest possible losses, but above all to demoralize him by the maneuver.

It is based upon a preconceived idea, because it involves very extended movements which consequently must begin before much information concerning the enemy has been obtained. Against a passive enemy it is a terrible weapon, because it shuts in the enemy and puts him at one's mercy. The Germans in 1870 and the Japanese in 1904-5 constantly used it.

Against an enemy who keeps himself well informed and who parries the blow with the aid of his reserves, or who himself takes the offensive, it may result in a serious check.

It has the greatest disadvantage of removing the reserve from the field of action, which at certain times may be very dangerous.

Direct frontal attack.

The purpose of a direct frontal attack is to pierce the enemy's front at the center or the flanks, at a certain point, chosen so as to result in his demoralization by preventing the continuation of his resistance.

The objective chosen must permit the use of all the arms, particularly artillery. Generally, the attack does not move through wooded terrain, as its progress could not be supported by artillery. Besides, it would risk being scattered before reaching its destination.

FORCES TO BE USED IN THE ATTACK.

The forces to be used in an attack vary according to the method adopted.

A *turning or investing* attack being generally decided upon by the commander, according to a preconceived idea, without much information concerning the exact position of the wings of the enemy, his strength, or the turn which the combat may take, the commander determines on the forces he must use, according to the general results to be obtained. He may keep a reserve for possible emergencies.

The commander who decides on a direct frontal attack or a direct flank attack on account of early engagements, is usually better informed than in the preceding case; on the other hand, such wide flanking movements are not necessary in this case. The attacks must be conclusive, and require all the forces available.

Composition of the attacking force.

A force whose purpose it is to make a decisive attack consists, if possible, of units of all four arms: infantry, to carry out the attack; artillery, to open paths for the infantry, neutralize the enemy's fire, and break down resistance; engineers, to destroy the obstacles; cavalry, to intervene at any moment, but principally at the end, charging the enemy when demoralized and completing its defeat. All these troops are placed under a single commander, who directs them and bears the responsibility.

Moreover, the commander of the troops takes measures in order:

(1) That all the artillery which is available or which can be spared from the front may at the desired moment concentrate its fire on a chosen point.

(2) That all the troops engaged, which up to that time have taken part in the preparatory combat, may attack the enemy energetically, using their last supports and reserves to prevent him from reaching the chosen position.

Methods used by the attacking force.

As soon as the commander of the attacking force receives orders to attack he makes his arrangements so that the action may be rapid and crushing.

It must, as far as possible, be rapid, in order to demoralize the enemy by surprise.

It must, by accumulating the means of attack:

(1) Crush the enemy with its fire so as to destroy him and prevent his firing.

(2) Impress him with the uselessness of resistance before an attack which nothing can stop.

Preparation for the attack.

The commander of the attacking force leads his troops into a covered zone as near as possible to the terrain where the engagement is to take place. All the while he seeks information from the troops already engaged, or even makes a personal reconnaissance of the terrain if he is able to do so.

The attacking troops, as long as possible, avoid exposing themselves to loss, concealing themselves from the enemy if a surprise is planned.

The use of aeroplanes often forces them to make the best use of the cover of woods in reaching the point of departure.

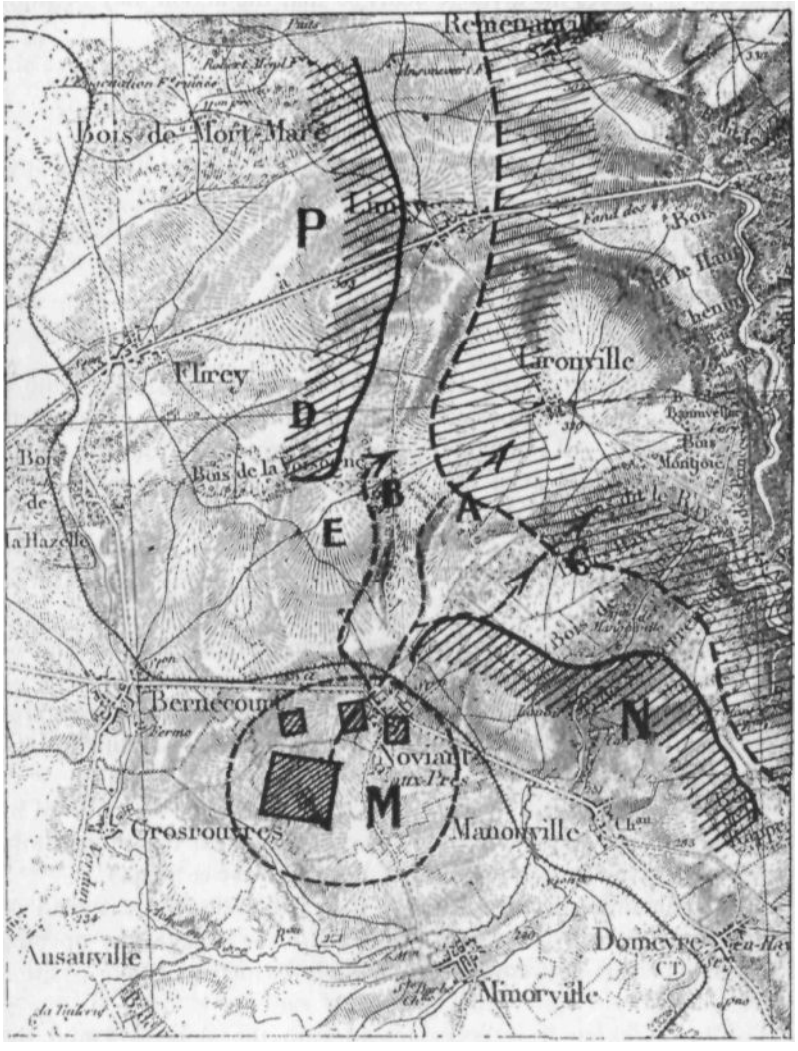
Their commander then takes measures to insure an opening for the attack, securing certain positions which serve as starting points.

Example:

Let us assume that a brigade is held in reserve at M, covered by the troops of N and P who have been engaged in the preparatory combat, receives orders to attack Lironville. (See map.)

The commander decides to move forward, following the road A, which leads toward the weakest salient of the village, the opening towards which is best covered by artillery, which will take position at D and E.

Before attacking it is necessary to gain the slope 292 and the edge of the woods called "Le Ray," which will serve as a starting point. The attacking force is aided in this movement by the neighboring units N and P, which act in concert with the detachments B and C, established for this purpose.


Remenauville
Bois de Mort-Mare
P
Lironville
Flirey
D
Bois de la Forge
B
A
E
C
Bois de la Hazelle
Bernecourt
N
Voviant aux Prés
M
Grosrouvres
Manonville
Ansauville
Domevre
Nmorville

EXECUTION OF THE ATTACK.

As soon as the opening is assured, the attack is pushed forward.

The artillery (D and E) neutralizes the hostile artillery so as to prevent its firing on the infantry, then shells the defending force, forcing it to seek cover, and thus allowing the infantry to advance, which is its principal aim. It also watches the places from which the enemy might send out a counter-attack.

The infantry then advances as in ordinary attack.

The combat in this sector has the same aspects as elsewhere, but on account of the large force employed the results are greater. The successive efforts of the supports are more rapid, and thus they make a greater impression on the enemy and leave him no time for rest.

The attack cannot succeed unless the troops which carry it out are ready for any sacrifice.

PURSUIT.

Theoretically, a force which is victorious, that is to say, one which has succeeded in advancing and driving the enemy from his position, must pursue the enemy. A pursuit carried out directly after the success may have great results. In fact, the enemy, demoralized by his losses and by defeat, immediately after the action is at the mercy of a vigorous attack or partial enveloping movement. Cavalry especially, due to its rapidity and the moral effect which it produces, can change a defeat into a rout by harassing the hostile units.

But, in practice pursuit is rare. Generally, after a victory the victor is as weary as the vanquished. Human endurance has its limits. Save in exceptional cases, victorious troops cannot continue their forward movement without a slight pause, and history is there to prove it. Now, on the day after the defeat the defeated force is often already reorganized, rear guards are established, and it may suddenly face about.

Everything must be done to carry out a pursuit without counting too much on obtaining this result. A pursuit is generally carried out over a broad front, so as always to endeavor to envelop and turn the enemy. A march with widely-extended intervals in this case has few objections, because little is to be feared of an inoffensive and helpless enemy.

DEFENSIVE COMBAT.

The offensive is the only means of bringing about a decisive action; but we have seen that by order or through necessity certain units are sometimes held in place and forced to defend themselves.

The inferiority of the defense as compared with the offensive is due to the fact that it is uncertain of the direction in which it will be attacked. The offensive is free to move its reserves as it sees fit, and consequently to direct its principal efforts toward the most suitable point. This obliges the force acting on the defensive to block all the menaced directions. It must avoid scattering its forces, but must seek to increase its power of resistance by taking advantage of terrain which permits it:

(1) To diminish the strength of the troops charged with holding the enemy to the front.

(2) To keep in reserve a large force which will assume the offensive when the occasion presents itself, when the order arrives, or when it will be necessary to oppose a turning movement of the enemy.

Consequently, the commander of a force who wishes to act on the defensive:

(1) Selects a zone of resistance which, as far as possible, has the following positions:

(a) Artillery positions from which the probable points of exit of the enemy can be attacked.

(b) Good infantry positions, where the lines may be organized and which are well covered, well supported by artillery, reached with difficulty by hostile fire, and affording an open field of fire.

(2) Cover this zone of resistance with outposts which serve to maintain security.

(3) Form his reserves in echelon, in order:

(a) That he may act in directions conforming with the terrain and the mission.

(b) That he may oppose, if necessary, a turning or enveloping movement of the enemy.

The commander of the force does not provide for a rallying position unless he is sure of being obliged to retreat.

The organization of a second line of resistance presents grave difficulties. From the moral point of view, it tends to bring about the retreat of the troops holding the first line, and forces the troops

holding the second line to remain inactive during the combat on the first line, or become demoralized witnessing a defeat. From the material point of view, it absorbs the units which might be better used in assuming the offensive or even in reenforcing the line of resistance.

Except in extreme cases, only a single line of resistance is formed, which comprises:

(1) A zone of artillery position.

(2) A zone of positions in front of the artillery, firmly held by infantry.

First phase of defensive combat.

The first phase has the same characteristics as the corresponding phases of the offensive combat. It consists of partial offensive and defensive actions, during which each side studies its opponent, endeavoring to advance at every opportunity in order to wear out the attack materially and morally.

Second phase of defensive combat.

The commander of the defense, as soon as he feels that the attacking force has used up all its supports, makes preparations to assume the offensive. A forward movement may be the natural result of a successful counter attack.

The counter attack may be partial or general.

The purpose of a partial counter attack is the local defense of a position on the line of resistance, which may be accomplished by increasing the volume of fire. A general counter attack begins by increasing the infantry and artillery fire along the whole front, and is continued by the attack of a force formed at a definite point for this purpose. It may be followed by a general offensive action. The counter attack must particularly be on its guard against hostile artillery which is assigned to await such a movement. In fact, the attacking force can, to a certain degree, determine in advance the places from which counter attacks will be pushed out. The attacking force, therefore, keeps part of its artillery in observation of these places. It is important that the batteries be ready at the moment of the general attack.

Parts played by the different arms in defensive combat.

The infantry of the defense wins the various positions and holds them as long as possible. Its power of resistance, greatly increased by a judicious choice of well-sheltered firing positions, allows it to temporarily stop units much larger than itself. It energetically assumes the offensive when the occasion is offered.

Cavalry guards the flanks, which are often menaced by a turning or enveloping movement. It may thus render great service, as was the case of the cavalry on the right of the Russians at Moukden. It then enters into the combat at every favorable occasion, accompanies or masks counter attacks and cooperates with them, finally covering the retreat when it becomes inevitable.

Artillery delays with its fire the hostile units by forcing them to deploy. For this purpose, it may be used in its entirety from the very beginning. It prepares the way for counter attacks or general attacks, accompanying with its fire the troops engaged in them.

The engineers play an important part in a defensive action. They receive direct orders from the commander of the forces:

(1) To strengthen the supports with temporary fortifications;

(2) To establish communication in the event of a final retreat;

(3) Or, to destroy bridges, roads, etc., during a retreat, so as to delay the enemy.

Aeroplanes can quickly indicate to the main units the line of march of hostile supports and reserves, and detect turning and enveloping movements.

COMBAT BY NIGHT

Combat by night is becoming more and more frequent in modern warfare. It is generally carried on by infantry alone, aided sometimes by engineers. In fact, cavalry can seldom operate by night, except by moonlight or on very favorable terrain. Artillery can only fire in exceptional cases, as, for example, when the firing data have been determined during the day.

A night action usually takes place when two forces remain in contact after an unfinished battle. A force weaker in artillery than the enemy often finds it advantageous to attack at night.

The attack is resorted to in order:

(1) To gain possession of an exit for the troops on the following day.

(2) To recapture a position lost during the day.

(3) To surprise the enemy.

Night combat is often restricted to a limited and well-known objective. In fact, it is difficult for the main body to insure its advance by night over a broad front. Often overlapping and mistakes in directions result, which lead to disorder and confusion. The Japanese in Manchuria, however, often carried out successful night attacks.

Organization of a night attack.

The characteristics of a night attack are:

(1) The absence of "liaison par la vue."

(2) The impossibility, in most cases, of preparing the attack by artillery fire.

(3) The difficulty in indicating objectives and maintaining the unity of the attacking force.

These conditions make it necessary:

(1) To close the distances so that the enemy will not be able to get between the attacking units.

(2) To attack practically with the bayonet alone, so as to prevent the units from firing on each other, and increase the surprise by keeping down the noise.

(3) To divide the attacking force into units, each of which has a well-defined objective which it must reach at a certain time in order that the different attacks may be simultaneous. This may be called "Liaison by time" (Liaison par l'heure), which takes the place of "Liaison par la vue" and "Liaison par le bruit" (Liaison by noise). The objective of the different units are generally determined in such a way that the attack will end in surrounding the position to be captured, cutting off the enemy's retreat.

In this sort of combat more than in any other the infantryman must be of strong moral fibre, because he is left to his own resources at the moment of gaining contact.

ORDERS.

All the preceding matter shows the theoretical way of carrying on war, and forms the directing trend along which the decision of the commander must be guided without reference to personality. But correct ideas alone are not sufficient. It is necessary, also, that one

should know how to make one's subordinates carry them out. This result is obtained by means of orders, in which we pass from an idea to its execution—from theory to practice.

If the order is clear, precise, short, simple and easily understood, if it gives to everyone a clear and reasonable mission, it will be well executed.

If it is poorly conceived, confused, and likely to cause hesitation among the subordinates, it runs the risk of leading to disorder and reverses, even if the general idea is correct and in conformity with doctrine. Therefore, a commander must be able to determine upon and to assign the various missions in a clear and brief manner. This result can only be obtained through long practice. To be able to condense one's thoughts and impart them to everyone, avoiding cumbersome details, is, in fact, a great art.

If a commander should know how to frame an order, it is equally important that the subordinate should understand it. An order, merely by the fact that it is condensed, even if it be clearly expressed, is often difficult to grasp quickly. Frequently those who execute the order make decisions directly opposed to the purpose of the order, merely because they have misinterpreted it or passed over an important phrase. The best way of learning how to understand an order is to try to frame an order oneself, and above all, to understand the method of framing orders.

Various sorts of orders.

An order from a commander may be verbal or written. A verbal order is given to subordinates near at hand, when rapidity is necessary. A written order is preferable whenever there is time enough to frame it, which usually is the case. The subordinate can read it over and think about it, thus avoiding confusion. We can easily understand that if it is difficult to read a written order without leaving out any parts, it is still more difficult to understand a verbal order, which may often be misunderstood or incorrectly transmitted.

The order may be general or special.

A *general order* indicates to all concerned the general situation and the mission of each individual. It has the great advantage of giving all the subordinates an idea of the whole action, thus facilitating tactical connection between the various units and unifying their efforts. Moreover, it can be well understood, as it explains in

itself certain movements which, if taken alone, might at first seem illogical.

A *special order* is used when no other course can be taken, when, for example, an order must be sent to an isolated unit, when rapidity is necessary, when the secret of the project must be guarded, when particular parts of the general order must be given in greater detail.

There are many disadvantages in supplementing a general order by a series of special orders, as these often convey insufficient information and take longer to issue, because they must be written, one after the other. To decide upon the form to be adopted in issuing an order, we must make an estimation of the situation, just as was done in framing the order.

Issue of an order.

A commander who prepares orders must take into account the following considerations:

(1) The conception of the order.

An order must:

(a) Without ambiguity, explain to each person the end to be attained and the general means of attaining it.

(b) Avoid double missions, which would cause the person who is to carry it out to hesitate and fear to assume responsibility.

(c) Avoid the introduction of useless details the importance of which may be exaggerated.

(d) Allow the greatest possible freedom of action and initiative.

(e) Above all, be possible of execution.

(2) The material point of view.

(a) Read over the order carefully as soon as it is put in writing.

(b) Cut out every word which is not essential in understanding the text.

(c) Shorten sentences which seem too long.

(d) Give great attention to the form of the order.

(e) Use large handwriting.

(f) Underline important words.

(g) Put the entire order on one page, if possible, so that it may all be seen at one glance.

(3) Preparation of the order.

The main qualities of an order should be briefness and precision. When possible, it should be reduced to one or two sentences, which may be read and understood.

The order should only contain matter of general importance, avoiding all useless details. The parts which must be elaborated upon and only concern single units should be made the subject of a special order.

General Orders.

There is no fixed type for an order. The clearest and the shortest is the best. However, the method generally adopted in preparing an order has the advantages of preventing important details from being forgotten, and rendering the whole order more clear. Titles are unnecessary. Useless paragraphs should be avoided.

At the top write: "GENERAL ORDER." *Below* this: The place, date, and exact time of day.

Then: *Situation of the enemy*. This paragraph is usually a copy or brief of the information received, without comment.

Situation of the force in question.—The situation, which is briefly explained, indicates the position of the troops and the general end to be attained.

Mission of the detachment.—This paragraph is usually merely a copy of the mission. The decision usually follows the statement of the mission, in the same paragraph.

The detachment will move: on—(means) in order to—(purpose) or will take position *at* (means) in order to—(purpose).

When the mission has not changed since the last order, it is not necessary to repeat it.

If a body of troops is formed for the first time, in order to insure unity it is well to indicate in the order:

(1) Its composition.
(2) Its commander.
(3) Position of the various units of which it is composed.

It may be written thus:

The —— Reg. of Infantry at ——.
Two squadrons of Cavalry at ——.
Under the order of ——.
Has as its mission ——.
Therefore, it will move on ——, in order to ——.

CAVALRY.

Indicate

(1) The necessary reconnoitering patrols.

(2) Method in which the cavalry is to be divided.

(3) General mission.

Indicate this very briefly. The rest of the necessary information may be made subject to a special order, if necessary.

The other paragraphs of the general order have to do with the means employed in carrying out the decision:

To march, or

To take position.

MARCHES.

To set a detachment in march. *Route*.—Indicate very carefully the route to be followed, particularly so as to avoid confusion at points such as cross-roads, villages, etc.

Initial point of the march, or rendezvous.—The simplest way to indicate this is to give a brief table:

	UNITS:	TIME OF PASSING the initial point or distance
Advance Guard:	Cavalry platoons Battalions, etc.	X o'clock
Main Body:	Battalions Artillery Battalions, etc.	Time the head of the column must pass, or the distance from the tail of the advance guard.
Rear Guard:	_____ _____ _____	Time or distance from the tail of the main body.

Flank-Guards (if needed).

Each flank guard is treated separately.

The first thing determined is:

(1) Its composition.

(2) Its commander.

Then it is briefly determined whether it is to be fixed or mobile.

(1) *Fixed flank guard:*

(a) Zone toward which it must move.

(b) Part of the route of the main body which it must cover.

(c) Method of departure (isolated or behind the advance guard).

(d) Time of departure.

(e) Point at which it will rejoin the main body of the detachment at the termination of its mission, or place where it will take position.

(2) *Mobile flank guard:*

(a) Route to be followed, parallel to the main body.

(b) Time of departure.
(c) Point where it will rejoin the main body.
(3) *Mobile and fixed flank guards:*
(a) First position it must occupy.
(b) Portion of the route it must cover.
(c) Menaced directions which it must block, one after the other.
(d) Point where it will rejoin the main body.
(e) Time of departure.

OCCUPATION OF POSITIONS.

Indicate in order:

(1) *Position of the main body*.

The main body will enter into cantonments or encamp in the zone ——.

The Xth Reg. of Inf. at ——.

Artillery at ——.

(2) *Service of security:*

(a) Compositions of the outposts.

(b) Sectors, if designated, their commander, troops assigned to each, zones to be held.

(c) Positions of the outpost reserves, lines of support, sectors to be guarded:

A company, or two sections ——, will move towards ——, to hold the position from —— to ——.

(d) The partial reserves (if organized).

(e) The number of mounted men assigned to each unit.

(f) Steps to be taken in case of an attack (hold the line or fall back on ——).

SPECIAL DETACHMENTS.

Composition, position, and mission.

Tactical connection.—Indicate the units charged with maintaining tactical connection between neighboring detachments.

The general order then contains the following general indications:

Regimental trains: Indicate in a few words their place in the column or their position.

Place of the commanders of the column or the commander of outposts, or the route followed by them, designating place to which all information must be brought.

PREPARATORY ORDER.

A rather long time is required for preparing and recopying the general order, and therefore often it is not issued if the force must be moved immediately, or if there is any other way of issuing the necessary orders for immediate action, for example by telegraph. In this case it is well to send in an order to each of the units, the information necessary for starting on the march. This is called a preparatory order.

The commander then prepares a general order which more clearly designates the position of the various units.

The preparatory order may be: "Tomorrow march toward ——, leaving at ——," or simply: "Be ready to move at ——." if the force is covered and it is necessary to move forward, the order may be sent to the various units which must be assembled:

"Move at once toward —— with your force for the purpose of marching forward. Your rendezvous is covered."

ORDER FOR COMBAT.

During combat the orders are naturally very brief and simple. Generally, they consist of one or two phrases:

(1) The situation of the enemy and of the detachment in question.

(2) The general intention of the whole force.

(3) Its particular mission.

(4) Tactical connection to be maintained.

Special orders are used:

(1) To indicate to the units concerned details which would encumber the general order. The general order is sent along with the special order, and consequently there should be no repetition.

(2) Whenever the order merely concerns a single unit.

EVOLUTION OF IDEAS IN THE METHOD OF PREPARING ARTILLERY FOR BATTLE.

BY COLONEL AUBRAT.

Translated from the Journal des Sciences Militaires, beginning January 1, 1914, by 1st Lieut. N. Pendleton Rogers, Jr., Coast Artillery Corps.

PREFACE.

Since the War of 1870 there has been a constant search for the best method of instruction for preparing the artillery for battle, and this quest has finally resolved itself into seeking the answer to the following question: What ideas in effect at the present time shall be abandoned and what method of instruction shall be finally adopted?

This article is written principally to show the various stages of progress in the past due to the persevering efforts of the officers. Progress in the future depends to a great extent upon that already made, and it is felt that this presentation of the past will aid us in securing a clearer insight into the probable progress to come.

During the years preceding the adoption of rapid-fire guns, the principles of the use of artillery were never discussed. As long as the 80mm. and 90mm. guns were in use, all officers held the same beliefs; but since 1898 this has all been changed. The 75mm. guns had no sooner been issued than ideas began to change, the regulations were constantly being altered, and radical changes in the use of artillery were made. Artillerists who in the early part of 1898 were all of one mind, by the end of that year held widely varying opinions. Everyone was more or less affected by the widespread enthusiasm and began to realize that it was necessary to change the method of using the guns. Individual progress, however, was more or less rapid, due to differences in surroundings and temperament.[1]

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[1] In an article in the "Militar-Wochenblatt" of July 7, 1901, containing an analysis of the ideas of R. Chapelot published in Paris, the same year in a pamphlet entitled "What is the Present Status of the Tactical Use of Rapid-Fire Guns?", the author makes the following remarks on the state of mind of the French artillerists: "Since the adoption of rapid-fire guns by the French artillery, enthusiasm has run high. The officers are divided into two classes, the Conservatives (Konservataren), and the Radicals (Radikale). Of course, all the new ideas will not be accepted without opposition, but it is almost certain that the new regulations will be greatly affected by the ideas of the new school, represented in France by General Percin (Use of Artillery Fire) and Major Aubrat, who in a succession of articles appearing in the "Revue d'artillerie" fully explained the application of these new ideas."

Those officers whose minds were such that they could not get away from preconceived ideas, began by using the 75mm. guns merely as improved 90mm. guns. Always behind the times, they were slow to fall in with the new ideas, and in fact did not take them up until absolutely required to by the regulations. On the other hand, officers at all open to conviction admitted at once that the use of the rapid-fire guns would be very different from the use of the old types. This class of officers was responsible for all the changes in the use of the guns, and all practical suggestions made by them were little by little embodied in the regulations. Between these two classes were the rest of the officers whose opinions ran the entire scale from one extreme to the other.

At present the progress of ideas is far from being over, even though the end has frequently been supposedly reached, and those officers who are anxiously awaiting a definite and final plan of the use of artillery still have a long time to wait. Today, sixteen years after the adoption of the 75mm. guns, there is still a great difference between the opinions of the two extremes, and discussions are always more or less impassioned.

It is interesting to follow the progress made in these ideas, and an attempt will be made to show these stages successively, starting with the ideas universally held in the early part of 1898, and ending with all of the ideas held today by those officers who are considered as innovators. In taking up this matter we have no intention of going into new and comparatively unknown details, as we desire merely to show the relation between the facts and the cause of the change in ideas. We are firmly convinced that in such cases as this a thorough knowledge of the past together with a proper understanding of the same will prevent the recurrence of many errors and will point the way for future progress.

The reader who will follow us through the entire evolution of ideas may class himself with those whom we have called extremists. He will have a clear idea of the entire evolution of ideas, and will be able to decide which preconceived ideas to abandon, which new ideas to adopt, and which of the former even though given up by many others he will still retain.

Colonel Bielaieo, in the advertisement in the front of his book, "The Effect of the Russo-Japanese War on Artillery Tactics," published by R. Chapelot in 1908, said: "The theories of the use of the new artillery set forth in the works of Percin, Aubrat, Rouquerolle, and Lerond, assistants and pupils of General Langlois, have been brilliantly confirmed during the campaigns in Manchuria."

INTRODUCTION.

What was the Doctrine Universally Accepted in the Early Part of 1898?

To reconstruct this doctrine, let us go back to the period before the adoption of rapid-fire guns and recall the principles and rules controlling the artillery commander during exercises and the method of training the personnel.

The following principles were considered by all officers as dogmas: At the beginning of a battle, the opposing bodies of artillery took up positions on ridges facing each other and began the artillery duel. This duel took place as if in a ring, in view of both armies, and when it was over the victorious artillery, using such batteries as came through the duel successfully, opened fire on the opposing infantry.

The rules governing the installation of the battalions in battery and the distribution of the targets were as follows:

The officer commanding the troops indicated to the artillery commander the general position to be occupied by the artillery. The artillery commander picked out the most favorable ridges and there placed in battery the various battalions in the order of their arrival on the field. The commander of the troops never assigned to the artillery its mission, for this was always the same, *i. e.,* to silence the hostile artillery as soon as it appeared. Since the latter was always visible, the artillery commander merely divided them up among his battalion commanders, assigning to each as a target the particular battery or batteries which he considered most dangerous among those within range. The targets thus assigned were again subdivided by the battalion commanders and a target assigned to each particular battery. Upon completion of the artillery duel special tasks were assigned to each of the battalions and batteries.

Let us now take up the question of the method of training the personnel of the battalions to prepare them for battle. The 90mm. were always placed on or slightly in advance of the crest of a ridge, while the targets were generally wooden silhouettes representing guns in battery, lines of skirmishers, infantry in line or column, etc. These silhouettes were so placed as to be visible from the battery when in position, and were pointed out by the battery commander to the men, and particularly to the chiefs of platoon and gunners, who then selected their targets. Each gunner then

aimed at the silhouette chosen in exactly the same way that an infantryman aims his rifle.

The battery commander controlled the fire, that is, determined the elevation to be used, by observing the location, with respect to the target, of the bursts of trial shots fired with varying elevations. As soon as this elevation was determined the battery delivered a heavy fire, using both time and percussion fuses, and the balls and fragments of shell riddled the wooden targets. When this firing was completed the battery commander either changed his target or else took up another position and repeated the operation just described.

The Evolution of Ideas and the Various Stages Therein.

The reader is now thoroughly conversant with the doctrine universally accepted at the time that it was about to be altered, for this was just at the time that the first steps were taken in the evolution we are about to describe. This evolution was brought about by the progressiveness of those young officers called upon to command batteries and who were thrown into daily contact with the 75mm. guns, for in this way they were the first to appreciate the capabilities of the new matériel and to break away from the old ideas.

By the time the battery and battalion commanders were thoroughly acquainted with the use of the new guns assigned to them, the colonels and general officers in their turn determined the proper employment of the divisional and corps artillery.

As we wish this article to be arranged chronologically, we will take up: First, the successive changes in the method of handling the artillery by the battery commander, due to the adoption of the 75mm. guns; second, the effect of these changes on the general use of artillery.

These changes and their effects have been very great. We will not go into this matter in detail, but to show the progress made will only discuss the successive stages in the following:

The choice of artillery positions;

The form of the targets;

The methods of firing.

The discussion of the above will take up the first part of this article, while the second part will show the modifications caused by these changes in the rules governing the following:

The choice of positions;

The distribution of targets, the assignment of missions, and the fire control;

Service target practice.

PART I.

THE SUCCESSIVE CHANGES MADE IN THE METHOD OF CONTROL BY BATTERY COMMANDERS BY THE ADOPTION OF THE 75MM. GUNS.

Selection of Battery Positions.

While the 90mm. matériel was in service and for a short time after the adoption of the 75mm. guns, artillerists always placed their guns on the crests of ridges. At the present time the following rule, which the originators always applied strictly, is usually applied:

Choose such a position as will give the battery the maximum amount of cover compatible with the proper execution of the task assigned.

At present, however, due to the ease with which the 75mm. guns are aimed, even when concealed, and also to the fact that it is as easy to control a battery under cover as in the open, there is only one consideration limiting the extent of cover, *i. e.,* that the position shall be such that projectiles fired with the minimum elevation shall not penetrate the screen protecting the guns from the view of the enemy.

Experience has shown that to give the guns the maximum amount of cover compatible with their mission they must be placed somewhere other than on the crests, and in fact should be placed so as to be screened by the convolutions of the ground or concealed behind woods, houses, walls, etc., or under cover of some kind.

The originators never selected a position on a ridge for the 75mm. guns, though this was the position always selected for the 90mm. guns. At first, when the new matériel was more or less strange, the 75mm. guns were placed in the same kind of position as would have been used for the 90mm. guns, but little by little they disappeared from the ridges and at the present time occupy such positions only in exceptional cases when there are very important reasons for placing them there. Therefore, as far as the selection of positions is concerned, the artillerists of today without exception do

exactly the opposite of what was done by everyone up to and including 1898.

Stages in the Evolution of Ideas.

These stages may be divided as follows:

1st. Crests of ridges;

2nd. Cover for the matériel with respect to the target; the guns placed slightly in rear of the crests; the gunners could just aim through the sight at the target without being prevented by the ground;

3rd. Cover for a man standing with respect to the target; the guns placed still farther to the rear than in the preceding case; the gunner could no longer aim through the sights at the target, but by standing erect just behind the piece he could give it the general direction;

4th. Cover for a man mounted with respect to the target; the gun given direction by the battery commander, the chief of platoon or the gunner mounted (on a horse) just behind the gun.

During these first four stages the artillerists were still somewhat influenced by the old errors. Cover was always taken with respect to the target, and it was not until later when they had discovered a method of easily aiming the guns under all circumstances, that they were able to get out of these habits and select cover, not with respect to the target, but, as is most logical, with respect to the enemy's artillery. Thereafter, whenever possible, cover was chosen which would hide the flashes of the guns from positions, that might be occupied by the hostile artillery. This may be called the next stage, or:

5th. Concealment of the flashes from the enemy's artillery.

Finally the old errors were all corrected by not occupying the ground immediately in rear of a crest, where a battery ran the risk of being destroyed by torpedo shells, and adopting the following rule which may be considered as the next stage; or:

6th. The best positions are those in which the guns will be masked by distant ridges, woods, houses, walls, embankments, etc.; batteries in occupying such positions will make use of the maximum amount of cover compatible with their mission.

Approximate Dates of the Different Stages.

The first provisional regulations for the 75mm. matériel was the

work of the members of the commission for the practical study of fire of Poitiers. It was distributed to the officers soon after the issuing of the new guns. These regulations prescribed the positions to be occupied with reference to the amount of cover, and while it was not expressly stated that the cover was taken with respect to the target, this was deduced from the fact that the amount of cover depended on the method of sighting at the target. These regulations prescribed four degrees of cover, as follows: For the matériel, for a man standing, for a man mounted, and for the flashes. This classification shows clearly that in the minds of the members of the commission, artillery in the future, would usually occupy positions concealing it from the enemy. With respect to the degree of concealment, however, their ideas were still very much confused.

In 1903, the practical course recommended in most cases as the most desirable cover that for a man standing, and at this time this was a very satisfactory decision. The protection afforded by this amount of cover was sufficient to give a decided advantage when opposed to the artillery of those nations which had not yet adopted rapid-fire guns, and which as in the past continued to take up positions on the crests of ridges. In addition, with only this amount of cover, the old methods of aiming the guns gave perfect satisfaction. These methods, however, were useless if the cover was greater than that for a man standing, or if the post of observation of the battery commander was at any distance from the guns.

It was at this same time that the practical course of fire first recommended the occupation of positions located elsewhere than in rear of ridges, as for example, in valleys behind various screens.[2]

During succeeding years, the situation changed little by little. In France, the methods for giving direction to the guns and for determining firing data were improved, while abroad, the different powers in turn adopted rapid-fire guns. Artillerists, in order to minimize the effect of the fire of hostile artillery, increased the amount of cover more and more, until it became a case of going each other one better in an attempt to find the method of doing the greatest damage to the enemy, and at the same time, due to the extent of the cover, themselves suffering the least. The practical course of

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[2] Since 1900, we have recommended the occupation of such positions for service practice and during field exercises. (See—"Field Exercises for Artillery Battalions," Extract from the "Revue d'artillerie," April, 1899, and March, 1901.)

fire in 1905, adopted the following rule: Batteries will take cover at least as great as that for flashes with respect to the position of the hostile artillery, whenever such cover is compatible with their mission, and is not prevented by considerations of command, observation, or communication.

As shown by the above, the progress of ideas among the members of the practical course of fire, who were using the 75mm. guns every day, was very rapid. Among those who were not using these guns as often, progress was slower, while among those who were not thrown into contact with the artillery at all, progress was practically nil. This explains many criticisms, some of which will be quoted hereafter, for they were made by officers who had only a very superficial knowledge of the properties of the new matériel, which had been in service only a short time.

In 1903, during the fall maneuvers in Lauraguais, most of the artillerists placed their guns on ridges, though there were a few that placed them under cover, showing that at that time a tendency to conceal the guns already existed.

In 1905, during the fall maneuvers in Champagne, the Chief of Artillery settled the question of cover for the artillery in the following words: "Artillery should never be concealed. I want the target to be seen from the guns, and when I say 'to be *seen,*' I say so intentionally. To certain batteries of the advance guard and to them only is authority to take cover given."

We have never for one moment thought that in giving this order the General had the slightest intention of prohibiting the concealment of the guns on the battle field; all that he intended was to control the placing of the artillery during the maneuvers. His order was, however, at that time justified for if we had been actually in the field, any hostile batteries, if under cover at all, would not have been so much so that most of them could not have been located by the flashes. During maneuvers, however, the supply of ammunition is so limited that concealed batteries are seldom located in this way. It was without doubt to compensate for this difference in visibility during maneuvers that the batteries were ordered to take up positions on ridges. Whatever the facts of the case, this order stirred up violent discussions between those who believed in cover during maneuvers in time of peace as well as during actual warfare and those who believed in only that amount of cover that allowed the guns to be aimed directly at the target.

During the same year of 1905, we were fortunate enough to attend target practice at the camp of Chalons. We refer to this practice because it assists in the determination of an important date.

A battalion was directed to take up a position in rear of the Niel ridge in order to fire at the wooden targets representing infantry placed among the bean hills of Vadenay. The cover ordered by the artillery commander was that for a mounted man in order that the batteries might take up position without being seen. The General said merely, "without being seen," believing it unnecessary to add "from the targets," for as shown at the critique, he, of course, meant that and supposed it would be understood. The battalion commander, however, imbued with the ideas of the course of fire, established his batteries using cover for a mounted man, not with respect to the target but with respect to the crest of the ridge of Vadenay, above and beyond the targets, in rear of which ridge it was perfectly reasonable to suppose the hostile artillery would take position. The batteries as placed had, with respect to the infantry targets placed on the near slope of the hill, a greater cover than that for a mounted man and also greater than that ordered by the General, who during the critique asked why the batteries had taken so much cover. The battalion commander explained that this cover had been taken with respect to the ridge in order to prevent its being occupied by the hostile artillery. This explanation greatly surprised the General and many of the other officers present, as if for the first time the idea had occurred to them of placing batteries under cover with respect to a ridge, possibly concealing hostile artillery which might become dangerous, rather than with respect to the targets at which they were to fire.[3]

In 1908, we took part in the fall maneuvers of the 6th Corps in the East. No orders were given to the artillery, other than that they comply strictly with the regulations, and for the first time we saw the commander of the divisional artillery require strictly that the batteries exactly simulate war conditions and take all cover available and suited to the particular situation. What was the result? The artillery of each side could not be located by the opposite side,

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[3] Today we are surprised that it took so long for officers to appreciate the value of such ideas. Two years before, in 1903, during the practical course of fire at Poitiers, the instructors were in the habit of treating in a rather off-hand way, the question of the selection of positions allowing the guns to fire at a target in the valley and at the same time providing the greatest amount of cover with respect to the hostile artillery.

even when occasional flashes were seen. We were convinced that in a fight against concealed artillery, the first data for firing, could be obtained only from the bursts of the shells, for in this way only was it possible to determine the direction (and sometimes the range) necessary for laying the guns. Today even the same thing is more or less true for there is no certainty that aerial scouts will always be available.

One day, at the end of an engagement, the only part of the artillery on one side engaged consisted of two pieces in a concealed position, while opposed to them was a brigade of infantry and three batteries of artillery of four pieces each. The lieutenant in command of the two guns fired very rapidly and the commander of the opposing forces was convinced that he had in front of him the entire two batteries which he knew were attached to the other side, and it was not until the critique that he found out that there had been but two pieces and where they had been. We do not wish to convey the idea that two pieces are equal to twelve, but we do believe that for a short time they can give the impression that there are engaged, not two pieces but two batteries. The effect would be still greater if the batteries were using service ammunition.

These two examples show the value during all field exercises of simulating as nearly as possible war conditions. If this had always been done, it would have taken the artillerists a much shorter time to employ the 75mm. matériel as it is used today. If these ideas, together with many others now accepted by most officers, had been sooner taken up, the following rule would have been in effect for some time, *i. e.,* "the artillery commander, in order to deliver his fire at the targets under the most favorable conditions, should not hesitate to place his batteries in a number of different lines, nor to use varying degrees of cover."

Form of the Targets.

During the time that the artillery was equipped with the 90mm. guns and for some time after the adoption of the 75mm. guns, the targets usually consisted of wooden silhouettes. They were shaped to represent guns in battery, lines of skirmishers, infantry in line and in column, etc. These silhouettes were always placed in full view of the batteries firing, from where they were usually plainly seen, though to increase the visibility they were frequently painted

white, and placed so that even the bottoms of the boards were in sight.

Since the adoption of the 75mm. guns, opinions have undergone a considerable change and today the innovators have a very different conception of what a target should be. The last war demonstrated that the modern guns and rifles absolutely force deployment. A body of troops in close order only in rare cases exposes itself to the view and the fire of the enemy. In battles of the future, the normal target will be troops in line of battle delivering a heavy fire of shot and shell. To put this in another way the target will be either a line of skirmishers and the supporting troops or masked batteries. These targets will be marching, maneuvering, and firing. There will be the whistling of the bullets, the noise of the rifles, the explosions of the shells, and the booming of the cannon. The troops while remaining themselves practically invisible, will be able to locate the enemy behind the ridges and under cover only by seeing isolated men or small parties, by reconnaissance, by the dust, the smoke and the flashes, etc. All this will keep them constantly in a state of extreme tension.

A target of this kind is troops actually fighting, not a line of lay figures, which are inert and could represent only the dead. The question then becomes: How can we represent for target practice troops actually fighting?

An officer is designated to direct the target practice of each battery. Throughout the exercises, he remains with the battery commander and by a series of word pictures indicates to the latter the various stages of an imaginary battle. The battery commander is therefore able to practically simulate actual conditions, and must immediately size up each situation in order to take such steps as are required under the particular circumstances.

Target, A Line of Skirmishers.

Formerly the officer directing the exercises merely pointed out to the battery commander the line of skirmishers represented by the wooden targets, which was assigned to him as his particular target, and this was the extent of his rôle in the exercises. Today this is no longer the case. A battalion commander does not specify what the battery commander is to do but merely indicates to him the supposed situation in an imaginary battle. For example: He

points out our own line of skirmishers and assumes that they are firing and also indicates the position of the hostile line of skirmishers or of bodies or even isolated men. As soon as he is certain that the battery commander thoroughly grasps the situation, he directs him to act as if he had discovered the enemy just as the line of skirmishers moving at a run was approaching or leaving the firing line. This is the method of first designating a target.

It is not always necessary to place silhouettes in the field of fire, for the director of the exercises can usually indicate the positions with respect to ditches, hedges, thickets, piles of stone, etc.

From time to time after the ranging fire has begun, the battalion commander furnishes the battery commander with additional information, part of which will affect the method of conducting the ranging practice while other parts will require the delivery of an effective fire.

The battalion commander may make any of the following assumptions:

The enemy's line has been reinforced and occupies a position against which an attack must be made;

The friendly infantry is preparing to charge the enemy's position and the battery is to act in conjunction with the infantry;

The friendly infantry is forming a dense line and advancing and will reach a certain position.

Target, A Battery.

Formerly the director of the exercises would have said: "Target; the battery represented by the six silhouettes in such and such a place." The battery commander would have taken up the fire and destroyed the figures.

Today the battalion commander designates the target in an entirely different way. He may say: "A battery to your right front is under a heavy fire which prevents it from accomplishing its mission which is to prevent the advance of the hostile infantry up this ravine. Mission; silence the hostile battery that is delivering this fire." He would frequently add: "The location of the hostile battery is unknown. An aerial scout is (or is not) placed at your disposal." The battery commander must then locate his target with (or without) the aid of such a scout. His mission is very definite. He must discover from the reports of the guns the probable location

of the hostile battery and when this is determined, to take up the fire as demanded by the requirements of the situation.

The director of the exercises outlines to the battery commander a series of word pictures, describing actual conditions that might exist. The method of locating the target, the determination of the firing data, and the delivery of an effective fire, or in general the method of operating, is constantly influenced by these pictures of an imaginary battle.

Since the hostile battery is considered as being invisible it is not necessary to represent it by actual targets except when the battalion commander wishes to actually fire projectiles or to make use of an aerial scout.

As it is absolutely necessary for a director of target practice to know the results of an effective fire delivered with data obtained by ranging, the following scheme is recommended: Place a silhouette or similar target in a location known only to the director of the practice and for the target for firing use a tree or bush, the corner of a woods, a stretch of road, etc., in the same vicinity. To check the firing on the target, get the range from the guns to the figure or the natural feature representing it, and the data thus obtained compared with that used for the firing will show whether or not the fire constructively delivered was effective. The use of figures in this way or of the features of the terrain representing them, avoids the many inconveniences accompanying the placing of targets, providing shelters for observers and establishing a telephonic communication, usually unreliable, between these shelters and the position of the guns. In addition to these advantages, it promotes an economy in the use of ammunition by obviating the necessity for trial salvos, which formerly were necessary.

To sum up: The old wooden targets, placed in full view, visible and as immobile as a wall, have been replaced by targets not necessarily represented by figures since they represent troops nearly and sometimes entirely invisible, but assumed from the information contained in the word pictures furnished by the director of the practice to have the power of real troops to maneuver and fire. In other words, the actual targets are replaced by the disclosure of a series of situations which might actually arise in war, bringing to the mind the picture of the field of fire with troops actually fighting thereon, and a portion of these troops whose position is marked either by a silhouette or a hedge, etc., is the target of the battery.

Stages in the Evolution of Ideas.

1. Silhouettes or similar targets placed so that even the bottoms of the boards were plainly visible from the battery;
2. Silhouettes slightly concealed, representing infantry or artillery; disappearing targets, allowing the silhouettes to be visible for a short time;
3. Silhouettes representing skirmishers behind embankments, in shelters or trenches, or artillery so masked as to be only slightly visible;
4. Lines of skirmishers and infantry and artillery troops whose positions were indicated by the following: For infantry, by accidents of the terrain, roads, ditches, edges of cultivation, etc., and for artillery, by flashes, smoke, explosions of shells using percussion fuses, etc. The explosion of shells could only be used when firing could take place in diametrically opposite directions.
5. Same targets as the preceding but the director of the practice was not satisfied to have them remain in one position during the entire time, as if they were alive only for the particular instant when they were designated. They were given the properties of a live target throughout the phase by a succession of situations in an imaginary battle, which made the battery commander simulate actual conditions.

Approximate Dates of these Stages.

Both the choice of position and the form of the target passed through the same phases, but progress in the latter was much slower than in the former, but this is easily explained, especially with reference to the artillery target. Rapid fire guns were not adopted by the other Powers until many years after they had been adopted by the French. It was therefore natural that while the 75mm. guns were being usually fired from behind cover, the batteries representing the target were still placed in full view on ridges, since that was the position that would have been taken by a German battery. Since 1902, however, on account of the adoption of rapid fire guns by the other Powers, in the practical course of fire at Poitiers, for outdoor drills and consequently for service practice, every effort has been made to give the officers as targets, masked batteries assumed to be real throughout the practice, in order to give the impression of being real batteries. The instructors were

clever enough to get away from the old mistakes and to no longer use the visible wooden targets representing infantry or artillery, considered against all reason as remaining upright and immobile under the fire of the artillery.

It is impossible to say how much firing at targets considered as alive has aided in the proper determination of the instruction and at what point the reverse is dangerous.

In 1905 there were still many artillerists who had never fired at anything but perfectly visible wooden targets, and when after several volleys or a series of progressive fire they found the targets full of holes, they naturally concluded that an enemy would have been destroyed. Under these conditions, the idea of considering the targets as alive, at least after the firing had started, never occurred to them, for they believed that their task was over as soon as they had delivered a destructive fire.

In 1906, at the camp of Chalons, during a service practice for a number of general officers, we noticed the assignment to a battery of a target consisting of about forty skirmishers, upright and painted white, covering a front of about 50 meters, and placed slightly in front of a wood and at the head of a shallow depression. Real skirmishers would have gotten out of sight of the battery either by lying down in the wood or in the hollow. The battery commander calmly opened fire on these skirmishers. He secured a 50-meter bracket and when this was determined, delivered an effective fire. No one dreamed of considering these skirmishers as alive and the battery acted as if they would remain upright and immovable during the ranging fire until the 50-meter bracket was obtained. Such is the force of habit, that at the critique, no one dreamed of calling attention to this absurdity, and the battery commander was highly praised for the way in which he had conducted the practice.

During the following years, through 1911, we noted many other batteries which fired their ranging shots at standing skirmishers, represented by white figures, considered as remaining stationary throughout the firing. Such cases, we are glad to say, have now become exceptional, but it is astounding that it took so many years to root out such mistakes. And what an absurdity, what a waste of ammunition. Such firing is the opposite of preparation for war.

It is unnecessary to state that the form of the targets is of

primary importance and should be such that firing will as nearly as possible simulate war time conditions. The use of silhouettes as above described could have a most unfortunate effect on the instruction of the officers.

During the years 1905, 1906, 1907, we talked with many officers at the School of Musketry at Chalons. There were present there each year 250 officers, principally from the infantry, of whom about 150 were field officers. These officers were all questioned as soon as they arrived at the school, and they all knew the high percentages of hits obtained with the 75mm. guns firing at infantry targets. During target practice at Poitiers in 1897, 1898, 1899, the batteries always fired at visible and immobile silhouettes. Figures of 50, 60 and even 90 per cent were often obtained at these practices, and all officers appeared to be much impressed by such figures. Nearly all them concluded that only after the artillery had massacred parts of the enemy's line, would it be necessary to send the infantry forward. Deceived by these figures, made on unconcealed and unsheltered silhouettes, which were far from the figures of actual war, they failed to see any reason why the infantry should advance while the artillery was firing, the absolute necessity of which has been so well demonstrated by General Langlois in his works. If at that time war had broken out, the action of the infantry would not have been concomitant with that of the artillery. The infantry was about to fall into the same mistakes that were so frequent in 1870, which General Metzinger so plainly sets forth in the following anecdote:

"In 1870, a regiment of the Vinoy Division, at the beginning of the siege of Paris, was charged with the storming of the village of Hay, occupied by the Prussians. This regiment, composed of excellent soldiers, advanced boldly to the attack. To support the attack, the artillery took up a position in rear of the infantry and opened fire on the village. What was the effect of the fire of the artillery? The attack immediately stopped. Why? The same thought had come to everyone at the same instant. What is the use in being killed by the Prussians? The artillery is going to massacre them, and when they have finished their work we can advance without danger."

We will only add that the attack on Hay was a dismal failure.

This example is typical and shows clearly the ideas which the officers at the School of Musketry must bring to light and what

kind of firing must be used to make the officers change their convictions. Artillery does not always kill, in fact the losses which it inflicts are often small. It has, however, a powerful effect in preventing the enemy from advancing or firing, at least firing accurately. The infantry should therefore advance while the artillery is firing, since at this time it runs the least risk.

We wish to repeat, since it is of particular interest in view of the position we hold in this matter, the remarks made by us and submitted to the War Department in 1906 and 1907, on the subject of a neutralizing fire on an infantry line.

The paper in question had the following title: "Recommendations with Reference to Modifications in the Artillery Drill Regulations."

When the 75mm. guns were first adopted, the rules governing artillery charged with neutralizing the fire of a hostile infantry line were contained in paragraph 677 of the regulations, and were the rules applying to the 90mm. guns.

Article 677 was worded as follows:

"Artillery ordinarily fires over the friendly troops, but the projectiles must pass at a height sufficient to avoid any feeling of uneasiness."

"The ground for 500 meters in front of the batteries is considered the danger zone."

"When the friendly troops are within 500 meters of the target, firing will cease or will be changed from the enemy's firing line to the reserves in rear."

The following are our remarks on this article:

"Let us analyze the three fundamental rules contained therein."

"'The projectiles must pass over the troops at a height sufficient to avoid any feeling of uneasiness.' The noise caused by the passage of projectiles over troops always affects them very disagreeably. This noise, however, varies only slightly with the height of the trajectory, and a projectile passing overhead at a height of 40 meters produces as disturbing a sound as one passing at 20 meters. Whether the projectiles pass at a greater or less height is of only comparatively slight importance, the important point being that the troops should see the shells bursting regularly well in front of them."

"'The ground for 500 meters in front of the batteries is considered the danger zone.' This requires that the infantry place itself at least 500 meters in front of the muzzles of the guns or

that the artillery take up a position at least 500 meters in rear of the troops. The regulations for the 90mm. guns as well as the first regulations for the 75mm. guns, prescribed a distance of 500 meters because the only case they knew anything about was that of a battery placed on a ridge and firing often at less than 1,000 meters. Assuming the present theories on the use of artillery, it would appear that in future battles the batteries will usually be placed where they are hidden from view. This will frequently be far in rear of and below the crests, and sometimes even under cover on counter-slopes or in depressions. The batteries will certainly never be placed on the crests. Under these conditions, the regulation fixing 500 meters as the width of the danger zone in front of the guns, is undoubtedly a mistake. When artillery is in position far in rear of and below a crest, all of the rising ground in front of the muzzles and even the ground immediately beyond the crest, frequently more than 500 meters, is often dangerous. The troops should not cross this zone, not only during the ranging fire, but even later, for variations of range causing shells to fall therein are often to be expected. It is only by inquiry of the artillery commanders, and especially the battery commanders, that an officer can know when it is safe to pass under the trajectory, and where to halt his troops. When the artillery is on a counter slope, as the ground in front of the guns is descending, the infantry may be immediately in front of the muzzles of the guns, though they should be far enough in front of them not to be annoyed by the sound of the firing, say 50 to 100 meters."

"'When the friendly troops are within 500 meters of the target, firing will cease or will be changed from the enemy's firing line to the reserves in rear.' This distance of 500 meters was perfectly reasonable as long as the artillery was equipped with the 90mm. guns, and when the use of the 75mm. guns was still imperfectly understood. Today, however, this distance should be changed. Let us follow the operations of a battery which in an attack has been designated to neutralize the fire of an enemy's line. When the attack begins, the battery commanders have their firing data, and almost all of them are delivering an effective fire. Formerly, when using the 90mm. guns, the gunner after each shot had to assist in running the piece forward, and then in spite of the fatigue caused by this, to again aim the piece, being bothered also by the smoke enveloping both the piece and the target. Under the circumstances,

large range errors were frequent, and the requirement of ceasing the fire or changing it from the firing line to the reserves in rear, when the friendly troops were within 500 meters of the target was entirely justifiable. Today, however, conditions are very different. The 75mm. guns when firing with percussion fuses, can really support the infantry without danger, practically until contact. They need not change the fire to the reserves, until the infantry arrives at some plainly marked point, say 150 meters in front of the target. The 75mm. guns, after once firmly seated by the firing of several shots, will continue to fire without sensible alteration of the setting, so that the gunner does not need to aim the piece after each shot. If a 75mm. gun, *without relaying,* is fired, for example 20 times, all the shells will burst at practically the same point. Sometimes after the twentieth shot, there is a slight sinking of the trail, which increases the range a little, but never more than 50 meters."[4]

"Due to the regularity of fire with percussion fuses, which can be depended upon on the battle field, since it is obtained without aiming, the personnel merely loading and firing, artillery can support infantry until contact with the enemy's line. If the hostile line is at a range of 3000 meters, projectiles fired at the last minute, when the infantry is 150 meters from the enemy, will pass above the troops at a height of at least 20 meters, which is increased to 25 meters, if the ground in front of the enemy's line slopes downward, if even only slightly."

"Seeing the shells falling regularly among the enemy is, for well trained infantry, advancing to the attack, a sure sign that the artillery is actively cooperating with it[5] and that it can advance to within 150 meters of the enemy without danger of being hit by short shots. Later, seeing the shells bursting in rear of the enemy's line, is for the same infantry, another sign that the artillery is cooperating with it,[6] and that it can throw itself on the enemy without danger of being struck by the shells. The changing of the fire to the enemy's reserve also shows the infantry that the enemy

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[4] This experiment was always made before the student officers at the School of Musketry in order to demonstrate to them the facility with which the artillery of the present day could support an attack right up until contact.

[5] At this stage of a battle there is no other way of establishing coöperation between the infantry and artillery. (J. des Sc. mil., 16 S. T. VII.)

[6] At this stage of a battle there is no other way of establishing coöperation between the infantry and artillery. (J. des Sc. mil., 16 S. T. VII.)

is a comparatively easy prey since the firing line cannot be reinforced."

One year after the preceding was written, we were pleased to hear that a new draft of paragraph 677, partially agreeing with our ideas, had been made, and included in the regulations. The new paragraph was as follows:

When firing on level ground, using time fuses fire will cease or will be changed from the enemy's firing line to the reserves in rear, when the friendly troops are within 500 meters of the enemy. Advantage will be taken of any favorable circumstances, which in many cases will allow the firing to continue until the friendly troops are much nearer the enemy's position; such as, the slope of the ground, the ease of observing the points of fall, the accuracy of the ranging and the data secured, and the use of percussion fuses.

After the publication of the amended paragraph we wrote as follows: This gives great satisfaction to those who hold the present ideas and is a big step forward. In the future an artillery commander using percussion fuses, can support his infantry until actual contact without breaking regulations. It is a pity, however, that the new regulation does not require the artillery to thus support the infantry whenever possible, and make the exception the case when the fire is to be changed to the reserves when the troops have approached within 500 meters of each other. It would seem to be better to prescribe that the artillery will make every effort to support the infantry until contact, and will act otherwise only when unfavorable conditions necessitate it, such as, level ground, difficulty of observing the points of fall, impossibility of determining the distance to prominent points which the infantry must pass, etc.

To sum up, it seems to us that paragraph 677 might better be made to read as follows:

The artillery ordinarily fires over the friendly troops. The danger zone in front of the batteries is variable and its limits will be set only by the artillery commander.

When the friendly troops approach within 500 meters of the targets at which the artillery is firing, the latter will use only percussion fuses. If the artillery can accurately control this fire, it will change the fire from the enemy's firing line to the reserves only when contact is made, that is when the two firing lines are about 150 meters apart.[7]

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[7] The German regulation is as follows: "The artillery may fire over the heads of the troops when they are more than 300 meters from the guns or more than 300 meters from the enemy.

These are very nearly the same as the new regulations, the only difference being in form.

By taking advantage of all favorable conditions, such as, nature of the ground, good observation, accurate ranging, oblique impact, use of percussion fuses instead of time fuses, etc., it is possible in most cases to fire on troops being attacked practically until contact. On level ground and under poor conditions of observation, firing with percussion fuses will be sustituted for firing with time fuses when the two parties approach within about 500 meters of each other.

METHOD OF FIRING.

All firing may be considered as being divided into three stages: preparation, ranging, and effective fire.

Preparation for Firing.

With the 90mm. guns and also with the 75mm. guns when first placed in service, the rôle of the captain during the preparatory stage consisted merely in pointing out to the chiefs of platoon and gunners the wooden silhouettes assigned as targets, and in determining the data for the beginning of the fire. Each gunner aimed his piece, at the foot of the silhouette allotted to him as his particular target by the chief of platoon, using the range given by the captain, and the preparation for firing was completed. Today preparation for firing is conducted very differently.

We have previously stated how, in our opinion, an objective should be pointed out. The director of the target practice should always place before the captain the picture of an imaginary battle and assign to him the mission of his battery. This being done, the captain would proceed as follows: Since the guns are nearly always concealed, the gunners cannot see the target and therefore cannot aim at it. One gun, usually that on the right, is pointed at some prominent feature in the field of fire, such as a steeple, a house, a tree, etc. Then by the use of aiming points or the process of reciprocal aiming, the axes of the other guns are arranged in the form of a regularly opened sheaf, like a fan, the one on the right passing through the prominent point selected. Without moving his piece each gunner directs his sight on some prominent point and notes the deflection. The sheaf of the four lines of fire is thus

determined and may be reformed at any time by means of the deflections noted and the aiming points selected by each gunner.

When an objective is assigned to the battery commander, he measures the deflection in mils between the right of the target and the prominent point in prolongation of the axis of the right piece, where, using the usual expression, the sheaf is "hung." The four guns are then turned in the proper direction the amount necessary to put them on the target. All that is now required to commence the fire is to determine for the four guns the proper angle of site, angle of elevation, and corrector.

STAGES IN THIS EVOLUTION.

1. Pointing in direction and range by aiming each gun at the portion of the target assigned to it. This method was always used for the 90mm. guns since for them laying with a quadrant was very exceptional.

2. Pointing in direction only, obtained by aiming at the target as above described, laying for range being by the use of a quadrant for giving the elevation for the angle of site, the angle of elevation being secured automatically by means of a range drum. This method of pointing was exceptional for the 90mm. guns, but is the normal method for the 75mm. guns.

3. Pointing in direction is collective instead of individual. The four pieces are aimed in direction by having the gunners all use the same aiming point and varying the deflections so that the axes of the four guns form a regular sheaf, and then turning this sheaf on the target. Laying in range is as above described.

4. The extent of the cover prevents the use of aiming points near the objective. The lieutenant, instead of the captain, forms the sheaf, and uses the method last described. The right piece is directed on some prominent point and by means of aiming points or the process of reciprocal aiming the sheaf is formed, and as soon as this is completed, the pieces are trained on the field of fire. When an objective is assigned to the captain, he turns the guns sufficiently to point them in direction.

Ranging.

Up to 1898 there was only one method of ranging for the 90mm. guns, and during that year, for the 75mm. guns also, and this all

the officers observed to the letter. Firing was identical for all targets, irrespective of the tactical situation. The reason for this, however, is plain. The objective was always represented by wooden targets, placed in full view, so that, as a matter of fact, in the field of fire, there was only one kind of target, made of wood and representing infantry, artillery or a wall, depending upon the shape or even the designation given to it by the director of the target practice.

At the risk of astonishing their fellow-officers, the innovators said: "There is not only one method of ranging; there are certain devices used for firing and certain principles governing the use of these devices." There is not only one method of ranging, there are as many as there are concrete cases.

The personnel serving the pieces should be trained in all the mechanical operations of firing and the battery commanders should employ all the equipment to the best possible advantage in each particular case. To this end, they should be trained in the solution of all problems of fire which might occur on the battlefield. Faced with any particular condition of affairs, they should always be able to find a satisfactory solution.

Formerly the instructors pointed out faults in the methods used, but today this is not the case, for now they call attention to errors of observation, improper use of the matériel, hesitation in the delivery of an effective fire, and most important of all, errors in the estimation of the tactical situation.

The method of ranging varies with the nature of the objective and the tactical situation. It is not conducted similarly for a body of infantry in close order or a wall, for a line of skirmishers or a support moving to the assistance of a firing line, for artillery in battery, when the pieces are wholly visible or are located by flashes or smoke, when they are disclosed by the bursts of the projectiles, some of which using percussion fuses make furrows in the ground, or are revealed by an aerial scout.

The method of ranging will also vary as much in the following cases. For a line of skirmishers depending upon whether it is advancing or retreating or is occupying a fortified position and is prepared to offer a desperate resistance. Also upon the importance of overcoming more or less rapidly the resistance of the enemy. For a battery, depending upon the objective upon which it is firing. Some batteries must be quickly silenced at whatever cost of ammunition

on account of the effect they are producing, as, for example, a battery whose fire prevents a column from getting on the battlefield. There are other batteries the fire of which has only a minor influence on the result of the battle, which it will not be necessary to silence, as, for example, a battery endeavoring to hit concealed artillery, so nearly undiscoverable as to make the zone of indecision very large.

Some high-ranking officers have accused the innovators of merely trying to make trouble for the battery commanders, for, they say, if the captains have to take into consideration the nature of the objective and the tactical situation, they will no longer be able to apply *one method,* and there will be many mistakes and a great deal of hesitation. However, is it not better, if there must be mistakes and delays that these should occur on the practice ground rather than on the battlefield? These same officers also say that each captain will have his own particular method, and then what will become of the uniformity of drill. As far as the enlisted personnel is concerned, the uniformity of drill is assured, for the matériel used is the same in all cases. The best method of using this matériel can be determined only by practice. The number of fire problems like the number of bridge problems is infinite. To learn to fire just as to learn to play bridge, many problems must be solved. To accomplish this, the battery commander, on all occasions, in quarters, in barracks, on the drill ground, in field exercises, must be given problems as nearly as possible like the ones occurring on the battlefield. By this method, preparation for war is necessarily secured under the best conditions. As far as the officers are concerned, unity of instruction is secured, by learning how to fire upon the enemy. Practice in firing, as in bridge, causes everyone to operate in exactly the same way.

All ranging is for the purpose of determining the data for direction, height of burst and range.

For the 90mm. guns and for the 75mm. guns until 1903, regulation of the direction was done by the lieutenants, that is the chiefs of platoon, the captain having charge of the regulation of the height of burst and the range. Captains and lieutenants determined the data by observing simultaneously the burst of the projectiles with respect to the position of the target.

The method of firing used just after the adoption of the 75mm. guns was similar to that used previously for the 90mm. guns, with

one exception. The term "rapid fire" guns, excited everyone, and all that was desired was an ultra-rapid ranging followed by a withering, effective fire. To save time, firing was by salvo to regulate at the same time, direction, height of burst and range. Also, in order to deliver as soon as possible, an effective fire, usually a progressive fire, ranging ceased as soon as a 200-meter bracket was obtained.

As long as the objective consisted of wooden figures, perfectly visible to all the personnel of the battery, the application of this method was easy, for it was a simple matter for the battery commander and lieutenants to secure simultaneously and rapidly the data for direction, height of burst and range. Everything was different, however, as soon as the figures were replaced by a true battle objective, and the battery was so concealed that only the captain from his post of observation could see indications (assumed in our exercises) of the position of the objective. Only the captain sees the target, therefore he alone can conduct the ranging.

When a battery commander has to fire at a battle objective, which in general lacks clearness and preciseness, the problem of ranging assumes an entirely new aspect. Let us take up this matter with respect to the three parts of the data to be determined.

Direction.—The front of the objective is no longer definitely fixed and the direction of the points of burst of the shots fired from the four guns can no longer be determined as formerly with respect to four points selected on the figures, but must be determined with respect to certain points in the field of view, either by firing by piece after having fixed the four directions, or by firing salvos after having fixed the right and left limits of the objective.

Height of burst.—The determination of the corrector may be difficult, if, for instance, the objective has a long front, different parts of which are at varying heights, or if it is difficult to determine the elevation on which to range, as is frequently the case when the objective consists of artillery which discloses its position either by the trace of its projectiles, or by partially visible flashes, seen above a poorly defined screen in front of and below the horizon.

Range.—The objective itself not being located by the bursts, the position of the latter must be noted with respect to all cover in the field of fire. The result will be that nearly always when the objective is artillery and often when the objective is skirmish lines, there must be determined, not a bracket, that is two ranges differing by 50

meters, one over and one short of the target, but the inferior and superior limits of a zone of indecision, within which it is probable that the troops the captain wishes to hit are located.

The determination of the limits of a zone of indecision, particularly when the objective is concealed artillery, is nearly always a problem which cannot be readily solved. The captain should make a thorough examination of the terrain in order, if possible, to locate the objective. Aerial scouts are of great assistance in the determination of the range, but as their presence cannot always be counted upon, all captains should be trained in the determination of the limits of a zone of indecision, by means of a study of the formation of the ground by the use of a series of shots. The object of this operation is the determination of the profile of the suspected ground, in order to decide upon the probable position of the objective, or, more exactly, the position of the zone of indecision. When the captain is sure of being able to see the points of impact, he uses percussion fuses, and fires at ranges differing by 100 or 200 meters. It is preferable to fire two or three shots from one gun, using the one that will give the best observation, than to fire salvos. The principal reason for this is, that in firing salvos using percussion fuses, the captain has his attention divided among a number of different points, all at the same time, and will be able to see and get information from the bursts only when they are all easily seen. When firing two or three shots successively from one piece, he can observe all the bursts, even those that are only slightly visible, because he is on the lookout for them. In addition, since he makes his observations at the exact instant of burst, he can note and make use of even the slightest indications.

That firing two or three shots from one piece is preferable to firing salvos will be admitted by all officers who have made comparative tests of the two methods.

The preceding considerations show that ranging can no longer be conducted as it used to be. It has not become any more difficult, but it has become different. It no longer consists of the arbitrary application of a single method, nor can it be satisfactorily completed in two or three minutes. In particular, the determination of the range or ranges which must be used in order to hit the target, is a problem which must be treated separately, and whose solution nearly always requires a fairly long time. Usually, in the field, to secure

dependable data, the captain should make several trials and should use every indication of whatever nature as soon as it is discovered. The imaginary pictures of directors of target practices should have the effect of causing the captains to conduct the ranging as just described.

Changes in the Method of Firing.

As has already been shown, these changes were a direct consequence of the modifications in the choice of battery positions and in the manner or representing the objectives. The method of firing was changed in proportion to the increase of cover for the guns and the tendency of the targets to become more nearly duplicates of the objectives of war.

In the early days of the 75mm. guns batteries were placed on the crests of ridges while the targets were figures in full view of all the personnel of the batteries. This was the period of ultra-rapid ranging.

Soon the amount of cover given to the guns and targets increased little by little, and the chiefs of platoon gradually found it less easy for them to range in direction. From their posts, standing behind the pieces or mounted on caissons, they were able to see less and less clearly in proportion to the increase in the amount of cover given to the pieces and targets. It became more and more difficult for them to establish the ranging points for their pieces and to determine accurately the lateral deviations of the bursts with respect to these points. Experience soon showed everyone that the interference of the chiefs of platoon usually resulted in confusing the sheaf and delaying the ranging. Often the use of a general correction, alike for all the guns, placed the battery in direction immediately. Individual corrections by the chiefs of platoon spoiled everything and confused the sheaf. These considerations led the artillerists to break an old tradition and take away the ranging in direction from the chiefs of platoon and turn it over to the captain, who was thereby compelled to range in all three ways simultaneously.

This step has reduced considerably the rôle of the lieutenants during firing, in fact it is now limited to a supervision of the personnel. To justify their presence at all it has been necessary to consider them as reserve commanders. It is expected that there will be a new organization in which each battery will have assigned to it

only one lieutenant instead of two. This officer will act as an assistant to the captain, and should remain near him so that when necessary he can easily take his place. During firing he will be in the vicinity of the battery, and the captain will command the personnel through him whenever the post of observation is at any distance from the guns.

As long as foreign artillerists were not using rapid-fire guns cover was seldom greater than that for a man standing, while the cover of the objective was practically nil, and ultra-rapid fire remained in favor. As soon, however, as the artillerists knew that the Germans were going to use rapid-fire guns and would certainly copy our methods, cover for the guns and objectives rapidly increased in amount and the methods of ultra-rapid fire had to be modified.

The targets being more and more concealed, ranging by observing the smoke of the bursts with respect to the objective itself became exceptional.[8]

To determine the range, it is necessary to observe the location of the bursts with respect to the terrain and the cover thereon, and in order to locate the objective, the firing must assist in determining the form of the ground. Firing by piece using percussion fuses again comes into favor, for only by having the shells burst when they strike the ground, is it possible to range on objectives without relief (skirmishers lying down in a depression), and obtain any idea of the actual form of the ground.

Rapidity of fire during ranging becomes out of the question as soon as it is necessary to study the ground by a series of shots. The present method of determining the range bears no resemblance to the one formerly used.

The above ideas, even though generally admitted to be correct, are far from being accepted by all officers, many of whom still adhere to the methods in favor during the early days of the 75mm. guns.

The following are the three stages characterizing the evolution of ideas in the method of firing on artillery:

Artillery represented by wooden figures visible to the battery commander.—Ranging with a 200-meter bracket on the figures and delivery of a progressive fire.

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[8] In 1903, during the course of fire at Poitiers, the instructors at the end of the meetings, often pointed out to the student officers, much to the astonishment of the latter, that in the fifteen or so target practices just completed, all ranging had been by observing the location of the bursts with respect to the natural features of the terrain and not once with respect to the figures.

Artillery concealed behind a ridge.—Ranging on the ridge to determine the range.—Delivery of an effective fire beyond the ridge.

Finally since the adoption of torpedo shells.—Ranging on the ridge to get an approximate idea of the range, using shrapnel.—Delivery of an effective fire either in salvos or progressively.—Ranging again with torpedo shells to obtain the range to the ridge for these shells.—Delivery beyond the ridge of a systematic fire of torpedo shells.

This last method of operating cannot be made general, for it is practicable only against artillery when the objective by means of certain indications (matériel, personnel, flashes or information from aerial observers) has been located behind a ridge. It is not applicable in a case which would be frequent in war, *i. e.,* that of an artillery entirely concealed, which only an aerial observer could possibly locate accurately, since it discloses its presence only by the bursts of its projectiles.

In such cases, lacking an aerial scout, data for firing can be obtained only by a study of the ground by a series of shots.

In 1910, throughout the fall maneuvers in Picardie, although constantly at the head of the column looking for the objectives, we saw only three or four flashes of guns, and one battalion of artillery surprised in the very act of maneuvering, and since that time it has always been about the same. In addition, during maneuvers the batteries certainly take much less cover than they would in actual service. The case of a battery that reveals itself only by the burst of its projectiles will in the future be common.

The following are the stages characterizing the evolution of ideas in the method of firing on an infantry line:

1. Objective represented by plainly visible silhouettes.
   Front; about 50 meters.
   Determination of the range.
   Delivery of a plunging fire at this range.
2. Same objective.
   Same front.
   Determination of a large bracket.
   Delivery of a progressive fire or salvos with different ranges.
3. Slightly visible silhouettes representing men lying down.
   Front; 100 meters.
   Groups of men standing in full view which the artillery must hit during the short time they are standing and in motion.

Determination of a 50-meter bracket, if possible, covering the entire front of 100 meters.

Laying on points of the terrain in order to hit the groups and delivery of a series of shots with regularly varying elevations from the piece which is pointed in direction.

4. Finally the last stage which took place in 1909. This was the result of the adoption of practically all the suggestions made by us to the War Department in 1907 after a thorough study of the notes of the infantry officers on the methods then used in the practical course of fire.

Slightly visible silhouettes.

Front; about 500 meters.[9]

Slightly visible groups of men in front of and behind the line.

After ranging and determination of the data for all prominent points of the terrain, each piece is trained so as to be prepared to cover a quarter of the front or to fire on any groups of men appearing in front of or behind this portion of the front. The diverging of the axes of the guns is for the purpose of pointing the guns at the approximate center of the quarter of the front assigned to them. If there happens to be a prominent point located in this direction its position should be noted on a sketch.

All data for firing secured by ranging is noted. Such as applies to the pieces is written on the gun shields, the rest being placed on the sketch made by the battery commander.

When an objective appears, the captain has only to designate the piece or pieces that are to fire. If he wishes to sweep the entire firing line he has only to give a particular signal. If he wishes to

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[9] This method which in 1906 met with many objections from the artillerists, in our opinion was justified by the following considerations, which have lost none of their value:

"In general, the support which artillery gives to infantry, by firing on the hostile skirmishers, is appreciable only when the batteries fire on a large front. A battery firing on a hostile firing line and covering 50 meters of front, interferes with the fire of 30 or 40 skirmishers and gives its own infantry only an insignificant amount of support. A battalion of three batteries covering 300 meters (100 meters to a battery), interferes with the fire of 200 skirmishers and also gives only an insignificant amount of support. It is another thing, however, when a battalion covers a front of 1500 meters (500 meters to a battery). In this case 1500 meters of the front of the hostile line is neutralized and the part of our skirmish line that is opposite this front, even if they are at a range of 1000 meters, certainly feels the effect of our fire, for the volume of the fire directed at them is materially reduced and those shots which are fired at them are much more poorly aimed than they otherwise would be."

fire at a body of troops in motion, he merely takes the necessary data from his sketch and turns it over to the personnel of the battery.

Effective Fire.

With the 90mm. guns, effective fire always consisted of a destructive fire, by piece, using the range to the target. The captain continued the fire until he thought that the figures were thoroughly riddled. Firing was with percussion fuses when the objective was artillery or a wall to be demolished, and with time fuses when the object was to inflict losses on troops.

After the adoption of the 75mm. guns, the search for the means of hitting the enemy in a minimum of time were so primordial that all the devices used to assist in the delivery of a fire were affected thereby.

To destroy artillery or a wall, that is, to demolish the figures representing such an objective, the captain would perhaps command: "Fire six rounds. At 2450 meters." Each gun then fired six shots, and if the captain considered the effect insufficient he would repeat the operation and continue to do so until he secured the desired effect.

To inflict losses on troops, that is, to riddle the figures, the captain, as soon as a 200-meter bracket was obtained, fired a number of salvos using varying elevations for each salvo and for each gun in any particular salvo, or delivered a progressive fire. The desire for rapidity was carried to such an extent that the battery commanders normally covered the ground progressively for a depth of 500 meters in order to hit a single line of skirmishers.

As long as the objectives were represented by visible figures, the result desired (to destroy the figures or riddle them with bullets) was perfectly evident and could be rapidly attained. Today the objectives are entirely different and an absolutely different method is used to deliver an effective fire. But before taking up the question of the present method of operating, let us show how the ideas have little by little changed.

With respect to a destructive fire, all attempts to secure great rapidity were abandoned and an effort made to secure greater accuracy by firing by piece.

With respect to fire against infantry under cover, as soon as the comparatively slight effect of shrapnel fire was understood, destructive

fire was abandoned and only neutralizing fire employed, the latter having as its sole object the compelling of the riflemen to stick close to the ground from fear of the artillery fire. Later, the adoption of torpedo shells again allowed the employment of a destructive fire against infantry under cover, when circumstances were favorable for obtaining a quarter-turn bracket and ammunition was plentiful.

With respect to effective fire against artillery, ideas underwent a considerable change. When the battery-objective was represented by visible figures, artillerists made use of the following kinds of effective fire: progressive fire or salvos with varying ranges, followed by a destructive fire using percussion fuses. When the battery-objective was concealed to such an extent that the matériel or personnel in sight was not sufficient to permit a destructive fire, artillerists made use of a fire with time fuses against the personnel. Such a fire was very effective whenever the personnel was not protected by the shields. When the battery-targets, as in our service, were equipped with shields, and were under cover at least equal to that for flashes, smoke or the bursts of projectiles, the only effective fire possible was a neutralizing fire, certainly until the adoption of the torpedo shells. The adoption of these shells again permitted an attempt to destroy the hostile artillery, but even then this was possible only at a tremendous cost in ammunition and when favorable circumstances limited the zone of indecision. The latter was seldom the case as long as the only method of investigation at his disposal was a series of shots covering the entire area.

If war were to be declared tomorrow, artillerists would find themselves opposed to German batteries occupying concealed positions, and if these batteries were to use a powder that gave no flashes, their position could be determined only by the bursts of their projectiles.

The evolution is about at the following stage. The determination by a series of shots of the data required for the delivery on a totally concealed artillery, of either a destructive fire of torpedo shells or a neutralizing fire of shrapnel, requires considerable experience on the part of the battery commander. The solution of the problem is always different since it depends on the terrain and the cover concealing the two opposing batteries.

Fortunately the aerial observer puts in an appearance at the very

time when the artillerist needs him the most. Whenever this new means of investigation is available, the battery commander will be able to fire effectively upon any concealed battery. When a battery commander has an aerial observer at his disposal, the process of ranging on concealed artillery becomes very simple, and may be very rapidly accomplished. All the observer has to do is to locate the objective with respect to two salvos, fired with percussion fuses, and as nearly as possible in the direction of, and with two ranges differing as little as possible from that to, the target. These two ranges may differ by 400 meters, but from the information supplied by the observer, the battery commander can easily determine the proper range and direction to be used for the effective fire.

To sum up, the normal objective for artillery is composed of troops usually under cover, whose vulnerability constantly varies, but at best is slight. Firing usually takes place at skirmishers lying down or at batteries more or less concealed. It is very exceptional to find a time when a body of any size is discovered in close order crossing an open space large enough for the artillery to have time to destroy it before it can gain shelter.

What Effect Will Artillery Usually Produce on Skirmishers and Concealed Batteries?

Skirmishers.—It will neutralize at certain times parts of the line and will endeavor to inflict serious losses on bodies of troops seen moving at a run from cover to cover. It may also try to destroy the entrenchments and kill the troops protected by them. In the latter case, however, appreciable results can be obtained only at a tremendous cost of ammunition, the probable extent of which all battery commanders should be able to quickly estimate. General Rohne, in the 1907 volume of the "Artilleristische Monatshefte," thus sums up the ideas advanced by us in 1906 in "La France Militaire," on the subject of firing on infantry: "The task of artillery in the future will be a double one: to keep under its fire for a short time, small targets suddenly appearing, or for a slightly longer time, the ground occupied by the enemy. It will employ in the former case instantaneous fire and in the latter case neutralizing fire."

Concealed Batteries.—Experience has shown us that most officers have only a very superficial knowledge of the proper method of

conducting a neutralizing fire on concealed batteries, and since this is a question of considerable interest, we will go into it in detail. Lacking the power to destroy hostile artillery, all that can be done is to try to neutralize it.

When the commander of one battery, "A," is charged with silencing another battery, "B," he must keep up the attempt to destroy it until absolutely forced to abandon the attempt. If he can, he always asks an aerial scout to locate the objective with respect to two salvos differing by 400 meters. Failing an aerial scout, he determines the data for an effective fire by a series of shots. From the information derived either from the aerial scout or from the series of shots fired at prominent points the ranges corresponding to the two limits of the zone of indecision are determined, and from these ranges the elevations to be used for firing with torpedo shells.

When the captain is forced to abandon the attempt to destroy battery "B," either because there is no aerial scout available or because the ranging on prominent points gives too large a zone of indecision or requires a greater expenditure of ammunition than the circumstances justify, the only course possible is an attempt to hinder or neutralize the fire of the battery in question.

What steps will be taken to accomplish these results?

Shells will be made to burst over the hostile battery at such times as are most favorable.

Which are the most favorable times?

The hostile battery has some particular mission, which can nearly always be discovered from the bursts of its projectiles. It must be neutralized, that is silenced, whenever it opens fire or whenever it is about to open fire. To put this in another way, Battery "B" must be silenced at two particular times, *i. e.:*

1. When the fall of projectiles shows that it has just opened fire, in order to compel it to cease firing on its objective;

2. When it is probably preparing to fire because a target has appeared, in order to prevent it from opening fire.

If firing is begun at either of the times just indicated, it will momentarily stop or at least retard the fire of battery "B," and in addition will have good chances of being particularly effective, since the projectiles will burst over the battery when it is in action and is therefore most vulnerable. Consequently, in many cases, loses

suffered by the personnel will be so great as to completely silence the battery.

The foregoing considerations show the great importance of the *time* in neutralizing fire. The most advantageous time to fire upon hostile artillery is during the short time that it is in action or is about to go into action. When a battery intends to fire under such circumstances, the pieces are laid and the ammunition brought up in advance, so that when the captain wishes to open an effective fire, he merely has to give a signal.

In all such firing, shrapnel is used and is conducted as follows:

By salvos, using in succession the different ranges necessary to cover the entire zone of indecision, in which case an effective salvo will occur once out of every 2, 3, 4, 5—salvos, according as there are 2, 3, 4, 5—different ranges.

By salvos, using different ranges for each piece in any particular salvo, and changing the ranges for successive salvos. Let us illustrate this last method by giving two examples. Assume that the ranging has been properly performed and the zone of indecision accurately determined.

1st example; with four ranges, for each salvo of four shots one projectile will burst above the battery:

2nd example; with seven ranges, say 2500, 2600, 2700, 2800, 2900, 3000, 3100, each piece uses each of these ranges in succession, the 1st starting with 2500, the 2nd with 2700, the 3rd with 2900 and the 4th with 3100.

	1st piece	2nd piece	3rd piece	4th piece
1st salvo fired with ranges of_ _	2500	2700	2900	3100
2nd salvo fired with ranges of_	2600	2800	3000	3500

The entire zone is covered in two salvos, and if it has been accurately determined, one projectile at least is effective.[10]

The effect of a neutralizing fire on artillery is questionable. In showing how such a fire should be conducted in order to have its maximum effect, we have been actuated merely with a desire to indicate to the artillery the most advantageous course to be pursued, when, finding itself unable to destroy the hostile batteries but still not wishing to remain silent, it attempts to hinder their action.

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[10] All this information was contained in the work submitted by us to the War Department, in 1907.

PART II.

The first part of this article has been devoted to showing the evolution of ideas by indicating the successive changes in the method of operating made by battery commanders. The second part will be devoted to a similar subject, but will consider, not the role of the battery commander, but that of a commander of an artillery force composed of a number of battalions. For this purpose it will be necessary to take up certain questions concerning the use of artillery. Experience has shown us that many officers who are in perfect accord with each other and would give similar solutions to any concrete problem, cannot by any chance agree with one another when discussing "the use of artillery," if they are confined to general considerations. To avoid this cause of endless discussions among the officers, we will endeavor to confine ourselves strictly to actual facts. To this end we will take up the question of the method of operating used by artillerists during the last few years showing at the same time the various ways in which they mark stages in the evolution of ideas on the use of artillery. We will have a sufficiently accurate understanding of the way in which the preparation of artillery for battle has changed, by taking up only the following subjects:

Choice of positions.

Distribution of the objectives. Assignment of missions. Fire control.

Preparation for service practice.

Choice of Positions.

As long as the artillerists were using the 90mm. guns and also after the 75mm. guns were first adopted, they placed the guns in battery on ridges. In all exercises, they formed a long line of batteries opposite the artillery of the enemy similarly placed on the opposite ridge. At first, all officers readily accepted this method of establishing the 75mm. guns in position, since it was in perfect accordance with custom, but it was not very long before it began to be criticised, and as soon as a more thorough knowledge of the properties of the new guns was acquired, ideas began to change, the theoretical was abandoned for the practical, and artillery took up concealed positions.

The captain of a concealed battery transmits his orders to the

personnel mechanically by the use of numbers or other signals and the projectiles almost at once commence to burst just where he wants them to. The captain of a battery installed on a ridge transmits his orders verbally but since the chiefs of platoon and gunners can see the objective and the field of fire themselves, these verbal orders nearly always have to be followed by long explanations.

The following statement, which until recently was usually questioned, is now admitted to be correct: A battery under cover in rear of a ridge fires more rapidly and more accurately than a battery placed *on* the ridge.

As soon as the truth of the above statement was generally admitted, a great many officers bent their energies towards the discovery of the best method of controlling the fire of a battery as it became more and more concealed, until finally almost invisible. Among the various schemes suggested were those simple and practical ones universally in use at the present time.

Once started nothing could stop the evolution of ideas. The only effect of the recommendations made during target practices and maneuvers with a view of overcoming the tendency of the artillerists to place the batteries under cover, was to delay the practice of occupying concealed positions.

Colonel Ardant du Picq speaks of one powerful reason for taking cover when he says: "Man does not go into a battle for the sake of a fight but to secure a victory. He does all in his power to avoid the former and attain the latter."

Artillerists have only obeyed the law of self-preservation. They have searched for and have found the means of firing rapidly, accurately and for a long time, while meanwhile exposing themselves as little as possible.

Stages in the Evolution of Ideas.

1st Stage—On the crest of ridges.

2nd Stage—Near the crest of ridges, either behind them or in front of them under cover.

3rd Stage—Anywhere except on the crest of ridges.

4th Stage—Anywhere except on the crest of ridges or immediately behind them.

To illustrate this succession of different stages, let us imagine a terrain similar to the majority of those used for maneuvers. Such a terrain might be described as follows:

Two opposing ridges of about equal heights within easy range of each other. Between these two ridges, from the foot of the slopes, ground more or less suitable for infantry, being undulating and possessing a certain amount of cover. Let us designate by the letters "A" and "B" these two ridges and the two forces occupying them.

1st Stage—The two opposing artilleries take up positions on the crests of the ridges "A" and "B", the battalions being placed in battery side by side.

2nd Stage—On both sides the batteries, designated respectively "a" and "b", are in position behind the ridges. Generally batteries so placed can, whatever the amount of cover may be, fire on troops exposing themselves on the opposite ridge, but frequently they are unable to fire on troops occupying the low ground without danger of having the projectiles strike the ridge protecting the battery. Other batteries, in such a case, will have to be designated to fire on these last troops. Let us call these batteries "a" and "b."

Assuming that the distance between the ridges is about 3000 meters, the quadrant angle of departure will be in round numbers about 100/1000 or 1 on 10. The "a" batteries usually can fire at objectives on the opposite ridge "B", for in order that this should be impossible, the ground in rear of the "A" crest must have a slope greater than the slope of the trajectory, that is greater than 1 on 10. A ground slope of 1 on 10, however, is very rare and for this reason we say that the "a" batteries, whatever the amount of cover may be, usually can fire on the "B" ridge.

Let us assume that the distance from the "A" ridge to the foot of the opposite slope is about 2000 meters and that the difference in elevation is about 60 meters. The "a" battery when firing at the foot of the opposite slope will have a quadrant angle of departure of: 50/1000-60/2000 or 50/1000-30/1000 = 20/1000.

In order that the "a" battery may be concealed behind the "A" ridge and fire at objectives at the foot of the opposite slope, the ground in rear of the "A" ridge must have a slope of less than 20/1000 or less than 2 per cent, as otherwise the projectiles will strike the ridge. A slope of 2 per cent is a very gradual rise and it is therefore safe to say that in order that the "a" and "b" batteries may be able to fire at their objectives, they will usually have to be close to the crest of the ridge. If the range becomes less than 1500

meters, the other conditions remaining the same, a similar calculation will show that the quadrant angle of departure is zero, or in other words that the line of departure is horizontal. In such a case, the "a" and "b" batteries cannot be under cover and should be placed in front of the crest.

The above considerations show the great effect that sheltering batteries behind ridges has had in causing changes in the manner of placing artillery. We are nearly always compelled to use two distinct kinds of batteries, each kind having its own particular mission. One class, "a", concealed behind ridge "A" has a "distant zone of action," and can attack artillery placed behind ridge "B" or fire on any troops appearing on that ridge. The other class, "a′," has a "close zone of action," and cannot take cover behind the ridge while firing, for the projectiles would strike the ground. Such batteries conceal themselves by taking advantage of any available cover, such as hedges, walls, etc., but if no cover can be found they remain exposed to view. In the latter case, certain of the "b" batteries are assigned the mission of silencing such part of the hostile artillery as can bring their fire to bear on the "a′" batteries.

For the past few years the "a" batteries have been known as "artillery batteries" and the "b′" batteries as "infantry batteries." The latter which will be exposed to view, and the fire of the enemy, do not take up position until the former are in position and about to open fire.

The above corresponds to the second stage of the evolution of ideas. This was perfectly satisfactory as long as the artillerists were unable to use batteries completely concealed but now that the "a" and "b" batteries have become practically invisible, this method has lost all value. It is impossible for a battery, "a", to silence for a sufficient length of time, a battery, "b", entirely concealed, and trying to destroy a battery, "a′," entirely unprotected. Battery "a′" would be destroyed in a few minutes, and certainly long before "a" battery charged with protecting it, would be in a position, not to destroy "b", but merely to silence it.

The use of airships may to a certain extent modify these last conclusions. In fact, in some cases, the assistance of an aerial observer may allow "a" to fire under such conditions of accuracy and rapidity as to permit it, in the time allowable, to master "b" if the latter endeavors to prevent "a′" from fulfilling its mission.

3rd Stage—Since, as just noted, the protection afforded by the artillery batteries is often negligible, artillerists say that until "b" is silenced or the artillery duel ended, it is impossible to count on placing the "a‴" batteries in front of the crest with the slightest chance of their accomplishing their mission. Therefore, since they are of the opinion that the artillery duel is going to last much longer than it used to, they are looking for a position for the "a‴" batteries that will be more favorable than the ones just described. The first modification was the placing of the batteries at the foot of the slope (low batteries) and the next, the placing them under any available cover on the slope in such a position as to permit of oblique fire.

The batteries will not always be able to stay continuously under cover while taking up these positions, but whatever risk they may run in reaching them, it is of short duration and certainly less than there would be if they took up a position without cover in front of the crest.

Often after the low batteries have reached their positions they cannot be fired upon by the concealed batteries "b", and to silence them one or other of the following courses may be necessary:

To place certain of the "b" batteries in front of ridge "B", in which case the latter batteries run the risk of being destroyed by the concealed batteries, "a", or.

To oppose them by other low batteries, which requires that the necessary positions and posts of observation shall be available for such batteries, which will not always be the case.

Batteries placed side by side under cover masking them and allowing them to fire obliquely are nearly always invisible.

Today, the batteries are placed so as to make use of all shelter available. On the high ground, under all possible cover, are placed the batteries having a distant zone of action, and whose projectiles will easily clear the screen. On the low ground, behind cover permitting an oblique fire, or sometimes partially screened on the ridge, are placed the batteries having a close zone of action and a flat trajectory. It is well to note that semi-concealed batteries can fulfill their mission only when their action is of short duration or the artillery duel has ended favorably.

4th Stage—The adoption by the German field artillery of howitzer batteries intended to cover with a systematic fire, the ground

in rear of a ridge, in the same way that we do with the 75mm. guns using torpedo shells, and if necessary the Malandrin disc, fortells a 4th stage.

Batteries concealed immediately in rear of the crests of ridges run a great risk of being destroyed and it is foreseen that in the future, positions in rear of and close to the crests will be less and less sought after. Even today, the battalions are placed anywhere except on the crests or immediately in rear.

The choice of positions and sites is no longer, as it used to be, a simple matter. Much more is necessary than for the battalion and battery commanders to make a bee-line for the crests of the ridges. The problem has become very complex and it can no longer be properly solved except by officers who have served a thorough apprenticeship in reconnaissance on varied ground.

Distribution of Objectives—Division of Missions—Fire Control.

"In 1870, the artillery commanders, being only partially prepered for their duties on the field of battle, did not know how to employ to the greatest advantage the power of their batteries."

"They were untrained in the distribution of objectives, in the division of missions and in the control of the fire."

"Each captain usually went ahead on his own account and fired at whatever objective he considered the most favorable."[11]

At the present time, the three expressions, distribution of objectives, division of missions, and fire control, have a very definite meaning and show part of the progress made by the artillery commanders since 1870 in the preparation for battle.

Throughout the entire period from 1870 to 1900, the directors of the exercises believed that on the battle field the lines of infantry and batteries of artillery would be perfectly visible. Consequently the targets which they used for practice were made of wood and placed in full view of all the personnel taking part in the target practice. Since the captains saw all the objectives, they could fire at any one of them that they wished. It was by sight alone that the objectives were divided by the artillery commanders among the battalion commanders and by the latter among the battery commanders.

As soon as the 75mm. batteries commenced to fire at lines of infantry under cover and at artillery visible only by its flashes, the

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[11] Germain Bapst, "Marshal Canrobert," Vol. VI, "Battle of Saint-Privat."

method of sight distribution of the objectives became impossible and had to be modified. In addition, since the targets composed of troops under shelter could seldom be destroyed, the batteries so to speak really took part in a duel with the objectives. It is for this reason that we say that the artillery commander not only distributes the objectives but also that he divides the missions. The mission fixes the manner in which the various troops are to be attacked.

Still another modification of the method to be used by the artillery commander becomes necessary as soon as the battery objectives, being totally concealed, no longer disclose their positions by their flashes but only by distant reports and the bursts of their projectiles. In such a case what must be divided among the batteries is not a visible artillery nor even the horizon, awaiting the sight of flashes thereon, but is actually the various groups of projectiles which are bursting among the troops.

During the war of 1870, it was the batteries massed on the ridges and visible by matériel, personnel and smoke, which drew our attention rather than the projectiles themselves which followed irregular trajectories and made very little smoke. The artillery disclosed its position more by the firing of the guns than by the striking of the projectiles.

In the following years, although firing became more accurate and the projectiles made more and more noise and smoke, it was always the batteries themselves which attracted attention and were used in the distribution of objectives.

In 1900, artillerists commenced firing at artillery visible only by its flashes, but even then, in the distribution of the objectives, the artillery commander preferably made use of the indications supplied by the battery itself rather than by the projectiles.

Finally the batteries became totally concealed and the artillery commanders did the exact opposite of what they had done previously. To determine the distribution of the objectives, they no longer considered the batteries, since these had become invisible, but only the projectiles, which made more noise and more smoke than the guns themselves.

Since 1911, aerial observers have been available for reconnaissance and the power of such observers to locate troops under cover has given artillery commanders a new kind of sight distribution of objectives.

By the discovery of the best method to be used in the distribution of the objectives and the division of the missions, artillery commanders will be in a position to most advantageously control the fire of their batteries according to the requirements of the situation. In other words, they will be able to make their dispositions so that each battery will fire at a particular point selected for it within its zone of action. This result will be attained and the proper fire control secured as soon as the artillery commander is in a position to transmit his orders to the battalion commanders and is in possession of the necessary information with respect to the exact positions of the batteries and their possible zones of action.

1st Stage—Objectives visible as indicated below:

Troops moving over open ground; lines of skirmishers, standing; batteries placed on ridges, each shot making a large cloud of white smoke that was entirely visible:

Similar batteries but after the adoption of Powder "B" the cloud of smoke was replaced by a flash:

Batteries placed on ridges but use of rapid-fire guns gave visible flashes only once or twice out of every three shots.

Sight distribution was always possible. When, in exceptional cases, it could not be made until the skirmishers or batteries opened fire it could always be made as soon as this firing did start.

2nd Stage—Objectives were lines of infantry under shelter or masked batteries. Sight distribution was possible only after hostile skirmishers were seen or the hostile artillery had opened fire and the flashes of the guns were discovered.

In order to return the fire of such batteries as show flashes, as soon as possible and so to speak, shot for shot, the artillery commander divides the horizon of the ridges in rear of which he suspects these batteries are concealed, among the battalion commanders, assigning to each of them a particular zone which they are to watch. Each battalion commander then takes such measures as may be necessary to open fire immediately on any hostile batteries that disclose themselves by their flashes.

The distribution of batteries visible by their flashes is therefore made at both of the following times:

1st. Before the battery-objectives have opened fire; assignment of the zones to be watched by the different battalions.

2nd. As soon as flashes are seen in the zone being watched; opening fire immediately on these flashes by a battery.

The task of the artillery commander has become more complex than it used to be. Not only must he make the distribution of the visible objectives but he must also watch all suspected cover, in order to be prepared to open fire on hostile infantry or artillery the minute that it appears.

3rd Stage.—Let us now consider the case of battery objectives masked to such an extent that they can fire without there being any indication of their presence visible on the horizon. When such batteries open fire, we will notice the sound of distant reports and will hear and see the bursts of the projectiles. This will be the normal case when opposed to German artillery which we may be sure will use a powder giving no flashes. Sight distribution, as used until the present time, is no longer practicable. The division of the horizon becomes useless since nothing appears thereon. The battery-objectives ordinarily disclose their presence only by the bursts of their projectiles. It is therefore necessary to wait until they have opened fire before they can be assigned as targets to the batteries charged with returning their fire. Let us see what dispositions are necessary in order to reach these batteries as soon as possible. The artillery commander is kept informed by the commander of the troops as to the progress of the attack and he can therefore foresee the zones in which the projectiles of the enemy will burst and assign the watching of these zones to various battalions or batteries. These battalions or batteries take up position and await the fire of the enemy in order to determine from a study of the bursts the data necessary to effectively fire upon them after they have disclosed themselves.

As in the preceding case, distribution is made at two times:

1st:—Before the hostile batteries have opened fire; distribution among the battalions or batteries of the dangerous zones, within which it is foreseen our troops will be under the fire of the hostile artillery; in order to fulfill their missions, the battalions or batteries will take up positions under cover close to these dangerous zones.

2nd:—As soon as shells commence to burst over our troops; designation of the batteries to open fire on the hostile batteries firing these shells.

The study of the position and inclination of the cloud of smoke from the bursts of time shells and of the furrows made by the explosions of percussion shells may give some idea of the direction and

range of the battery firing each kind of projectile. An idea of the range may also be obtained from an examination of the fuses and a study by a series of shots of the cover that may be concealing the hostile batteries. The accuracy of all data so obtained depends upon a number of different things, but when it is all that can be obtained it must be made the most of. We also wish to call attention to the fact that only those batteries which are in position in close proximity to the troops under fire from a hostile artillery totally concealed are in a position to fire with any degree of accuracy upon such hostile artillery. The officers in command of such batteries are, in fact, the only ones in a place where they can examine the bursts and their effect with the amount of care necessary to determine the data for a searching fire and can ultimately deliver an effective fire as required by the circumstances of the fight.

These considerations show how important it is for an artillery that wishes to fulfill its mission to always have some units ready to act in conjunction with the infantry and in all marches to push a fraction of the artillery well to the front, for it can not only support the infantry both morally and materially but will often find opportunities of delivering an oblique fire against the enemy's lines.

The case of the third method of distribution of the objectives when the artillery commander has at his disposal only such information as is derived from direct view may be considered from the following points of view:

What will the commander of the troops require of the commander of the artillery?

To support the advance of the infantry, particularly within a particular zone.

What will the artillery commander do in order to accomplish this mission?

He will endeavor to lessen the intensity of the fire of rifle bullets and shell which the enemy can deliver on this infantry.

How will he accomplish this result?

By firing on the lines of skirmishers and batteries whose fire is the most dangerous.

It is a simple enough matter to reconnoiter and fire upon lines of skirmishers and batteries only partially masked, but when they are totally concealed it is very different. What will happen will be

that most of the skirmish lines will be under the fire of the artillery while one-half or three-quarters of the hostile batteries in action will remain undiscovered, will not be fired upon, or not until after a considerable delay and then only when the artillery commander has made certain special dispositions.

Let us see what such "special dispositions" might be.

Both artillery forces are acting under identical conditions. Totally concealed batteries reveal themselves only by the burst of projectiles and they can therefore be attacked only by artillery placed under cover near the points of burst in order to make use of the data furnished by the first bursts and thus reduce as much as possible the zone of indecision. Such conditions do not seem to promise a particularly effective fire, but it is the best that can be done if we are to attempt to do anything at all.

The above shows how delayed and ineffective will be the fire of an artillery that is not assisted by aerial observers. The lack of such observers has almost the same effect as a bandage over the eyes. There are many of the hostile batteries which can not be fired upon at all, and it is only at a tremendous expense of ammunition that even the most trifling effect is secured.

This explains the closing paragraph of an article which Colonel Estienne recently published in one of the daily papers, in which he said:—

"Artillery is useless if it cannot see. It asks for aeroplanes just as it previously asked for large shells. The power of the artillery will probably be increased tenfold if it is given airships manned by its own officers, without any increase in the strength of the personnel and without any other expense than the purchase of the machines."

4th Stage.—Assuming that the artillery commander has aerial observers at his disposal everything is different. Instead of returning the fire of the enemy's batteries hesitatingly and even then firing at only one-half or even one-quarter of them, he attacks them all immediately and soon hits and destroys them.

Let us suppose that, as recommended by Colonel de Grandmaison and so often mentioned by our General, the commander of the maneuver division is forcing the enemy into a position in front of our guns where we will be able to fire upon him.

How will the artillery commander operate?

He will immediately place a portion of the batteries in action to fire on the targets already in view. At the same time he will direct another portion of the artillery to watch the parts of the horizon behind which he suspects the hostile batteries may be placed. In order to ascertain definitely just what is concealed behind the horizon, he will, as soon as possible, send out aerial scouts, the zones to be reconnoitered being approximately indicated by salvos. If such reconnaissance discloses the presence of troops, artillery either in battery or on the march, their destruction is at once undertaken. Additional flights may be made as required for purposes of fire control.

Artillery no longer waits for the hostile batteries to open fire in order to return this fire; it starts the attack, that is, endeavors to be the first to deliver an effective fire.

The coöperation of aerial observers has doubled the offensive value of artillery and allows it to more rapidly open the way for the infantry by breaking down resistance before the latter has time to make itself felt.

Such, we believe, will be the method of distribution of objectives among the batteries when artillery is supplied with those aerial observers which are indispensable to it. At least, such is our belief today while awaiting the results of those experiments now being made.

DATES OF THE STAGES.

After 1903, at the practical course of fire, ideas on the distribution of objectives, division of missions and fire control were practically those generally held for several years before the appearance of the aeroplane, say 1910. To verify the truth of this statement, it will only be necessary to read the accounts of the exercises which we published during this period in the *Revue d'Artillerie*. These ideas, however, were far from being accepted in all the regiments in 1903, for at this time the evolution of ideas had hardly begun.

In this same year of 1903 we took part in the army maneuvers in Lauraguais. The divisional artillery, whose operations we will follow, maneuvered exactly as if it had been equipped with an improved 90mm. gun. Positions were always selected on ridges. The artillery commander did not always distribute the visible objectives among the battalion commanders while the latter were as careless with respect to distribution among their batteries. No attention

was paid to the division of missions or the control of the fire of several batteries. The artillery simply made a lot of noise after having carelessly pointed the guns in the general direction of the objective which it regarded as its probable target.

Towards the close of the maneuvers we were fortunate enough to find ourselves, several minutes before the arrival of the commanding general of the artillery of the army corps, on the ridge where all the artillery was about to deploy in order to attack the position of Aigrefeuille. Soon all the batteries from the course of fire, that were taking part in these maneuvers arrived to go into position on this ridge. Examining the situation with the officers of these batteries, we all, with respect to the use of the artillery in this particular case, arrived at the same identical conclusions. These ideas would be almost exactly the same today.

The terrain in question was about as follows:

A valley with a flat bottom; in the middle of this valley, a small stream with very little water in it but having very high banks so that artillery could cross it only on bridges. This stream at the beginning of the maneuvers was the dividing line between the opposing forces. There was a difference of elevation of about 50 meters between the bottom of the valley and the tops of the ridges encircling it, while the distance between these ridges themselves was about 3,000 meters. Let us designate by "A" and "B" the two opposing forces and the two ridges. The position occupied by the defense and which it was necessary to attack included the park of the chateau of Aigrefeuille. This park took in all the slope from the bottom of the valley to the summit of ridge "B" and was surrounded by a wall.

It was necessary, therefore, to carry a position defended by infantry placed on the opposite side of a stream and sheltered behind walls and in the edges of the woods, and supported by artillery placed behind the ridges to the right and left of the position.

The various tasks assigned to the artillery of the attack were at once apparent. They were:—

To assist the forward movement of the infantry by firing on the skirmishers manning the walls of the park and the edges of the woods;

To make breaches in the walls at the points at which the attacks would probably be launched;

To destroy, or at least temporarily neutralize, the batteries placed in rear of the ridge to the right and left of the position.

Summed up, these tasks were:—In the bottom of the valley, to neutralize the infantry and make breaches in the walls; on the opposite ridge, destruction or neutralization of the artillery.

To accomplish the first task, the artillery commander should make use of all cover available in front of the ridge and in the valley and should place in these positions as many batteries as possible. He should not, however, until the artillery "B" has been silenced, think of placing batteries in front of the ridge for the purpose of firing at the bottom of the valley, for such batteries would certainly be immediately destroyed. There were certain paths by means of which the batteries "A" could, without too much risk, reach the cover found on the slopes and in the bottom of the valley.

To accomplish the second task, the artillery commander should place behind ridge "A" certain batteries, which would watch ridge "B" and hold themselves in readiness to open fire on any hostile artillery which was discovered.

To all the majors and captains of the course of fire the solution of the problem seemed plain and unquestionable.

The general commanding the artillery arrived at the position. We expected to have him give certain orders concerning the division of the missions and the zones to be watched, but to our great astonishment, he did nothing of the sort. All the batteries which followed him on the field proceeded to take up positions in plain sight on the ridge beside the batteries of the course of fire which were already in position. The latter had taken light cover with respect to the opposite ridge. On the latter ridge no artillery could be seen though in reality there were two battalions there in command of an officer, who, imbued with the ideas of the course of fire, had concealed his pieces. As soon as the "A" batteries appeared on the ridge, they drew the fire of the two "B" battalions and many flashes were seen on the opposite ridge. When this happened, the general was in the interval between the battalion from the course of fire and one of the battalions of his brigade. He immediately became aware of the unfavorable situation of his batteries and quickly sent for the two captains next to him and ordered them to immediately open fire on the hostile artillery. The captain, commanding the battery from the course of fire, asked upon which part of the front disclosed by the flashes he should fire, and by this question called attention to

the error committed by the artillery commander in not making the division of the front before the battalions went into battery. The general impatiently ordered him to fire on the opposing artillery which he pointed out to him by a gesture. The captain at once commanded "Attention" and after a rapid survey of the front followed this with "Increase by so much.—Lay" and then "By battery from the right," when he was interrupted by the general who said: "Fire, Sir, fire, you can go through all this rigmarole later." The other captain who had his guns pointing in no particular direction, without a moment's hesitation commanded "Fire," and was highly commended.

It is very exceptional, today, during maneuvers, for the artillerists to be left, as they were in the above case, without a definite mission or to open fire without pointing their guns at some objective.

The foregoing example shows that the principles held in 1903 at the course of fire with respect to the distribution of objectives, the division of missions and fire control, were to all intents and purposes dead letters in the artillery which took part in the army maneuvers in Lauraguais.

In 1905, during the army maneuvers in Champagne, except in one or two isolated cases the same mistakes were made. Only during the maneuvers of 1908, in the East, and later, in 1910, during the maneuvers in Picardie did we find a fairly general application of the foregoing principles.

It is to be noted that during the maneuvers of 1908 and 1910, the battalions making up the divisional artillery were frequently removed from the control of their colonel and placed under the orders of the brigade commanders. This amounted to a kind of division of missions by the division commander among the battalions of his artillery.

Later we will give the text of the War Department circular condemning this method of operation and combining precept and example. We will refer to the account of a staff officers' exercise which took place in 1913 and which demonstrated in a startling manner the necessity for leaving the fire control of all the batteries of a division in the hands of one man.

Today, except when absolutely necessitated by the nature of the terrain, the divisional and corps artillery remain, with reference to the distribution of objectives, the division of missions, and fire control, under the orders of the colonels. To these officers alone belongs the distribution of visible objectives, the division of missions among

the battalions, and the control of the fire in accordance with the orders of the division or artillery commander. This, however, is a task which requires a great deal of practice and a moment's reflection will convince us that nowadays artillerists can no longer approach in an offhand way the problems which they will have to solve in battles to come, when they will fimd themselves opposed to an artillery which will reveal itself only by the bursts of its projectiles and the sound of distant reports.

A short time ago, thanks to the suggestion of the commanding general of the artillery of the 2nd Corps, we had an opportunity to actually control the fire of a divisional artillery supplied with aerial observers and assumed to be opposed to a hostile artillery the greater part of which was entirely concealed.[1] The conclusions reached as the result of this experience have been set forth in this article.

The use of airships causes us to anticipate a satisfactory solution of all the problems of the distribution of objectives and we feel well assured that a little work in conjunction with aerial observers will rapidly bring to the solution previously set forth (4th Stage) the necessary improvements.

Atmospheric conditions, however, will not always permit the use of airships and artillerists are therefore required to experiment with a solution similar to that previously mentioned under the 3rd Stage.

SERVICE PRACTICE.

Under the influence of the unceasing efforts of the officers to discover a method of instruction that would as nearly as possible simulate actual conditions, the manner of fire control during service practice, during the last few years, has been completely revolutionized, the principal stages in which we wish to indicate.

Previous to 1870.—The artillery regiments did not have service practice. They had target practice at silhouettes placed in front of the butts on target ranges. These ranges, Satory, La Fere, Toulouse, etc., are now used for maneuvering ground.

From 1870 to 1878.—During the years which immediately followed the war, all the batteries were equipped with breech-loading guns; at first with 5 and 7mm. Reffye guns and later with 80 and 90mm. Bange guns. The artillerists no longer fired at targets but at objectives.

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[1] During the year 1913, eight lieutenants of the 17th Regiment were sent to the camp of Sissonne to be trained in the duties of aerial observers. At present, five of these lieutenants are considered competent to fill such a rôle.

They commenced to use ranging fire and to fire at the extreme range of the guns. The ranges equipped with targets and butts became too small, for they neither gave the desired variety of objectives nor guaranteed safety by positively stopping all projectiles. The ranges began to be used only as drill grounds and were replaced by proving or practice grounds. For this purpose, the artillery selected ground in the form of a trough, closed in rear of where the objectives were to be by an elevation of the ground sufficiently great to replace the old butts and stop all projectiles. At Fontainebleau, Coetquidam, Auvours, Cercottes, Bourges, etc., are to be found true types of practice grounds in the form of troughs. At Fontainebleau, the trough is closed by a high wall of rock; at Coetquidam, by the enormous ground fault called the Grand-Bosse; etc.[1]

For many years the artillerists worked with great enthusiasm on these practice grounds. Practices held there were primarily for the purpose of executing ranging fire at wooden silhouettes.

From 1878 to 1898.—During this period of 20 years, which ended with the adoption of the 75mm. guns, regimental target practice consisted principally of ranging fire by the different batteries and of only a little group target practice. Only in 1882 did we have occasion to assist in a group target practice that required the solution of a problem. During the entire period from 1882 to 1898, it was only at the group maneuvers, held certain years at the camp of Chalons, that service practice was held by a number of battalions and that the higher officers of the artillery could improve their state of instruction, either by taking part in the maneuvers with the batteries, or by following them as spectators.

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[1] It seems to us to be interesting, with respect to the evolution of ideas, to recall the steps taken by the artillery of the 13th Army Corps to establish a practice ground in the vicinity of Clermont-Ferrand, since it shows how far, about 1875, the thoughts of everyone were taken up with the search for a suitable butt rather than for a piece of ground that would allow the artillery to prepare itself for war under as nearly as possible the same conditions as would be encountered in actual service.

There is, on the plain of Limagne, a geological landmark, Le Puy Crouel, which has the form of an enormous butt. Its height above the plain is about 180 meters. The artillerists thought that this was a regular godsend and thought of using Le Puy Crouel as a butt. They called it in their report "The target-butt of the modern artillery." The project to use this as a practice ground, however, came to nothing, but it is more than probable that the result would have been very different, taking into consideration the ideas in force at that time, if the price of ground in the rich plains of Limagne had not been very high compared with the price of land at the foot of Puy-de-Dome, which made it very much more economical to establish a practice ground at the latter place. Such a practice ground was established and was known as that of "la Fontaine du Berger."

In 1889 we had the good fortune to assist in the group maneuvers in which General (then Colonel) Langlois took part with his regiment. We wish to mention one fact which made a great impression on us during the course of these maneuvers.

At one of the critiques, the director general called the attention of the officers to the method of operation used by Colonel Langlois, in the following words:

This officer considers his battery as representing the artillery of a division and instead of merely transmitting the orders which he receives from the director general, he endeavors to amplify them by imagining the particular condition of affairs in war that would call for such orders. In other words, he always maneuvers his battery in conjunction with the infantry under assumed conditions and with a definite end in view.

The Colonel discreetly criticised the group maneuvers in which the artillery showed a certain tendency to act entirely independently and without paying any attention to conditions that might be met with in battle.

We might add, to be entirely truthful, that this method of Colonel Langlois was not at all criticised by the general, in fact the latter spoke of it as a "very interesting experiment."

The group maneuvers have been much criticised. There is no doubt that they were more or less theatrical and that they tended to develop narrowness. Nevertheless there is no question but that they aided the instruction of the officers, particularly in giving them a larger field of action than was possible on practice grounds in the form of a trough, where it was practically impossible to fire all the batteries of a battalion at once.

During the period from 1882 to 1898, all practices in which we took part, either by regiment or in group maneuvers, were conducted in the same way. At the start a problem was given out. This problem brought a body of imaginary troops and a real group of artillery from some distant point to the practice ground. The batteries took up positions and fired on the wooden objectives. The conditions of the problem did not have the slightest effect on the method of conducting the practice, and as soon as the first shot was fired everyone forgot all about it. Such a result was only to be expected. The size of the practice ground was so much reduced that considerations of safety required the positions of the guns and objectives to be selected in advance. The problem had no influence at all on the

method of conducting the fire and the entire purpose of the latter even was to destroy or riddle the wooden targets, which represented at will either artillery or infantry or even a wall.

Under such conditions, it was only natural that the battery commander should be indifferent as to his mission, the conditions of the battle and even the nature of the objective, and that he should always use one particular method in firing. This method, established by the commission for the practical study of fire, was "scientific" and was considered as being independent of the circumstances of any particular battle.

In the words of General Langlois, these problems were real romances used to induce the artillery to fire at the targets.

From 1898 to 1900.—The same principles were in force. As in the past, the practice was made up of a problem, followed by placing the battalion in battery and finally "the simultaneous ranging on the figures by the three batteries."

To perfect this method, all instructors, and especially those at the practical course of fire at Poitiers, exerted themselves to the utmost.

In 1900.—General Langlois, Commandant of the Staff College, came to the practical course of fire at Poitiers, accompanied by Major (now General) Fayolle, Professor of Artillery at the Staff College, and a class of student officers. Service practice was held for the General and the other officers. The method of conducting this practice, the criticisms made by Major Fayolle at the time and the drill ordered upon its completion by General Langlois, make up a very interesting set of papers, for they show clearly the progress in 1900, of the evolution of ideas in the method of conducting service practice.

Report of service practice held at the practical course of fire in 1900, before the officers of the Staff College.

A major of the course of fire is placed in charge of the practice. This officer performs the duties of director of the exercises, supreme commander of the troops and battalion commander of the artillery. He acquaints the officers with the general situation and afterwards with the opening situation. He then announces the orders of the commander of the troops to the battalion commander and indicates how the latter will proceed to carry out these orders. He then goes to the batteries and actually puts these orders into operation. During the development of the exercise he repeats this same series

of operations for each successive situation so that all the personnel assisting in the firing may follow and understand what the batteries are doing.

General Situation.

A brigade of infantry, "A," the advance guard of an army corps, composed in part of three batteries of artillery of four 75mm. guns each, is marching from La Chauvinerie towards the forest of Saint-Hilaire under orders to occupy the plateau of Montpouet. (See map on page 259.)

Situation I.

Our infantry, "A," occupies the two farms of Les Bournalieres and Les Renardieres. The enemy is seen on the plateau of Montpouet, but in no very large numbers. I will endeavor to proceed both to the right and the left.

Orders.

Place your three batteries in position to watch abreast of and to the north of the farm of Les Cosses and watch all the ground to the north of the woods "A" (Marked on the map "Abri A") on a front of 800 meters.

Execution.

The three batteries were installed as directed.

(Criticism of Major Fayolle.)

The force "A" knows that the enemy occupies the plateau of Montpouet and intends to attack them.

Profiting by the cover of the ground, the infantry advances to the right and left of the narrow hill forming the field of fire. The three batteries of the advance guard take up a position to cover this hill between the two columns of infantry.

This solution is incomplete.

What is the matter with it?

It fails to support the advance of the infantry.

Now, from its position the artillery cannot see the zone of action of the infantry and therefore can be of no use to it. The infantry of the force "A" as soon as it takes the offensive finds itself entirely abandoned to its own devices.

Actually the action of the hostile artillery has been foreseen and the battalion "A" has been accordingly placed, but its position fulfills only one of the two requirements of the situation.

Suppose the hostile artillery takes no part in the action, or suppose it fires on the infantry "A" with only a few pieces concealed from view or placed outside of the zone being watched.

The use of the artillery is always controlled by the mission assigned to the infantry. The infantry "A" is to attack; it must therefore be supported by its artillery. But artillery "B" may put in an appearance. That is why all the artillery "A" which is not used for the first purpose (supporting the infantry) is placed so as to be ready to act against artillery "B" (position of watching).

Situation II.

The hostile artillery "B" is opening fire on our infantry which is appearing near Les Bournalieres. We can see three batteries occupying a front of about 70 mils.

Orders.

None.

Action of the "A" Battalion.

The commander of the "A" battalion opens fire with two batteries on the hostile artillery.

Should we fire on the three "B" batteries with one, two or three batteries of the "A" battalion?

The commander of our battalion finally decided on two, because, he said, the "B" batteries appear to be echelonned from front to rear, otherwise the front being less than 80 mils, he could have in action only one battery.

At all events, with two batteries, he hoped to overcome three. We must confess that we don't understand how.

What was desired; to destroy the hostile artillery or merely to force it to cease firing?

Let us assume that the equipment on both sides is of equal effectiveness, that is, both artilleries are equipped with rapid-fire guns protected by shields.

That one battery, "A," can temporarily silence three batteries occupying a front of 175 meters and so placed that they cannot return the fire, is self evident.

But what of it?

It is very evident that the "B" batteries are not going to calmly make up their minds to let themselves be destroyed by a fire against which they can do nothing. They will cease firing on the infantry—this in any case will be the first effect of firing; they will put the personnel under cover then when the firing is over they will quickly recover their freedom of action and will change the objective and take up the ranging. They will probably have suffered, to be sure, but no one for a minute can imagine that they will have been finally put out of action.

In addition, let us consider the percentage of casualties caused by a progressive fire against a battery equipped with shields when the battery has ceased firing and the personnel has taken cover behind the armor plates on the caissons and the shields on the carriages.

Lacking actual experience, nothing exact can be said in regard to this, but it is fair to assume that the percentage is very small.[1] We may get an approximate idea of the percentage by considering the percentage obtained against skirmish lines, which have ceased firing and taken shelter in the trenches.

There is certainly no reason for assuming that because a battery has been submitted to a progressive fire it is no longer to be considered. To obtain a decisive result the duel must be of considerable length. It is therefore not logical, after the decision is made, to engage in an artillery duel using an insufficient number of guns.

We will go into this matter more in detail in connection with situation VIII.

Situation III.

The hostile batteries have ceased firing and the personnel had taken shelter behind the shields.

Orders.

None.

Action of the "A" Battalion.

The two batteries engaged continue to fire reducing the bracket by 50 meters.

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[1] In 1900, no firing whose results were known had yet been made against artillery equipped with shields.

(Criticism of Major Fayolle.)

However it may have happened, in this duel of two "A" batteries against three "B" batteries, the latter have come off second best, as is always possible, because there are in war many other elements of success besides superiority of numbers.

The "B" batteries have ceased firing and the personnel has taken shelter behind the shields.

What does the commander of the "A" battalion do?

He reduces the bracket by 50 meters. He might perhaps do better than this.

Preventing the hostile artillery from firing is good, when there is nothing else that can be done, but the best way to prevent it from firing is to destroy it.

We are placed in a very exceptional situation; three unconcealed batteries against two concealed batteries, and since the latter have obtained the upper hand, the artillery duel may be said to have been justified. We must now fire on the "B" batteries with torpedo shells using percussion fuses in order to destroy the matériel and personnel.

This is possible without an enormous expenditure of ammunition using as accurate matériel as the 75mm. guns.

Situation IV.

A new line of the artillery "B," visible only by its flashes, has appeared on the left of the original line.

Orders.

None.

Action of the "A" Battalion.

The third battery of the battalion, still available, is opposed to the new hostile artillery.

Situation V.

The enemy reopens fire along his entire line.

Orders.

None.

Action of the "A" Battalion.

The three batteries will divide up the total front of the hostile artillery and will deliver a heavy fire.

Situation VI.

The fire of the "B" artillery has ceased but the enemy has not been able to withdraw his batteries. I will again take up the advance.

Orders.

Move one of your batteries to a position south of the farm of Les Bournalieres, near point 136, to support my movement.

Execution.

Two batteries of the "A" battalion kept up firing while the third executed the movement directed in the above order. This battery went into battery by the flank near point 136.

Criticism of Major Fayolle on Situations IV, V and VI.

The front of the "B" artillery has been prolonged by the arrival of new batteries which are visible only by their flashes. The "A" battery still available has opened fire on them. This is merely an incident in the artillery duel.

When can this duel be said to be over?

The "B" batteries have ceased firing even though they are 4 or 5 against 3, but they have not been wiped out.

Why should they be?

They can reopen the fire at any time as they did do in Situation V.

Let us assume a state of inferiority and that these batteries have abandoned the duel and are confining themselves to acting against the infantry "A."

Can these batteries be prevented from firing?

Evidently not.

To accomplish this is would be necessary to keep them continuously under fire. They can always fire during the interval between successive rafales.

If they decide to fire two salvos (three seconds) and then put the personnel under cover, any reply would arrive too late (time of flight of the projectile—6 seconds).

What will the "A" batteries do to prevent this fire?

The artillery duel is without value since it has not been pushed to a conclusion. The two adversaries have been merely confined to firing by successive rafales.

This situation might have been indefinitely prolonged if the "A"

force had not decided to move one battery (situation VI) to the front to support its infantry.

Situation VII.

Hostile skirmishers concealed behind hedges in front of the wood of Montpouet have checked our infantry by a heavy and murderous fire in the direction of Les Renardieres.

Orders.

At any cost dislodge the enemy from this position.

Action of the "A" Battalion.

The battery in position near point 136, after ranging delivers a progressive fire on the hedges in front of the wood of Montpouet.

Criticism of Major Fayolle.

This battery has just gone into battery by the flank within 1000 meters of the "B" infantry firing in a south-easterly direction against the "A" infantry.

Going into battery in the open within 1000 meters of infantry is very apt to be fatal. Unlimbering must take place in rear of the ridge and then the pieces and caissons pushed by hand up to the summit.

Assuming that the ground, covered with prickly broom did not permit such a maneuver, would it not have been preferable to endeavor to arrive in line?

Situation VIII.

Our infantry has reached the plateau of Montpouet and has captured the hostile batteries. The enemy is retreating towards the forest of Saint-Hilaire. The cavalry reports that there is artillery in position on the plateau of Dognon.

Orders.

Under protection of the battery in position near point 136, move the other two batteries to the north of the farm of Montpouet and attack the hostile artillery. As soon as these two batteries open fire, take the battery from point 136 and place it near the wood of Fosse Service in such a position that it will be able to support a turning movement to our left.

Execution.

In compliance with this order only one battery could be put into action to the north of the farm of Montpouet, against a line of hostile artillery about 200 meters long in position on Le Dognon. The second battery took up position to await the turning movement.

Criticism of Major Fayolle.

The two batteries in the original position received orders to move to the front and take up position near the farm of Montpouet to attack the hostile artillery in action on the plateau of Le Dognon.

Actually only one battery took up position near this farm, the other remaining in the rear in a temporary position.

Three hostile batteries separated by large intervals were in action, their total front being about 90 mils (225 meters at 2500 meters).

What should be done?

Evidently to assemble the artillery before starting a new artillery duel.

Instead of this, the commander of the "A" artillery engaged one battery against three "B" batteries.

The same principle is always applied: Against a front of 50 meters one piece is sufficient, or against a front of 200 meters, one battery, without regard to the effectiveness or number of the pieces on the other side.

This principle appears to us to be manifestly wrong.

Having on one side a battery "A" on a front of 50 meters and on the other side, three batteries "B" on a front of 200 meters.

The duel between these two artilleries is affected by the following considerations:

(a) It is impossible to prevent a battery from protecting itself almost completely from a fire to which it cannot reply; all that is necessary is for the personnel to take cover behind the shields. The question of being the first to open fire has therefore not as great importance as is usually given to it.

(b) It is impossible to prevent a battery, even one closely watched, from firing and consequently controlling its fire. To prevent the "B" batteries from firing it would be necessary to keep them under a continuous fire.

(c) Finally, two artilleries opposing each other, will always, sooner or later have their fire controlled. At this particular time

we have two artilleries opposed to each other, both able within one or two seconds of each other, to engage in a duel with equal effectiveness. It is very evident that if the "A" battery takes part in this duel that it will surely come out second best.

(d) The "A" battery and the three "B" batteries represent two forces which have a relation to each other of 1 to 12. The number of projectiles fired will in the same time be to each other as 1 to 3; the fronts covered are to each other as 1 to 4 (as 50 is to 200); while the density of fire is to each other as 1 is to 3 times 4 or 12. Under such conditions no artillery duel is possible, and it is for these reasons that we say that it is not a question of the fronts but of strength of personnel, number of batteries, etc. The best way to get the better of the hostile artillery is, as in the past, to have a superiority in power.

It is interesting to find in this criticism the gist of all the ideas which General Fayolle has so vividly brought out in his book: "Concentration of Fire and Concentration of Power."

[CONCLUDED IN NEXT NUMBER.]

PRESENT TENDENCIES IN GERMANY REGARDING THE USE OF HEAVY ARTILLERY.

BY CAPTAIN J. PESSEAUD, FRENCH ARTILLERY.

Translated from "Revue d'Artillerie," November, 1913.

BY FIRST LIEUTENANT FRED T. CRUSE, 5TH FIELD ARTILLERY.

During the last few years Germany has been making considerable efforts to equip her army with a powerful heavy field artillery.

The Revue d'Artillerie has published descriptions of the various types selected and assigned to this arm, heavy and light howitzers, a 21cm mortar, and 10 and 13cm guns. It is known that the last three are provided with turntable limbers and are independent of platforms for firing, which makes them suitable for field work in spite of their weight.

The Revue has also shown the progress made in organizing this heavy field artillery, especially the preparation for its increase shown by the bill of 1911, which provided for the personnel.

What is the purpose of this recently-organized new arm? What plan calls for this piling up of forces? This is what it may be interesting to look into at this time.

To begin with, we know that German ideas about the use of heavy field artillery have progressed rapidly since the time when the Germans created this force for use against our permanent fortifications. Later, they planned to use it against field fortifications. And now a further advance appears, and we can clearly see the present idea, which is, that the heavy artillery is to be a field arm operating with the other arms and to be used principally for the destruction of hostile artillery.

The first indication of this intention is shown in the changes made in drill regulations for foot artillery, which changes went into effect last year. (Provisional Regulations, 1908. Part IV.)

If we examine the official text in conjunction with the criticisms and comments of the press and the military publications we will see the ideas underlying these changes very clearly brought out.

We will give the new text of the articles changed, and with each article extracts from the comments of German writers. The conclusions will need no explanation.

Principal Changes in the Regulations for German Foot Artillery. Art. 356—The diversity of targets makes necessary pieces of different kinds and

different powers. The field gun is the principal artillery weapon in the field. It is used against all except covered targets. Its great mobility makes it the most useful for working with infantry, and the rapidity of its fire makes it the best fitted for use against moving targets.

The light howitzer plays the same role as the field gun. Against artillery, against targets situated close behind cover and against troops occupying thick woods it is much more effective than the gun. It can penetrate most overhead shelters met with in the field and can attack captive balloons and aeroplanes even when they are high up.

The heavy field guns are useful in destroying solid objectives and their great range and the depth and effectiveness of their shrapnel fire make them useful against living targets, roads, etc., as well as against captive balloons and aeroplanes.

The heavy field howitzer is superior to the light howitzer in penetration and power of the explosive shell. As a result it can be used effectively against artillery and strongly-fortified infantry. Against moving targets its usefulness is limited.

The mortars are useful in the destruction of permanent or temporary fortifications. They are quite effective against all kinds of targets.

Art. 358. Foot artillery should, together with field artillery, support the infantry. This it should accomplish by overcoming the hostile artillery. Against visible or definitely located artillery, against troops in or behind works, and against strongly fortified infantry positions its fire is of decisive importance.

Art. 368. Foot artillery will frequently take position behind field artillery. When it does, the observing station will be selected by the artillery commander. (Note—By the artillery commander is meant the senior artillery officer with a detachment of troops. In the zone of attack on a fortress it is the ranking officer of foot artillery in the sector.)

There should be no hesitation in firing over the heads of advancing troops. Every effort should be made to continue the fire to the last moment to support the infantry. When the first lines of the infantry have advanced to the point where this fire would endanger them the fire should be shifted to objectives in rear of the enemy's first line, to the artillery, or, no other objectives appearing, to points where reserves are suspected of being located.

Art. 370 to 373—These articles, which are too long to be considered here, prescribe the duties of the various commanders: commanding general, division commanders, chief of artillery, and artillery officers.

Art. 388. As a general rule, foot artillery should not be put into action when the situation is uncertain. In particular, in combats in the field, light or heavy howitzer batteries should in most cases not be used, like field guns, from the beginning of the action but should be held where they could most successfully help out in the artillery duel. Sometimes, however, the

heavy artillery will be placed on the line early, as when its long range would be useful in delaying movements of the enemy at a distance, making them make detours, or in closing or keeping open defiles.

"This heavy artillery can also carry on the artillery duel against a superior artillery and permit the light batteries to move forward and operate at shorter ranges."

Art. 415. By placing the heavy artillery as soon as possible in the center of the line of battle we gain the advantage of having them cover a great part of the field.

Art. 416. The light and heavy artillery should work in concert against the hostile artillery. Visible batteries can be rapidly annihilated or at least put completely out of action. Against located batteries, that is, against batteries whose positions are known by observation, reports of reconnaissance, etc., with sufficient accuracy to permit of searching their vicinity with reasonable brackets, these results could be obtained only with a correspondingly large expenditure of time and ammunition. We should usually be satisfied to damage them sufficiently to enable the smaller bodies of artillery to hold them in check.

The attack of batteries whose location is uncertain or whose position is simply guessed at leads to much waste of ammunition. If it becomes necessary to fire under such conditions, all that can be done is to consider carefully and try to use the method of fire best suited to the situation.

Firing on the enemy's observing stations may help considerably; it is often the only way to paralyze a battery, even one whose location can only be guessed at.

The assignment of targets depends upon the kinds of artillery available and the situation or stage of the combat. The principal thing is to try to get the situation in hand so that the greater part of the light artillery may be free at the earliest moment to open on the opposing infantry. In certain circumstances it may be advisable to help the light artillery in this attack on the infantry by using the heavy artillery also against it; this will be the case when the infantry is sheltered behind solid walls or earthworks or is holding deep trenches.

Against large living targets, such as columns on the march, assemblies, etc., heavy artillery is effective even at great ranges, but against smaller and more mobile targets it is not so, except in very unusual cases, and such targets should be left to the light artillery.

Art. 417. The position of heavy artillery on the march will be determined by the situation and the mission. If the corps is marching on one road this artillery would usually form part of the leading division. In an infantry division it usually marches in rear of the infantry. If it seems likely that the heavy artillery will be needed early in the action it may be put in ahead of the main body of light artillery. It should be noted that this will retard the deployment of both the light artillery and the infantry. The observation carts usually march at the head of the battalion, but when necessary they

may be further to the front. Unless otherwise ordered the combat trains march in rear of those of the light artillery.

COMMENTS BY THE PRESS AND IN THE GERMAN MILITARY LITERATURE.

These changes in the Regulations have been analyzed and discussed in the Kriegstechnische Zeitschrift No. 6, for 1912, the article being by Major Immanuel, a well-known writer in the German military journals. He interprets their significance in these words:

The substance of these modifications is of considerable importance in the tactical employment of foot artillery, as they have the force of a general order. They should attract the attention of all the arms, as they show clearly that the foot artillery has become a combat arm, a true sister arm, which will play its own important part on the battlefield.

Speaking of Article 358 Major Immanuel says that the text defines very precisely "the role of the two kinds of artillery and distinguishes between them." He comments as follows:

In the foregoing we find nowhere any indication that the foot artillery will be brought into position for the attack only of visible or located batteries. Its action against such artillery is particularly effective, but it is by no means to neglect opportunities to attack artillery which is neither visible nor located. Will it most often have visible or located artillery as its objective? It is not believed so, for the reason that the great armies of our neighbors vastly prefer defiladed positions.

On the subject of the heavy artillery assisting the light batteries in getting into action in the face of a superior artillery, he says:

The above question deserves particular attention and is notably important when the enemy has the start of the combat and can open with the fire of a strong body of artillery. In this situation well-placed heavy artillery would make possible without too great loss the bringing up of the light batteries.

In the Deutsches Offizierblatt Nos. 19 and 20, of 1912, an anonymous author likewise analyzes these same modifications. He says:

These are not simply lists of changes such as we generally get but are modifications of a fundamental nature. Their importance lies in the fact that they concern the most important part of the Regulations (Part IV, Combat), and that they lay particular stress on the combined action of light and foot artillery in field warfare and in the attack of fortified places.

The same author brings out the fact that in Article 356 the Regulations speak first of the action of howitzers against artillery and gives second place to their use against fortifications. He adds:

The primary task assigned to the heavy field howitzer is the attack on the enemy's artillery. This is clearly stated and gives to this howitzer the part which it plays most effectively.

In another article in the same journal we find the following:

It is evident that heavy field pieces may be of the greatest utility with a field army. Their principal advantage lies in their effective long-range shrapnel fire, which will make the enemy deploy long before the light artillery would have such an effect. Another advantage which would show up more quickly and thoroughly with howitzers, is in the attack on artillery protected by shields, not only with explosive shell, but with plunging shrapnel fire to reach behind the shields.

Lastly, a recent work by Captain Hans Friederich, on "The Tactical Employment of Heavy Field Artillery," contains numerous interesting indications of present German ideas.

The experiences of the last few years have established beyond question the possibility of successfully executing a sweeping fire with the explosive shell from the heavy field howitzer, Model 1902. The space covered by a howitzer battery is often, due to the great lateral efficiency of this projectile, 300 metres wide and 30 metres deep, or 9,000 square metres. If we open the sheaf to just the effective width of a single burst, which is 80 meters, the four pieces will cover a width of 4×80 or 320 metres, which means that the battery could effectively hold in check a battalion of light artillery.

By using different ranges the depth covered could be increased, and by shifting the sheaf more front could be covered, which means that any artillery target in a bracketed space, no matter what the size of the space may be, can be put out of action without undue waste of time or ammunition. It has been shown that against artillery objectives whose front is three times that of the battery firing on them, satisfactory results can be obtained very quickly (that is, in half or three quarters of an hour) without a serious expenditure of ammunition (70 to 90 rounds for each battery firing).

Each heavy howitzer battery in an army corps carries 1.728 rounds, from which it is easily seen that the expenditure of 70 to 90 rounds will leave plenty of ammunition available for use under other circumstances, such as attacking infantry and preparing for the actual assault. In fact, a much larger expenditure of ammunition would be justified if it accomplished the desired object and left the light artillery free early in the action for use against the opposing infantry.

In the same chapter the author reviews the methods of locating the opposing artillery when the latter has sight defilade. This involves the determination of the area in which the artillery can be definitely said to be located, so that this area can be systematically shelled as described above. There are a great many of these methods

of identifying artillery, such as reports from reconnaissance, patrols, balloons or aeroplanes; observations on the flashes, the smoke, the dust, and on groups of mounted men; the use of modern observing instruments, such as the scissors instruments, study of the map; study of the marks made by the enemy's projectiles, the furrow showing the direction and the setting of the fuze giving the range; reports received from the other arms; angular measurements from two different stations; and lastly knowledge of the enemy's methods of using the terrain. On this subject the author speaks as follows of the French artillery:

> As a usual thing we would look for the French artillery between 50 and 300 metres in rear of the mask. French ideas of defilade have long been unsettled. Beside total defilade we find four other kinds:
>
> 1. Sight defilade.
> 2. Dismounted defilade.
> 3. Mounted defilade.
> 4. Flash defilade.
>
> It is reasonable to suppose that these four kinds will continue to be used. Sometime ago mounted defilade was most favorably regarded. It is easy to see what heavy howitzers could do when this kind of defilade is used.

As regards mobility of the heavy field pieces, the author takes pains to refute in advance the oft-repeated assertion that the German heavy artillery could not reach the battlefield early enough to accomplish the mission assigned to it.

> The mobility of a heavy howitzer battery is, of course, that of a light battery, but it is sufficient to take it wherever a wagon can go, even in mountainous country in freezing or snowy weather. We have had proof of this in the maneuvers of the last few years, when heavy artillery had to march at least 50 kilometers a day for several successive days. It accomplished this without difficulty and was always on the spot when needed. Over good ground it could trot for 7 or 8 kilometres. When the heavy howitzer battery once reaches its position it is a very short time before it is ready to open fire.

Concerning the use of heavy artillery in supporting the infantry and in the preparation for the assault, the author lays stress on using every means to continue the fire until the last moment, in accordance with Article 368.

Ballistic firing must have shown that on account of the curved trajectory and the accuracy of the fire, the fire could be continued until the assailants were within 100 or 150 metres of the enemy's position. The author cites the instance of the Japanese heavy artillery

firing until their infantry were within 50 metres of the position. He adds:

> The history of war teaches that infantry would rather stand some loss from their own artillery than lose its support at the decisive moment.

Finally, in the last chapter of his article, Captain Friederich makes a study of the material, organization, and probable tactical use of the French heavy artillery, which he concludes as follows:

> It is evident from this that the French have no idea of systematically employing their heavy artillery to cripple the opposing field artillery. If we compare the German and French heavy artillery we see that the difference lies in the fact that the latter consider that their first and most important task is to cripple the opposing artillery. I believe I have shown in the present work that it will be able to accomplish this.

CONCLUSIONS.

From consideration of the foregoing it seems that we can interpret as follows the present German conception of the rôle and methods of handling of the heavy artillery:

1. Under favorable circumstances the heavy artillery before the battle will operate at long range to delay the enemy or to oblige him to deploy, to make impossible the use of passes, to interfere with his formations, prevent his artillery from coming up, etc., in short to delay and make difficult the formation of his forces for battle. To this end it will be placed much nearer the head of the columns on the march than it has formerly been.

2. The principal rôle of the heavy artillery is to crush the enemy's artillery early in the game by means of its long range and the greater effectiveness of its projectiles. It will thus render the greater part of the true field artillery, which will be used as supporting batteries for the infantry. To be sure of doing this the heavy artillery will be placed as soon as possible in the center of the line, if necessary, in rear of the light artillery. It is to accomplish the destruction of artillery equipped wth shields and completely defiladed, provided that it can determine the zone in which this artillery is located. It will then have to execute a systematic fire within the limits of this zone. Naturally this will require time and ammunition, but it will not hesitate to expend the necessary rounds. The very considerable supply at the disposal of the German heavy batteries allows them to expend such an amount without lowering too much the supply available.

3. Lastly, the heavy artillery will support the infantry, more especially so when the latter are in front of fortified positions, and it should show up strongly in the preparation of the zone of attack for the final assault. It will then continue its fire to the last moment compatible with the safety of its own troops.

It remains to be seen whether or not the difficulties of movement, the crowding of the roads, and the complications of ammunition supply for the heavier calibres will permit the execution of the whole of this program. However it may turn out, the idea is there, very clear-cut, and it is interesting to note its existence.

THE FIELD ARTILLERY IN THE BALKANS.

BY CAPTAIN ALVIN.

Translated by LIEUT. H. R. ODELL, 3RD F. A., *from the Journal des Sciences Militaires,* Feb. 1, 1914.

(*Continued from January-March number*.)

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* V. ARTILLERY MATÉRIEL OF THE BALKAN STATES.

In 1903 Bülgaria, at the proving ground at Hoc, conducted some tests of a Schneider gun, which were probably satisfactory, since the rate of fire was from 17 to 27 salvos per minute. The Bulgarian government was on the point of buying when the intervention of Germany caused her to start a new series of comparative tests. The result of these tests by a commission presided over by General Riaskoff, led Bulgaria to give an order for 81 Schneider system field batteries, the cost of which was covered by a loan contracted in France.

Servia kept the Bange type of gun until 1906. She then opened a competition between the Skoda, Krupp, Ehrhardt and Schneider factories. After a series of very severe tests she chose the Schneider 75 mm, model 1906 field gun, and the Schneider 70 mm, model 1906 mountain gun. Forty-seven batteries of the 75 mm matériel were ordered.

Greece had, in 1907, 36 batteries of a matériel similar to that of Servia, after having conducted competitive tests of the Armstrong, Ehrhardt, Krupp and Schneider matériel. These tests gave rise to some incidents which were seized upon by the press. The Commission, presided over by the Crown Prince Nicholas, was *à priori* favorable to the German pattern, but, nevertheless, recognized the superiority of the French type. Krupp withdrew from the competitions, taking with them the Ehrhardt people, and claiming that the Commission had an interest in preferring the Creusot type. The Crown Prince published an indignant protest, which set forth in detail the points of superiority of the French gun.

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* Editor's Note.—The first four sections contain nothing bearing upon the use of artillery, and are therefore omitted.

Montenegro was provided with Krupp matériel comprising a field gun of 80 mm, and a mountain gun of 75 mm., as well as some howitzers.

Turkey, in 1903, adopted, without any comparative tests, the 75 mm Krupp field gun, model 1903.

To recapitulate, Bulgaria, Servia and Greece were armed with Schneider guns, differing only in details. Turkey had Krupp matériel similar to the regular German matériel.

VI. CHARACTERISTICS OF THE SCHNEIDER AND KRUPP MATÉRIELS.

What differences exist between the Schneider and the Krupp field guns, and to what extent are we obliged to attribute to these differences the success of the former? This technical question may be put independently of every tactical consideration.

Both of these guns have the same caliber, 75 mm. Their projectiles have about the same weight: 6.5 kg. for the Schneider shell and shrapnel; 6.35 kg. for the Krupp shell and shrapnel. The muzzle velocity is about 500 meters per second. The explosive shell carries a non-delaying percussion fuse. The shrapnel contains 275 balls of about 10 grammes each. The weight of the piece in battery varies from 1000 kg. (Turkey) to 1030 kg. (Bulgaria) and 1040 kg. (Servia and Greece). The breech block is opened and closed by a single movement of the lever, by means of interrupted screw in the Schneider, and a wedge in the Krupp. The piece is discharged by a percussion mechanism.

These facts lead to the conclusion that the efficiency of a single shot is sensibly the same, whatever the matériel considered. But other considerations militate in favor of the Schneider gun.

First of all, we must point out the recoil mechanism, which takes the shock of recoil from the carriage, and the "recuperation," or counter recoil system, which stores up the necessary energy to return the gun to its position in battery.

All the brakes are hydraulic, that is to say, they utilize the resistance resulting from the passage of a liquid through narrow orifices. As for the "recuperation," the Krupp gun is equipped with spiral recoil springs, the Schneider either with springs or a compressed air device. Servia and Greece have shown a preference for the compressed air. Bulgaria has preferred the springs, which appeared simpler. The reports which will be made will perhaps determine

the respective merits of the compressed air and the metallic springs.

But it is specially in the method of laying that the Schneider gun possesses incontestable advantages. The gun may be moved in azimuth by a sliding of the top carriage along the axle, as in our 75 mm, model 1897. It has a sighting apparatus consisting of a goniometer with a sighting tube, capable of turning in azimuth. From these arrangements it results, first, that the force of recoil is always exerted in the direction of the trail spade, which prevents derangement of the laying; and, second, that the operations of laying are independent of the objective, which permits flexibility of fire.

These inherent advantages exist to a lesser degree in the Krupp gun. The latter, supported by a cradle, pivots on a vertical spindle immediately underneath the middle of the axle. Its sighting apparatus is not independent.

From these arrangements it results, first,—that the recoil has a component parallel to the axle, which causes derangement of the aim; and, second—that indirect laying, or masked fire is possible only in exceptional cases. Finally, the absence of the corrector scale in the Krupp matériel, and perhaps the bad quality of the shrapnel fuzes, have caused vexatious irregularities in the time fire, to which we will have occasion to refer later.

VII. SOME ARGUMENTS OF A TECHNICAL NATURE.

The Bulgarian, Servian and Greek batteries contained four guns; those of the Turks had six guns. May we find in this difference in the interior organization of the batteries an argument in favor of the allies? In answering this question in the affirmative we fear we may awaken in certain of the unconvinced the passion aroused at the time of the vote on the reorganization of the artillery in July, 1909.

Nevertheless, our methods of fire and our manner of conducting fire, have been copied by the allies. In 1905, a commission of Bulgarian officers came to take a practical course of fire at Poitiers; on their recommendations a similar course has been instituted in their own country. Several Servian and Bulgarian officers have served for some time in our regiments, and on returning home, have become instructors of their arms. The regulations of the Bulgarian Artillery are only an adaptation of our own.

Finally, while the Turks had practically no training in firing in

time of peace, the occupation of positions, followed by actual firing, formed part of the technical instruction of the gunners of the Allies.

VIII. TRUE CAUSES OF THE SUCCESS OF THE ALLIES.

From the preceding considerations, we may infer that the success of the artillery of the Allies has been due, in a certain measure, to the excellence of their matériel; but above all to the judicious manner in which they have employed it. A part of the moral and material superiority which the Allies so quickly gained over the Turks is due *to a more skillful employment, by a better drilled personnel, of a field gun of which the apparatus of laying and fuse setting are superior to those of the Krupp gun*.

We say *a part,* because the greater part is the result of *the bravery and aggressive spirit of the Allies, of the inferiority of organization of the Turkish army, and of the mediocrity of the Turkish officers. Much more than the technical factors, these are the true causes of the victory of the Allies*.

Be that as it may, the Allies have employed their field artillery, according to the principles laid down in our regulations, in close liaison with the infantry. Their batteries have striven, as far as the terrain permitted, to support as actively and as closely as possible, the movements of their infantry.

A more profound study of the rôle played by the artillery in the Campaign of the Balkans can only confirm us in the opinion, that the "implement is no better than the workman."

IX. EMPLACEMENTS OF BATTERIES.

Masked fire was employed to a large extent. The Bulgarians, operating over a gently rolling terrain (except for the fighting to the northwest of Kirk-Kilisse), have been led to place their batteries far in rear of the covering crests, and to employ the telephone. This practice sometimes resulted in a slackening of the fire, which was all the more deplorable as the opportunity for the artillery duel rarely occurred, the Bulgarian batteries having as their ordinary rôle the support of their own infantry. (Captain Bellenger.)

The Servians, operating over a very rough country, placed their batteries close under the covering crests. This method, which does away with the difficulties of transmission of commands from the

captain to the battery, appears to have permitted better employment of the rapid fire guns.

But neither Serbs nor Bulgars hesitated to sacrifice defilade when the situation demanded it. Sometimes the guns were pushed up on the crest in order to permit fire against the enemy's infantry. Our military attaché at Belgrade reports that during the Inter-Balkan War, complete defilade was scarcely ever obtained, and that even the howitzer batteries did not always use flash defilade. The reason appears to have been that they occupied themselves principally with firing on the enemy's infantry, which permitted very little use to be made of the telephone. The field batteries were placed in completely uncovered positions, as at Monastir, on the 17th of November. At the battle of Alince (November 6) all the artillery of the Division of the Drin was placed in an exposed position on the plain at 5000 meters from the enemy's position. During the combat it made a change of position by echelons, always in the open plain, in order to approach within a distance of about 3000 meters. A qualified correspondent who visited the field has declared that there was not another possible way in which the attack could have been made.

A beautiful example of audacity on the part of an accompanying battery is given us in the sige of Adrianople (report of Colonel de Mondesir). Major Drouleff (Bulgarian), whose group had received a mission of accompaniment, had lost a great many horses during the day (March 12) and his reserve teams had not been able to rejoin him in his position at Malask. In order to attack the infantry on the main line, he formed a battery of accompaniment from what remained of his command, pushed forward at the heels of the infantry (night of March 12-13) and, although he lost half his horses en route, succeeded in putting his battery in a sheltered position within 300 meters of the Fort of Aiji-Yolu and from there opened an oblique fire on the principal line of defenses around Aivas-Baba, aiding materially in its capture. Being rejoined by several pieces which had been left behind, he then established himself on the line of works, opened fire on the retreating Turks, and aided in repulsing their counter attacks.

The Turks, it seems, were ignorant of the principles of the occupation of positions, and, apparently, their batteries had not been exercised in indirect fire. At the battle of Lule-Burgas, Captain

Bellenger saw to the east of Turkbey, a battery placed in a position for direct laying at the top of the crest, when it would have been easy to have defiladed it completely. The same statement is true as to Kumanovo. At Monastir, near Kakurecani, the same officer found batteries in which all the pieces except one were defiladed. The remaining piece was in a direct fire position, and appeared to have been used as a directing piece.

X. EXECUTION OF FIRE.

The unanimous opinion of the belligerents is that fire, to be efficient, should have a low burst. The Servian field batteries, which have been most of all attentive to detail, have applied themselves to the careful regulation of the height of burst. On the other hand, the fire of the Turkish batteries, well adjusted for range, produced only mediocre effect because the height of burst was very poorly determined. The fault lies, partly in the poor instructions of the Turkish gunners, and partly in the absence of a corrector scale for the Krupp gun used in Macedonia. The Krupp gun, perfectly comparable from a ballistic standpoint to the Creusot, is rendered inferior by its apparatus of laying and by the absence of the corrector scale.

The ranges used by the Bulgars were usually very great; they often attempted to use their guns at ranges greater than 5000 meters. The Servians were less timid in this respect. At the battle of Monastir, the four pieces that the Division of the Morava succeeded in dragging up on the crest profited each night in approaching the enemy from cover to cover by jumps of 1500 to 2000 meters, lowering their pieces down the steep declivities with ropes. This advance of batteries by night over ground swept by fire during the day seems to have been frequent with the Serbs. It is worthy of emulation.

XI. CONDUCT OF FIRE

Was the superiority gained by the artillery of the Allies over that of the Turks obtained by a methodical duel between the two artilleries forming a definite phase of the battle and resulting in putting the Turkish batteries *hors de combat?* In other words, did every battle open with an artillery duel? From a detailed study of the battle of Kumanovo, Monastir and Tchataldja, General Herr thinks

we should come to that conclusion. But this opinion is far from being shared by the belligerents. On the contrary, General Savov's Chief of Staff thinks that the artillery duel, properly speaking, had no place in these battles. This point of view is held by many Bulgarian officers, who, in trying to make clear to one of our officers the character of the battles in which they participated, agreed that the artillery always sought to *"s'infanteriser,"* and that that was the only target to which it should devote itself. By the word *"s'infanteriser"* is meant that the first idea of artillery entering an action should be to occupy itself only with infantry; to try to destroy the enemy's infantry, and to break down obstacles which may stop the advance of its own infantry. If the enemy's guns constitute one of these obstacles, it should take them under fire, but if their fire is not dangerous to friendly infantry, even though it is directed against them, our guns should disregard the hostile artillery and fire only on the enemy's infantry. This idea is supported by an episode in one of the battles around Adrianople.

On the 13th of March, before Dooudjaros, the 12th Bulgarian Infantry regiment, repulsed the night before, could not return to the attack because of the well-directed fire of Turkish sharpshooters under cover in rear of their trenches. The 9th Battery of the 8th Regiment of Bulgarian Artillery then opened fire by rafales on the trenches and the ground in rear. After firing some 580 rounds, the battery succeeded in forcing the Turks to take cover in their trenches. The 12th was then able to make the assault. Meanwhile the battery which supported the attack was under fire from a siege battery, and a quick-firing field battery which was not under fire of any hostile artillery.

From the Serbs, we have the same statement. It is against infantry, first of all, that the artillery fires. Also, on the whole, the Turkish matériel suffered little. Out of 64 field guns and one mountain gun abandoned by the Turks, only one gun was out of service. The total number of imprints of balls on the other pieces did not exceed a dozen, which were distributed on only three guns. At Monastir, all the abandoned batteries were nearly intact.

As for the Turkish artillery, it may be said that it engaged in the artillery duel only in cases of absolute necessity.

Can it be said that the artillery obtained destructive effect on the infantry? The results, as we look further, show that these cases

were very rare. But the cases of neutralization and immobilization appear to have been frequent. This resulted, without doubt, to the large use made of temporary fortifications, as much by the Allies as by the Turks. The Allies always protected themselves by digging as soon as they received a few shells, but they knew when to quit their trenches to advance, when it was necessary. While the Turks nearly always intrenched (except in the attacks led by Mouktar Pasha on Bunar-Hissar and by Djavid Pasha on Kumanovo and Monastir), they do not appear to have shown any great desire to leave their trenches. In summing up, all the tactics of the arm, in that which relates to the conduct of fire, seem to have held to this principle:

"Fire, at each moment of the struggle, on the principal obstacle which opposes the march of the infantry."

XII. LIAISON OF THE ARTILLERY AND INFANTRY.

This result can only be obtained if the artillery remains in close communication with the infantry. In fact, this liaison has always been sought, especially by the Serbs, but it resulted more from the initiative of subalterns than from the orders of superiors. One point has been definitely established: that is, the necessity for the artillery, in order not to fire on friendly infantry, to keep constantly informed as to the progress of the firing line, which may sometimes be lost from view in crossing a ravine or cover. To this end the Serbs employed signaling by means of flags. During the Inter-Balkan War they marked each important change of position of the firing line by lighting fires of brush wood or straw, or in case of need, by setting fire to the houses of a village or an isolated farm.

In the Bulgarian army the service of communication did not always function perfectly. This resulted in mistakes of which we will cite two examples where the Bulgarian artillery fired on friendly infantry. One was the attack on the advanced positions of Papas-Tepe, near Adrianople, when the 12th regiment of infantry lost a fourth of their effective strength, and the other was the assault on Adrianople, when the infantry regiment which attacked Kestenlik suffered equally severe losses from friendly shrapnel fire. No arrangements had been made to secure the necessary cooperation.

Certain chiefs of corps and brigades had taken the initiative in seeking some practical means to establish this highly necessary

liaison between the artillery and infantry. Some employed flags and colored lanterns, others required the men to carry a little straw on their knapsacks, which when piled together and burned, served as a signal, either by day or night. Nothing conclusive appears to have resulted from these tentative and varied experiments.

With the Greeks, the *liaison* of infantry and field artillery was incomplete. This was one of the causes of the losses suffered by the Greek infantry. On the other hand, the mountain artillery always set an example of beautiful "*camaraderie de combat."* At Sarandaporos, in particular, the mountain batteries made a skillful preparation, regulating their fire on the advice of the infantry officers of communication, in order to avoid any chance of error in objectives. It was the same at Yenidje-Vardar. Unfortunately, *liaisons* of this nature were not the usual thing with the field artillery, and at Janina General Sapoundzakis, an artilleryman of the old school, involved himself in an artillery duel which did not hasten by a single day the reduction of the place.

XIII. EFFECTS OF ARTILLERY FIRE.

From what goes before, it is seen that artillery fire is most effective against infantry. The last war shows that fire against a defiladed battery is practically useless and that a battery suffers from shell fire only when it is taken in the act of maneuvering or in an exposed position.

It may seem improbable that, during the whole campaign, only one Servian artillery officer was wounded by a shrapnel ball. A Servian battery which fired more than 7000 shots lost only 4 killed and 7 wounded. This information comes to us from a very authoritative source. In the vicinity of the 120 mm. batteries of the 1st Bulgarian Division, before Adrianople, the air was filled with shrapnel bullets, yet the batteries lost only three men, killed at their pieces by a single percussion shell, and they had only a few wounded.

It was against the infantry that, on both sides, the artillery obtained the greatest effect. The losses suffered by the infantry, from artillery fire, appear to have been considerably greater than in previous wars. Although the exact statistics on the proportion of wounds caused by the different arms have not yet been published, one may, from information obtained from other sources, draw some conclusions: Doctor Guentchitch, director of the Sanitary Service

of the Servian armies, estimates that, with the Servians, 2 per cent of the wounds were due to artillery fire; with the Turkish prisoners, from 15 to 20 per cent. Generally speaking, the losses due to artillery fire on both sides were about 10 or 12 per cent of the total. The French Surgeon Cousergue, attaché to Belgrade and Sofia, examined 1200 wounded Serbs in the hospital at Belgrade, 15 per cent of whom had been struck by shrapnel balls.

Perhaps the Bulgarian losses were a little greater because their formations were more dense and the attacks more determined, not utilizing to so good advantage the irregularities of the ground.

A qualified correspondent estimates that the percentages put out of action in the Greek army by artillery fire and by infantry fire are in the proportion of 1 to 9. He assumes a proportion of about 1 to 8 in the Turkish army, without, however, showing his reasons for this assumption. Although these figures are not absolutely authoritative, they agree well enough to permit us to conclude that although *artillery fire was most efficient against infantry, it caused them only about 10 per cent of their total losses. It is therefore the rifle which in war causes the greatest number of wounds*.

In the opinion of Doctor Lacombe, Surgeon in Chief of the French hospital in Constantinople, shrapnel bullets cause wounds of a much more serious character than do rifle bullets.

We must take care not to draw from these conclusions, provisions for the case of a Franco-German war, because the conditions of the employment of artillery in the late war were influenced by contingencies which must be considered. First, the proportion of artillery was less in the belligerent armies than it would be in ours. In the Servian army, a division of two brigades of two regiments of four battalions, that is to say, 16 battalions, is allowed a regiment of nine batteries. This gives one and one-half field guns per battalion of over 1000 men. If we, count the mountain guns and 120 mm. howitzers, we arrive at approximately two pieces per battalion, or about half what we and the Germans have.

The Bulgars were still weaker proportionally in artillery, because their divisions, corresponding to our army corps, have three brigades and number 24 battalions of over 1000 men, while the Serbs have 16. Each Bulgar division is allowed only nine batteries, or 36 quick-firing guns, as against our 120.

On the other hand, the belligerents employed only shrapnel and

explosive percussion shell. They possessed neither the explosive time shell nor the explosive shell with a delayed action fuse, functioning on ricochet. It is therefore to be inferred that because of the greater proportional number of guns engaged, and because of the employment of more effective projectiles, the effects of artillery fire in a Franco-German conflict would be more severe.

But it is probable that our infantry will be all the more sorely tried by artillery fire and it will be necessary for our artillery to increase their activity in order to compensate for this. They should be convinced that an attack cannot succeed unless the participants are willing to come to close quarters. In this regard the Turco-Balkan War has shown uselessness of fire at long ranges, that is to say, beyond 4000 meters, either for field or heavy mobile artillery.

Should batteries advance with no other thought than to gain ground? The losses suffered at Kumanovo by a Servian battery, which, after advancing during the night, established itself in a position completely exposed by day, and at Turkbey by a Turkish battery which was abandoned by its personnel, and afterwards destroyed by the Bulgars, show that it is necessary to occupy positions judiciously, and to approach without useless exposure. This state of efficiency can only be attained by maneuvers in time of peace, in the course of which the batteries become skilled in their drill, and learn to seek, by the use of cover, a protection not afforded by the shields.

This does not mean that the protection offered by the shields is any less valuable. Many Bulgarian officers have stated to our attaché in Belgrade, that the gunners could continue the service of their pieces, whatever might be the fire directed against their battery. Without putting too much faith in this assertion we recognize the advantage of shields, and wish that they might be supplemented by the wearing of a helmet. In war, a man seeks instinctively to protect his head. Colonel Mondesir states that, before Adrianople, the Bulgar infantry placed their shovels or their knapsacks on their heads to protect themselves from bursting shells, and I have it from a Servian officer that their mess plates were not employed exclusively for culinary purposes.

XIV. HEAVY ARTILLERY—MORTARS.

One may be tempted to expect from the experiences of the Balkan War some enlightenment on the question of the employment of the

guns and mortars of heavy caliber. In spite of the opinion of General Herr, the facts borne to our notice do not permit us to decide either for or against the use of calibers greater than 75 mm.

One of the principal difficulties connected with the employment of field artillery in the Balkans was its weight. Frequently the Servian artillery arrived late, as at Kumanovo, when a division fought the whole battle with only one group of artillery; or it did not arrive at all—as at Monastir, where the Morava division was not followed by its batteries. The abandonment of Tukish matériel on the field of battle was due in part to the difficult terrain which hindered materially the movements of the carriages.

These episodes tend to prove that the matériel should be lighter. It may be remarked that Macedonia presents difficulties in the way of bad roads, which can only be surmounted by the more general employment of mountain artillery. As for the operations in Thrace, they were continually hindered by mud.

However, the Bulgars and Serbs managed to draw some of their 120 mm. batteries and mortars with oxen. Except at Adrianople and at Tchataldja they were not in action. On the Bulgarian side, the howitzers were used only at the battle of Bounar-Hissar, where their employment was justified neither by the need of a curved trajectory nor by the need of powerful guns, but by a critical situation that demanded the utilization of all available forces.

From the statements of officers who made the campaign, it would seem that the question if curvature of trajectories is an illusory one, and that the heavy calibers are necessary only in the attack of strongly fortified positions. But this opinion is the result of peculiar conditions under which the Balkan armies operated, and does not permit us to decide for or against the employment of heavy guns and howitzers in our occidental armies.

FIELD ARTILLERY GUNNERS AND SPECIALISTS.

The examining board that recently conducted the gunners' examination at Fort Bliss has submitted recomendations which, if fruitful, will secure for the field artillery enlisted specialist the recognition and compensation accorded specially qualified men in the infantry, cavalry and coast artillery.

The field artillery is now asking of its special details a character of work which calls for natural aptitude and painstaking effort, fully as much so as in the other arms which provide additional compensation for such men. The recognition suggested in the report requires legislation to put it into effect, but the amount involved is inconsiderable, and there is little doubt that Congress would be willing to remove the discrimination which now marks the field artillery specialist.

The report and recommendations of the board are as follows:

1. The board, in connection with its other duties, has examined into and discussed in detail the provisions of G. O. No. 161, 1911, War Department, prescribing the examination of candidates for F. A. gunners, and G. O. 45, War Department, 1913, prescribing that for the special battery and headquarters details.

2. The following conclusions have been reached unanimously, based on experience in command of field artillery troops and on that of examining candidates for gunners.

(a) The qualification of first or second class gunner should last during an entire enlistment, for the following reasons:
    (1) The qualifications of gunners of the coast artillery corps, and those of marksmanship in cavalry and infantry are for the entire enlistment, and after re-enlistment until the candidate has an opportunity to re-qualify, and it is believed that the field artillery soldier is thereby unduly discriminated against.
    (2) The work of preparing individually all the gunners of a battery each year for requalification requires such labor and attention on the part of the officers and enlisted men of the organization as to seriously prejudice the training of the battery in team work, and consequently in its collective efficiency.
    (3) The men become discouraged and do not care to volunteer for the examination, the result being a positive loss of morale.

(b) The examination of the specialists under G. O. 45 should be divided into two branches as indicated below, and special inducements

should be offered a limited number of men to try for this classification.

The examination is extremely difficult, if the proper standard is required, and only men of a much higher order than the average can attain proficiency, even in the second class.

The examination being optional, our best men will be completely justified in taking the regular gunner's examination, which is much less difficult, and which carries with it the same reward.

(3) The following recommendations, which are unanimously concurred in by the board, are therefore submitted for the consideration of the War Department:

FIELD ARTILLERY GUNNERS, UNDER G. O. NO. 161, WAR DEPARTMENT, 1911.

(a) That the qualification of a field artillery gunner be made to last through the current enlistment, and on re-enlistment, until he shall have had an opportunity to requalify as such.

(b) That a gunner of a lower class be authorized to take the examination for a higher class, at any stated examination.

FIELD ARTILLERY SPECIALISTS, UNDER G. O. NO. 45, WAR DEPARTMENT, 1913.

(a) That two groups of specialists be authorized, reconnaissance specialists and instrument specialists.

(b) That the first group be examined in the following subjects:

Reconnaissance.
Sketching, both topographical and panoramic.
Visual signalling.
Carrying of oral messages.

(c) That the second group be examined in the following subjects:

Preparation of firing data, including the setting up and use of authorized instruments.
Communications (telephones and other authorized means).
Visual signalling.

(d) To be eligible for examination in either group the candidate shall have first attained the qualification of first-class gunner.

(e) That the examination shall be competitive in character, with the present proficiency percentages, and the list of those qualifying in each group as first or second class specialists be published in orders by the War Department Commander, in the order of their relative merit as determined by the examination.

(f) That the number of specialists in each group who will act and draw pay as such be limited in each battery, battalion, and

regiment to the necessary number required for the special details in the organization, and that all others constitute an eligible list, from which vacancies shall be filled in order of merit by the regimental commander.

(g) Those constituting the eligible list shall continue to receive the emoluments of first-class gunner, until appointed as specialists, or otherwise until such qualification shall expire.

(h) That the pay of specialists in each group shall be seven dollars per month for first, and five dollars per month for second-class specialists.

4. It is requested that these recommendations be referred to the Field Artillery Board for its opinion and action.

MILITARY HISTORY.

The American Historical Association has offered a cash prize for the best original essay upon some topic connected with the military history of the United States. The object is to give a stimulus to the working of scientific military history and to bring into closer communication the professional military man and the historian.

If this departure is to become permanent and successful, army officers must show some interest.

The conditions governing the award are as follows:

A prize of $200 will be awarded by the American Historical Association in 1915 for the best unpublished monograph in military history submitted to the Committee before September 1, 1915.

I. The monograph must be based upon independent and original investigation into some field of the military history of the United States. While the Committee will receive any scholarly work on any American war, it would suggest that in the selection of topics for investigation preference be given to the Civil War. The monograph may deal with a campaign, a battle, a phase or aspect of a campaign or battle, with the fortunes of a corps or division during a battle, or with such subjects as the mobilization or organization of volunteer forces, the material, transportation or food supply of an army, or strategy and military policy.

II. The monograph must be a distinct contribution to knowledge.

III. The monograph must (1) be based upon exhaustive research, (2) conform to the canons of historical criticism, (3) be presented in scientific form, (4) contain exact references to sources and secondary works, and (5) be accompanied by a full critical bibliography.

IV. The monograph should not exceed one hundred thousand words in length. The manuscript should be typewritten, and must be neat, correct, and in form ready for the printer.

(In the typewriting of essays competitors are urged to use a strong, rather heavy paper of letter size; to have both text and notes double spaced to number the notes consecutively for each chapter, and to insert each note in the text immediately after the line in which its index number occurs, separating the note from the text by lines above and below extending across the page. In abbreviating

the titles of works care should be taken to make the abbreviations clear, consistent, and self-explanatory.)

V. In making the award the Committee will consider not only research, accuracy, and originality, but also clearness of expression, logical arrangement, and literary form. The prize will not be awarded unless the work submitted shall be of a high degree of excellence.

VI. The successful monograph shall remain the property of the author. The American Historical Association assumes no responsibility for publication of the prize essay, but the Committee has already received offers respecting its publication which will be communicated to the winner of the prize.

VII. The monograph must be accompanied by the name and address of the author, in a sealed envelope, and a short introduction setting forth the character of the material and the purpose of the work.

Address all correspondence relative to the Military History Prize to Captain A. L. Conger, Fort Leavenworth, Kansas.

BOOK REVIEWS

Chevaux et Voitures d'Artillerie. By Major of Artillery P. Machart. 1 vol., 8vo, with 70 figures and 2 plates. Published by Berger-Levrault, Paris. Price, 5 francs.

In this work Major Machart tells us that we do not know what can be asked of the draft horse. There is, he adds, a gap in artillery knowledge which is to be particularly regretted, as the use of this arm rests above all things upon the intelligent utilization of teams. The object of the present work is to fill this gap.

After some pages devoted to an interesting history of the draft horses, the author discusses the theoretical side of the question, and studies successively carriage draft, motor traction, the mechanism of draft, and the influence of the speed. Then, applying the results of this study to artillery carriages, he establishes some interesting relations between their weights and speed. Finally, he concludes with some practical conclusions concerning the draft horse, his training, feeding, and hygiene.

Major Machart's study, which is unique and well supplied with illustrations, should prove both interesting and instructive to all concerned in the important question of the draft horse.

Training in Night Movements based on Actual Experiences in War. Translated from the Japanese by 1st Lieutenant C. Burnett, 4th Cavalry. Fort Leavenworth, Kan.: U. S. Cavalry Association: 1914. 133 pages. $1.00.

The book is a translation of a work by a Japanese officer who was a company commander during the Japanese-Russian war. The translator states that the Japanese, from the standpoint of practical experience, would seem to be best qualified to discuss such operations as night movements and night attacks in the military operations of the present day, and he therefore thinks that this work contains much that will be of interest and profit to our own service.

Military Education in the United States. By Captain Ira L. Reeves, U. S. A. Burlington, Vt.: Free Press Printing Co.: 1914.

The book is of 431 pages, and is profusely illustrated. It contains chapters on military education in general, the Military Academy, military education in civilian institutions of learning, the Army War College, the various service schools, and the military education of the organized militia. It also contains sample sets of examination questions for admission to the Military Academy and the Army Medical Corps, and information concerning the strength and distribution of the Army.

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REGULAR ARMY.

1*st Regiment* (*Light*).—Col. S. D. Sturgis: Schofield Barracks, H. T.

2*d Regiment* (*Mountain*).—Col. E. A. Millar: Manila.

3*d Regiment* (*Light*).—Col. Charles G. Treat: H. Q. and 1st Bn. Fort Sam Houston; 2d Bn, Fort Myer.

4*th Regiment* (*Mountain*).—Col. Lucien G. Berry: H. Q. and 1st Bn, Vera Cruz, Mexico; 2d Bn, Texas City.

5*th Regiment* (*Light*).—Col. Granger Adams: Fort Sill; Bty D, Fort Snelling.

6*th Regiment* (*Horse*).— —— ——: H. Q. and Btys A and B, El Paso, Tex.; Bty C. Fort Bliss; Bty D, Brownsville, Tex.; Bty E, Laredo, Tex.; Bty F, Eagle Pass, Tex.

MILITIA.

1*st Inspection District*.—Capt. Robert Davis, Inspector, New Haven, Conn.

Massachusetts.—1st Bn, Maj. J. H. Sherburne: H. Q. and Btry A, Boston; Btry B, Worcester; Btry C, Lawrence.

Rhode Island.—Btry A, Capt. Ralph S. Hamilton: Providence.

Connecticut.—Btry A, 1st Lieut. Frank H. Frisbie: Brandford.

2*d Inspection District*.—Capt. J. B. N. Corey and Lieut. Harry Pfeil, Inspectors, New York City.

New York.—1st Regiment, Col. H. H. Rogers: H. Q. and Btrys B, D, E and F, New York City; Btry A, Syracuse; Btry C, Binghampton. 2d Regiment, Col. George A. Wingate: H. Q., Btries A, B and C, Brooklyn; Btries D, E and F, New York City.

New Jersey.—Btry A, Capt. C. E. Lanterman: East Orange. Btry B, Capt. Samuel G. Barnard: Camden.

3*d Inspection District*.—Capt. Marlborough Churchill, Inspector, Washington, D. C.

Pennsylvania.—Btry B, Capt. William T. Rees: Pittsburg. Btry C, Capt. Charles H. Cox: Phoenixville.

District of Columbia.—1st Btry. Capt. L. C. Vogt: Washington.

Virginia.—1st Bn, Maj. T. M. Wortham: H. Q. and Btry A, Richmond: Btry B, Norfolk; Btry C, Portsmouth.

4*th Inspection District*.—Lieut. E. P. King, Jr., Inspector, Atlanta, Ga.

Georgia.—1st Bn, Maj. Richard J. Davant: Savannah. Btry A, Capt. Edw. G. Thompson: Savannah. Btry B, Capt. J. E. Eubanks, Atlanta. Btry C, Capt. E. D. Wells, Savannah.

Alabama.—1st Bn, Maj. L. S. Dorrance: H. Q. and Btry A, Birmingham; Btry B, Montgomery; Btry C, Birmingham.

Louisiana.—Washington Artillery, Maj. Allison Owen: H. Q., Btries A, B and C, New Orleans.

5*th Inspection District*.—Lieut. Albert L. Hall, Inspector, Indianapolis, Ind.

Ohio.—1st Bn, Maj. Harold M. Bush: H. Q. and Btry C, Briggsdale; Btry A, Cleveland; Btry B, Toledo; Separate Btry D, Mt. Vernon, Capt. Arthur S. Thompson.

Michigan.—Maj. Roy C. Vandercock: H. Q., 1st Bn, Lansing. Btry A, Capt. C. B. McCormick: Lansing. Btry B, Capt. Martin C. Clippert: Lansing.

Indiana.—1st Bn, Maj. Robert H. Tyndall: H. Q., Indianapolis, Btry C, Rockville; Btry A, Indianapolis; Btry B, Fort Wayle.

6*th Inspection District*.—Capt. Charles C. Pulis, Inspector. St. Paul, Minn.

Minnesota.—1st Regiment, F. A. C., Col. George C. Lambert: H. Q., Btries A, B, and C, St. Paul; Btries D, E, and F. Minneapolis.

Wisconsin.—Btry A, Capt. P. C. Westfahl: Milwaukee.

Illinois.—1st Bn, Maj. Ashbel V. Smith: H. Q. and Btry C, Waukegan; Btry A, Danville; Btry B, Chicago.

7*th Inspection District*.—Lieut. Frank Thorp, Inspector, Kansas City, Missouri.

Missouri.—Btry A, 1st Lieut. Walter J. Warner: St. Louis. Btry B, Capt. H. M. Boyer, Kansas City.

Kansas.—Btry A, Capt. W. A. Pattison, Topeka.

Texas.—Btry A, Capt. F. A. Logan: Dallas.

8*th Inspection District*.—Lieut. B. M. Bailey, 5th F. A. Inspector, Denver, Colo.

Colorado.—1st Bn, Maj. J. B. Goodman, Jr.: H. Q., Btries A and B, Denver.

Utah.—1st Btry. Capt. W. C. Webb: Salt Lake City.

New Mexico.—Btry A, Capt. Charles M. DeBremond: Roswell.

9*th Inspection District*.—Capt. E. H. Yule, Inspector, San Francisco, Cal.

Oregon.—Btry A, Capt. Hiram U. Welch: Portland.

California.—1st Bn, Maj. Ralph J. Faneuf, H. Q. and Btry B, Oakland; Btry A, Los Angeles; Btry C, Stockton.

Unassigned.

New Hampshire.—Btry A, Capt. Edwin L. Towle: Manchester.