Tactical Deductions from the Course of Practice of the Swiss Field Artillery in 1890

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FOREIGN SECTION.

THIS portion of the Number, hitherto the Occasional Notes, has now become the Foreign Section, and is reserved for articles, either original or compiled, on professional subjects connected with Foreign Naval and Military matters; also for notices of Professional Books, either Foreign or English.

The Council of the Institution wish that this section shall be developed still further, and I have undertaken to continue my Editorship during the current year, with a view of aiding them in carrying out this work. It seems to me possible to make this section, and consequently the Journal, the means of keeping our Members acquainted with all naval and military progress abroad *pari passu* with that progress; and I shall be glad to receive from members of both Services, including in the latter those of the Auxiliary Forces, suggestions, information, or offers of assistance.

It is desirable, further, that I should state that, as regards editing the Naval matter in the Section, I shall have the aid of Naval Officers, thoroughly competent to give good advice and to pronounce sound opinions.

It must, however, be borne in mind that, as the change from a quarterly to a monthly issue has been made in order to ensure the more prompt publication of the Lectures after their delivery than has hitherto been the case, the Foreign Section will, as a rule, be restricted in extent during the Lecture season in the first half of the year, and will be prominent in the second half.

It is requested that communications and books for review (the latter under cover to the Librarian) may be addressed to me at the Royal United Service Institution, Whitehall Yard, London, S.W.

LONSDALE HALE,
Colonel ret. R.E.

TACTICAL DEDUCTIONS FROM THE COURSE OF PRACTICE OF THE SWISS FIELD ARTILLERY IN 1890.

By Colonel A. SCHUMACHER, Chief Instructor, Swiss Artillery. Translated
by Lieutenant-Colonel WALFORD, R.A.

I. *Practice, Description of Targets, and Results.*

It may be taken for granted that the Captains who are ordered to attend the course of practice have during the instruction which preceded their appointment fired at least 20 series at the normal targets.

The course of practice would, therefore, if we except the mere change of practice ground, by no means fulfil its object in the case of such Officers as have already practised at Frauenfeld or Bière, if it offered them only the same problems as are connected with elementary practice.

Just as the School of Recruits is the place where ordinary details can be thoroughly and correctly learnt, so the School of Instruction is that where the practice must be adapted to various conditions and problems; for this reason Majors also are ordered to attend the course, in order that they may learn how the higher grades of practice should be carried on. Moreover, at the present moment we are still without certain knowledge as to the value of tactical formations when under artillery fire. The tactical formations of the artillery date also, for the most part, from the days of solid shot, even though we have now in their place shells which give a wide burst, and though there can be no longer any question of the direct hit of a projectile.

While the character of the fire of artillery in former days showed that wide formations were the safest, it would appear as if wide-bursting shell, especially shrapnel, would warn us to avoid broad formations, and to offer only a small front to the fire of artillery.

In accordance with the preceding considerations, the programme for the course was founded on the following principles:—

1. Only the first instructional series should be fired at square wooden targets.¹

2. For the other series the targets should be such as would be met with on service.²

3. As far as possible, all formations which would be used in the tactics of the three arms should be employed as targets.

4. Each practice, advancing from minor to more complicated problems, should represent some phase of battle, and the targets should be arranged accordingly.

5. The duration of the practice and the number of rounds should be gradually increased.

It was further laid down that in all applied practice the distribution of fire should take place at the commencement of group firing, especially against artillery targets, since, on the one hand, the observation of fire at this period in no way demands a fixed and single objective, while, on the other, prudence forbids us to expose ourselves to the fire of such guns of the enemy as are not under our fire. The theory of the successive destruction of the enemy is derived from the days of solid shot; it had still some value when common shell was the principal projectile, but has none now when shrapnel are almost exclusively used.

It must, at the same time, be here mentioned that the utility and possibility of this rule, which have been doubted by some, have been sufficiently proved; it must, at any rate, be accepted that the distribution of fire must be carried out under some, and, when possible, under an invariable, rule.

The whole course of practice consisted of 66 series; of these, Series 1 to 12 were elementary, Series 64 to 66 were for indirect fire, while Series 13 to 63, and more especially 21 to 63, were dedicated to the main question.

The series were as follows:—

1st Series. 20th March. At Thun.—Infantry in column of fours (13) are seen; soon after some artillery (14) appears, which is to be silenced; under cover of the fire of the guns, the infantry forms first a column of sections (15), and then proceeds to extend groups and supports (16).

¹ Owing to an insufficient supply of dummies, they were used for the third and following series only.

² Troops in two ranks were invariably represented by a single row of dummies.

Target 13. Column of fours, 40 infantry in fours with 2 paces distance. Range by tangent scale, 2,140 yards. 30 rounds. Time, 11 minutes; interval between rounds, 22 seconds.

14. 3 guns with detachments and teams, limbers at 11 yards interval, following the guns. Range by tangent scale, 1,970 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

15. 2 ranks of 20 files, standing; interval, 10 paces. Range, 2,080 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

16. 4 groups of skirmishers, each of 10 men, kneeling; each group 20 paces wide; 1 man in rear of each group standing; 100 paces in rear of each of the flank groups a support, consisting of 20 men in one rank. Range to the groups, 1,910 yards; to the supports, 2,000 yards. 30 rounds. Time, 12 minutes; interval between rounds, 24 seconds.

2nd Series. 21st March. At Thun.—The enemy's artillery (17) has entrenched itself and must be silenced; in the mean time infantry in column appears (18); some artillery then comes up (19), and is fired on, presumably with success, after which the fire is diverted to the infantry, which has in the mean time extended (20).

17. Emplacements for 3 guns, connected by a shelter-trench; interval between guns, 17 yards; between each two guns is a limber (without its team) in a trench. The parapet is from 10 to 13 feet thick, and its command is, in front of the guns, 18 inches; in front of the limbers, 3 feet. Range, 1,720 yards. 24 rounds. Time, 13 minutes; interval between rounds, 33 seconds.

18. Target as in 15. Range, 1,970 yards. 24 rounds. Time, 18 minutes; interval between rounds, 45 seconds.

19. 4 guns with detachments and teams; limber 11 yards in rear of the guns. Range, 2,080 yards. 24 rounds. Time, 12 minutes; interval between rounds, 30 seconds.

20. Target as in 16. Range to the groups, 1,640 yards; to the supports, 1,750 yards. 24 rounds. Time, 10 minutes; interval between rounds, 25 seconds.

3rd Series. 22nd March. At Thun.—An enemy's battery (21) is to be fired on until an order is received to direct the fire on a company of infantry, which shows itself in column of sections (22). It is found necessary to again fire on the artillery (23), which has in the mean time changed its formation; after this the infantry, which has extended (24), is to be fired on, and finally a column which is advancing on the battery (running target, 25) is to be stopped.

21. 6 guns with detachments; interval, 16 yards; the limbers and teams 11 yards in rear of their guns. Range, 2,190 yards. 24 common shell. Time, 10 minutes; interval between rounds, 25 seconds.

Guns and detachments	188 hits, 41 per cent. of hits.
Limbers and teams.....	273 " 59 " "
	<hr/> 461 100

Mean burst of shell, 70 yards short.

22. Four ranks of 20 infantry with 11 paces distance. Range, 2,300 yards. 12 common shell and 18 shrapnel. Time, 11 minutes; interval between rounds, 22 seconds.

1st section	393 hits, 31 per cent. of hits.
2nd section	359 " 29 " "
3rd section	227 " 18 " "
4th section	271 " 22 " "
	<hr/> 1,250 100

Common shell burst 77 yards short.

Shrapnel 82 to 83 yards short ; 7 to 9 feet above plane.

23. 6 guns with detachments ; 3 limbers in column of route in rear of each flank ; leading limbers 11 yards from the flank guns ; interval of the others, 3.5 yards. Range, 2,130 yards. 24 common shell. Time, 10 minutes ; interval between rounds, 25 seconds.

Guns and detachments	255 hits, 40 per cent. of hits.
Limbers	389 " 60 " "
	<hr/> 644 100

Mean burst of shell, 68 to 70 yards short.

24. The two rear ranks of target No. 22 were posted 55 yards on the flank of the others ; the range of the two parts of the target differed by about 22 yards. Shortest range, 2,400 yards. 12 common and 18 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

1st section	1 hit, 1 per cent. of hits.
2nd section	9 hits, 7 " "
3rd section	59 " 44 " "
4th section	65 " 48 " "
	<hr/> 134 100

Mean burst of common shell, 60 yards short.

Ditto of shrapnel, 68 yards short ; 10 feet above plane.

25. A moving target, 6 feet high and 16 feet wide, in constant movement on a line slightly oblique to the normal to the front of the battery. Pace, walk. Range, 2,730 to 2,080 yards. 8 common and 16 shrapnel. Time, 10 minutes ; interval between rounds, 25 seconds.

91 hits.

Mean burst of common shell, 80 yards short.

Ditto of shrapnel, 67 yards short ; 19.5 feet above plane.

4th Series. 24th March. At Thun.—Open fire on hostile artillery in emplacements (26). Another battery comes up with its wagons following at 80 yards distance (27). In the mean time infantry have crept towards the battery, and suddenly appear (28). When they have been driven off, a battery in column of route is observed to be approaching the field of battle. The range is found on a conspicuous point, and the column is fired on as soon as it reaches that point (29). Finally infantry, who are visible at a distance in double column (30), are dispersed.

26. Targets as in 17. The guns fire puffs. Range, 1,850 yards. 18 common and 12 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

51 hits.

Mean burst of common, 55 to 57 yards short.

Ditto of shrapnel, 59 yards short ; 10.5 to 18.5 feet above plane.

27. A battery of 6 guns, with detachments and teams, unlimbered ; limbers 11 yards in rear of guns ; 6 wagons 80 yards in rear of the limbers ; teams facing to the rear. Range, 1,530 yards. 12 common and 18 shrapnel. Time, 9 minutes ; interval between rounds, 18 seconds.

Guns.....	118 hits, 42 per cent. of hits.
Limbers	62 " 21 " "
Wagons	102 " 37 " "
	<hr/> 282 100

Mean burst of common, 40 yards short.

Ditto of shrapnel, 41 yards short; 12 feet above plane.

28. Four swinging targets¹ 9 yards long, each representing 10 infantry kneeling: in echelon from the front at 11 yards distance. Range, 380 to 440 yards. 12 case shot. Time, 2 minutes; interval between rounds, 10 seconds.

24 hits.

29. A pole marks the point on which the guns are to be ranged; two other poles show the limits within which the target is to be fired on. The target consists of 4 small-arm ammunition carts, at a distance of 8 paces, and pulled forward by means of a wire rope. Range, 1,910 yards. 12 common and 12 shrapnel. Time, 12 minutes; interval between rounds, 30 seconds.

1st wagon	12 hits, 86 per cent. of hits.
2nd wagon	nil nil
3rd wagon.....	nil nil
4th wagon.....	2 " 14 " "
	<hr/>
	14 100

Mean burst of common, 55 yards short.

Ditto of shrapnel, 60 yards short; 7.5 feet above plane.

30. 320 infantry standing in two parallel columns at 4 paces interval, each column of 8 ranks of 20 men at 10 paces distance. Range, 2,640 yards. 12 common and 12 shrapnel. Time, 12 minutes; interval between rounds, 30 seconds.

Two 1st sections	37 hits, 9 per cent. of hits.
Two 2nd sections	63 " 16 " "
Two 3rd sections	62 " 15 " "
Two 4th sections	70 " 17 " "
Two 5th sections	35 " 9 " "
Two 6th sections	60 " 15 " "
Two 7th sections	29 " 7 " "
Two 8th sections	47 " 12 " "
	<hr/>
	403 100

Mean burst of common, 107 yards short.

Ditto of shrapnel, 107 to 112 yards short; 30 to 68.5 feet above plane.

5th Series. 25th March. At Thun.—Fire is opened on a hostile battery in action (31), of which the wagons stand on either flank at a distance of 330 yards. Under the fire of this battery infantry deploy into a line four deep (32) and open fire; other infantry (33) are advancing in column of fours; the latter are driven back, while the former form line of columns (34) and are broken up; a squadron advancing in column of sections (35) is driven back.

31. Six guns with detachments and teams, unlimbered, the limbers 11 yards in rear of the guns: three wagons on each flank 330 yards in rear of the limbers, in column at 4 paces distance; teams turned to rear. Range to the guns 1,910 yards, to wagons 2,240 yards. 12 common and 18 shrapnel. Time, 11 minutes; interval between rounds, 22 seconds.

¹ These targets are raised by means of a weight at the foot. When the weight is released by the range-party, the targets appear.—N. L. W.

Guns	121 hits, 26 per cent. of hits.
Limbers	275 " 68 " "
	<hr/>
	396
	<hr/>
Wagons	25 hits, 6 per cent. of hits.
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	421 100

Mean burst of common, 55 yards short.

Ditto of shrapnel, 58 to 70 yards short ; 16 to 21 feet above plane.

32. 320 dummies, representing a battalion in line, four deep ; 1st and 2nd ranks, 160 dummies in line kneeling ; 3rd and 4th rank, 160 dummies standing at 1 yard distance ; breadth of the target about 145 yards. Small puffs fired in front of the whole of the front rank. Range, 2,190 yards. 12 common and 12 shrapnel. Time, 10 minutes ; interval between rounds, 25 seconds.

Front rank	94 hits, 45 per cent. of hits.
Rear rank.....	116 " 55 " "
	<hr/>
	210 100

Mean burst of common, 68 to 70 yards short.

Ditto, of shrapnel, 72 to 74 yards short ; 16 to 23 feet above plane.

33. A company of infantry, 144 men (standing) in column of fours, 36 sections of four men with 2 paces distance ; the column is on the edge of a wood, descending a hill ; difference of level of the first and last files about 160 feet ; slope of the hill, 3 over 4. Range, 2,620 yards. 13 common and 11 shrapnel. Time, 10 minutes ; interval between rounds, 25 seconds.

Sections 1 to 9	209 hits, 52 per cent. of hits.
" 10 to 18	111 " 26 " "
" 19 to 27	47 " 11 " "
" 28 to 36	50 " 11 " "
	<hr/>
	417 100

Mean burst of common, 96 yards short.

Ditto of shrapnel, 105 yards short, 33 feet above plane.

34. 320 dummies representing infantry standing in 4 columns of sections, each of 4 ranks of 20 men at 10 paces distance ; interval between columns 27 yards (half deploying interval). Range, 2,190 yards ; 30 shrapnel. Time, 10 minutes ; interval between rounds, 20 seconds.

1st rank	343 hits, 29 per cent. of hits.
2nd rank	294 " 25 " "
3rd rank	255 " 21 " "
4th rank	302 " 25 " "
	<hr/>
	1,194 100

Mean burst of shrapnel, 77 yards short ; 2.5 to 23 feet above plane.

35. 54 cavalry dummies in sections of 18 men, width 20 yards, in 3 ranks at a distance of 20 yards, visible only through the interval between the columns in target 34. Range, 2,620 yards. 30 shrapnel. Time 10 minutes ; interval between rounds, 20 seconds.

1st rank	184 hits, 32 per cent. of hits.
2nd rank	179 " 31 " "
3rd rank	201 " 37 " "
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	564 100

Mean burst of shrapnel, 94 to 96 yards short; 11·5 to 14·5 feet above plane.

6th Series. 26th March. At Thun.—A battery in action (36) is silenced, and the fire is then turned on the wagons, which are supposed to be concealed behind a screen (37). In the mean time infantry deploy first into section-column (38*a*) and then into groups with supports (38*b*); in rear of these is seen a battery advancing in column of sections at full interval (39); this is to be fired on. The practice battery is suddenly charged by cavalry (40); when these have been repulsed, some cavalry which is seen coming up from the back of the practice-ground is fired on (41).

36. 4 guns, made of wood bound with iron, which each fire automatically 8 rounds at intervals of 1 minute. In rear are 4 limbers, teams facing to the rear, at a distance of 11 yards from the guns. Range, 2,080 yards. 30 shrapnel. Time, 8 minutes; interval between rounds, 16 seconds.

Guns and detachments	118 hits, 33 per cent. of hits.
Limbers	240 " 67 " "
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	358 100

Mean burst of shrapnel, 67 to 68 yards short; 14 to 16·5 feet above plane.

37. 110 yards to the rear and 82 yards to the left of the above battery is a wall of earth 22 yards long; in front of this wall is a hedge, made of fir-branches, 33 yards long and about 6 feet high; close in rear of the wall stand the 4 wagons of the battery with 5 yards interval, teams facing to rear. Range, about 2,190 yards. 24 common shell. Time, 8 minutes; interval between rounds, 20 seconds.

142 hits.

Mean burst of common, 69 yards short.

38*a*. Column of sections, 4 ranks of 20 men, standing, with 10 paces distance. Range, 2,130 yards. 24 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

38*b*. 4 groups of 10 skirmishers each, kneeling, 110 yards in front of 38*a*; breadth of groups about 16 yards. In the intervals between 1 and 2, and 3 and 4, groups, and partly in rear of them, are two supports, each of 20 men, kneeling; 55 yards in rear of each flank are 20 men, standing. Range, 2,020 yards. 12 shrapnel. Time, 5 minutes; interval between rounds, 25 seconds.

Skirmishers.....	98 hits, 11 per cent. of hits.
Supports, kneeling.....	13 " 1 " "
Supports, standing.....	159 " 17 " "
Main body, 1st rank.....	191 " 20 " "
" 2nd rank.....	153 " 17 " "
" 3rd rank.....	171 " 19 " "
" 4th rank.....	147 " 15 " "
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	932 100

Mean burst of shrapnel, 62 to 68 yards short; 10 to 13 feet above plane.

39. 6 guns with teams, advancing in section column with 16 yards interval

and distance. Total depth of target, 82 yards. Range, 2,080 yards. 2 shrapnel. Time, 9 minutes; interval between rounds, 19 seconds.

1st section	338 hits, 34 per cent. of hits.
2nd section	300 " 33 " "
3rd section	303 " 33 " "
	<hr/>
	941 100

Mean burst of shrapnel, 68 to 70 yards short; 16 to 18 feet above plane.

40. Three ranks of cavalry, each of 10 files, swinging¹ targets; in echelon, left in front, with 11 yards distance. The battery changes the direction of fire to the left. Range, 330 yards: 1 shrapnel and 12 case. Time, 2 minutes; interval between rounds, 9 seconds.

1st rank	21 hits, 17 per cent. of hits.
2nd rank	81 " 69 " "
3rd rank	17 " 14 " "
	<hr/>
	119 100

41. Target as in 25 (moving target). Range, 2,190 to 1,640 yards. 12 common and 12 shrapnel. Time, 10 minutes; interval between rounds, 25 seconds.

45 hits.

Mean burst of common, 63 yards short.

Ditto of shrapnel, 50 to 59 yards short; 13 to 16 feet above plane.

7th Series. 27th March. At Thun.—A squadron of cavalry in half column shows itself at the back of the practice ground (42); when these have been driven off, a battalion of infantry in company column is seen more to the front; this is compelled to extend (43). On its left, a battery tries to advance in column of sections (44), but is beaten back as it moves. In the mean time more infantry (45) in column of fours comes down the hill. The hostile battery succeeds in firing a few rounds (46), but is silenced. The infantry has now extended to the right, and is moving against the battery, appearing on the plateau from time to time, as it crosses the ravines, first as a main body (47), then as the front rank of a column of the attack (48), next as skirmishers (49), and, lastly, as rushing in on the battery (50).

42. 54 cavalry dummies in 3 ranks of 18 files, with 20 yards distance, in echelon, left in front. Range, 2,620 yards. 30 shrapnel. Time, 10 minutes; interval between rounds, 20 seconds.

1st rank	119 hits, 32 per cent. of hits.
2nd rank	163 " 44 " "
3rd rank	89 " 24 " "
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	371 100

Mean burst of shrapnel, 90 yards short; 19.5 feet above plane.

43. 320 standing infantry in four section-columns, each of 4 ranks of 20 men, at 10 paces distance; the two rear columns with an interval of 28 yards; the two front columns (110 yards further to the front) with 110 yards interval. Range, 2,350 yards. 36 shrapnel. Time, 11 minutes; interval between rounds, 18 seconds.

¹ See Note, page 149.

1st line, 1st rank.....	4 hits, 1 per cent. of hits.
" 2nd rank	9 " 2 " "
" 3rd rank	21 " 4 " "
" 4th rank	9 " 2 " "
2nd line, 1st rank	69 hits, 11 per cent. of hits.
" 2nd rank	185 " 31 " "
" 3rd rank	122 " 20 " "
" 4th rank	149 " 29 " "
	<hr/>
	568 100

Mean burst of shrapnel, 83 yards short; 15 feet above plane.

44. A battery on the move, in section column; interval, 16 yards; distance between sections, 2 paces; length of column, 55 yards. Range, 2,210 yards. 30 shrapnel. Time, 9 minutes; interval between rounds, 18 seconds.

1st section	278 hits, 30 per cent. of hits.
2nd section	235 " 28 " "
3rd section	400 " 42 " "
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	913 100

Mean burst of shrapnel, 74 to 77 yards short; 12 feet above plane.

45. Target as in 33. Range, 2,620 yards. 6 common and 18 shrapnel. Time, 7 minutes; interval between rounds, 17 seconds.

Sections 1 to 10	107 hits, 42 per cent. of hits.
" 11 to 20	75 " 30 " "
" 21 to 30	50 " 20 " "
" 31 to 40	21 " 8 " "
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	253 100

Mean burst of common, 92 yards short.

Ditto of shrapnel, 96 yards short; 27 feet above plane.

46. A battery unlimbered, 6 guns firing. The limbers on the flanks as with target 23. Range, 1,750 yards. 18 common and 12 shrapnel. Time, 10 minutes; interval between rounds, 20 seconds.

Guns.....	137 hits, 19 per cent. of hits.
Limbers.....	584 " 81 " "
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	721 100

Mean burst of common, 48 to 50 yards short.

Ditto shrapnel, 50 to 52 yards short; 8 to 9 feet above plane.

47. Infantry, standing, in section columns, 4 rows of 20 dummies with 10 paces distance; the fire to be directed on one column only. Range, 1,970 yards. 2 common and 18 shrapnel. Time, 6 minutes; interval between rounds, 12 seconds.

1st rank	295 hits, 26 per cent. of hits.
2nd rank	319 " 27 " "
3rd rank	283 " 25 " "
4th rank	249 " 22 " "
	<hr/>
	1,146 100

Mean burst of common, 59 yards short.

Ditto of shrapnel, 63 yards short; 9 feet above plane.

48. 90 files, each of 5 standing infantry, on 4 disappearing targets. Range, 1,530 yards. 12 common and 12 shrapnel. Time, 8 minutes; interval between rounds, 20 seconds.

1st rank..... 108 hits.

Mean burst of common, 41 yards short.

Ditto of shrapnel, 44 yards short; 7 feet above plane.

49. 3 groups of kneeling infantry, each of 10 men, on swinging targets. Range, 1,040 yards. 19 shrapnel. Time, 5 minutes; interval between rounds, 14 seconds.

1st rank..... 124 hits.

Mean burst of shrapnel, 22 to 24 yards short; 8.5 to 9 feet above plane.

50. 4 groups of kneeling infantry, each of 10 men, on swinging targets. Range, 330 yards. 8 shrapnel and 6 case. Time, 1 minute; interval between rounds, 4 seconds.

1st rank..... 79 hits.

8th Series. 28th March. At Gurbenthal.—Fire will be opened on a battery (51a) which is advancing; when this has been made to halt, some wagons which are 330 yards in rear of it in a hollow will be attacked (51b). In the meantime, infantry (52) come up on the left of the battery; these advance in two echelons (53) and extend in groups (54). The latter advance, being opposed by our skirmishers (dummies with their backs turned to the guns); the enemy, in a crowded formation, divides into a main body (55) and an advanced troop (56), and must be engaged over the heads of our own troops. The enemy's attack is stopped, and while drawing off in column of march, he is fired on at long range (57). The whole of the practice (252 rounds) is to be carried on without intermission.

51a. 6 guns, supposed to be moving, the detachments dismounted, the limbers horsed. Range, 3,390 yards. 18 common. Time, 10 minutes; interval between rounds, 33 seconds.

51b. 6 horsed wagons, detachments dismounted, teams facing to front 330 yards in rear and 55 yards to the flank of the battery, in a partially covered position, in section column, closed to 4 paces. Range, 3,770 yards. 18 common. Time, 5 minutes; interval between rounds, 16 seconds.

3,390 yards, limbers and teams	12 hits, 46 per cent. of hits.
Guns and detachments.....	11 " 43 " "
3,720 yards, 1st section wagons	1 " 4 " "
" 2nd section "	nil " nil " "
" 3rd section "	2 " 7 " "
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	26 100

Mean burst of common, 40 to 142 yards; 161 to 163 yards short.

52. 40 standing infantry, 2 ranks of 20 men, at 10 paces distance. Range, 3,600 yards. 24 common. Time, 7 minutes; interval between rounds, 18 seconds.

1st rank	6 hits, 46 per cent. of hits.
2nd rank.....	7 " 54 " "
	<hr/>
	13 100

Mean burst of common, 155 yards short.

53. Two lines each of 20 standing men, distance 135 yards. Interval, 55 yards. Range, 3,390 yards. 36 shrapnel. Time, 14 minutes; interval between rounds, 23 seconds.

1st line 111 hits; no hits on 2nd line.

Mean burst of shrapnel, 145 to 147 yards short; 32 feet, 20·5 feet, and 12·5 feet above plane.

54. 4 groups of 10 skirmishers kneeling, each group about 16 paces wide, half covered behind the bank of a road. Range, 3,170 yards. 36 shrapnel. Time, 19 minutes; interval between rounds, 32 seconds.

56 hits.

Mean burst of shrapnel, 127 to 129 yards short; 29 to 35 feet above plane.

55. 40 infantry, 2 ranks of 20 men, with 10 paces distance; the rear rank standing, the front kneeling. Range, 3,060 yards. 48 shrapnel. Time, 8 minutes; interval between rounds, 10 seconds.

1st rank, kneeling	11 hits, 12 per cent. of hits.
2nd rank, standing	80 " 88 " "
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	91 100

Mean burst of shrapnel, 118 yards short; 23 feet above plane.

56. 6 groups of 10 files of kneeling infantry, about 330 yards in front of target No. 55; between 55 and 56, in rear of the 2nd and 5th group, are supports of 20 men each, standing in line; our own troops are 275 yards nearer to the guns. Range, 2,620 yards. 48 shrapnel. Time, 20 minutes; interval between rounds, 25 seconds.

1st rank, skirmishers	51 hits, 35 per cent. of hits.
2nd rank, supports	93 " 65 " "
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	144 100

Mean burst of shrapnel, 90 to 99 yards short; 15·5 to 20 feet above plane.

57. Infantry in column of sections, 80 men in 4 ranks of 20, with 10 paces distance. Range, 4,040 yards. 24 common. Time, 10 minutes; interval between rounds, 25 seconds.

1st rank, 2 lines	2 hits, 50 per cent. of hits.
2nd rank	1 hit, 25 " "
3rd rank	1 " 25 " "
4th rank	nil
	<hr/>
	4 100

Mean burst of common, 189 to 211 yards short.

Time for the whole 252 rounds, 95 minutes; average interval between rounds, 22·6 seconds.

9th Series. 28th March. At Gurbenthal.—An enemy's battery opens fire, and is answered (58a); after supposed success the limbers, which are on the flank of the hostile battery, are attacked (58b). Infantry advance in front of the battery; they have extended from company column, and represent the reserve; fire is opened in succession on the reserve (59), the supports (60), and the firing line (61). When this attack has been repulsed, the enemy tries to hold a position farther to the rear (62), but is dislodged. Cavalry

come up in the background, but are driven back. The whole series fired consecutively.

58a. 6 guns in position with detachments, marked by puffs. Range, 2,900 yards. 24 common and 24 shrapnel. Time, 27 minutes; interval between rounds, 34 seconds.

58b. The limbers of the battery, about 110 yards to the rear, and 66 yards to a flank, in columns of sections, close intervals, teams facing the rear. Range, 3,060 yards. 18 shrapnel. Time, 10 minutes; intervals between rounds, 33 seconds.

2,900 yards, guns and detachments....	70 hits, 40 per cent. of hits.
3,060 " limbers	120 " 60 " "
	<hr/>
	190 100

2,900. Mean burst of common, 122 to 124 yards short.

Ditto of shrapnel, 124 to 156 yards short; 27 feet above plane.

3,060. Mean burst of shrapnel, 136 short; 12 feet above plane.

59. Two columns of sections, 80 men in 4 ranks of 20, with 10 paces distance. Range, 2,020 yards. 18 common and 24 shrapnel. Time, 8 minutes; interval between rounds, 11 seconds.

1st ranks	245 hits, 27 per cent. of hits.
2nd ranks	170 " 18 " "
3rd ranks.....	235 " 25 " "
4th ranks.....	275 " 30 " "
	<hr/>
	925 100

Mean burst of common, 61 to 63 yards short.

Ditto of shrapnel, 66 to 68 yards short; 21 to 28 feet above plane.

60. 2 squads 220 yards further to the front, each of 40 men, in 2 ranks, with 10 paces distance, kneeling, with intervals of 176 yards. Range, 1,800 yards. 24 shrapnel. Time, 6 minutes; interval between rounds, 15 seconds.

1st rank	144 hits, 54 per cent. of hits.
2nd rank	124 " 46 " "
	<hr/>
	268 100

Mean burst of shrapnel, 55 to 55 yards short; 9 to 15 feet above plane.

61. A thick firing line of 6 groups of 10 men kneeling, with 4 groups of 10 men kneeling covering the outer intervals. Range, 1,640 yards. 24 shrapnel. Time, 5 minutes; interval between rounds, 13 seconds.

Front groups	60 hits, 62 per cent. of hits.
Rear groups.....	37 " 38 " "
	<hr/>
	97 100

Mean burst of shrapnel, 45 yards short; 13 feet above plane.

62. 6 groups of kneeling infantry, each of 10 men; width of a group about 16 paces, that of the whole line about 110 yards. Front irregular. Range, 2,300 yards. 12 common and 32 shrapnel. Time, 13 minutes; interval between rounds, 17 seconds.

163 hits.

Mean burst of common, 70 to 72 yards short.

Ditto of shrapnel, 70 to 72 yards short, 21 feet above plane.

63. 36 cavalry (2 sections) in 2 ranks of 18 men, with 20 yards distance. Range, 4,150 yards. 13 common and 6 shrapnel. Time, 5 minutes; interval between rounds, 16 seconds.

1st rank	6 hits, 30 per cent. of hits.
2nd rank.....	14 „ 70 „ „
	<hr/>
	20 100

Mean burst of common, 187 yards short.

Ditto of shrapnel, 187 yards short; 46 feet above plane.

Time for the whole series (219 rounds) 80 minutes; average interval between rounds 22 seconds.

The record of the effect on the various targets gives the above results, in which the effects of shrapnel and of ring-shell are taken together; for the further deductions which it is proposed to draw, the effect which was the consequence of the united action of shells and shrapnel will be merely taken as caused by so many rounds. Materials are available which would render it possible to distinguish the separate effect of each projectile, but to do so would entail endless labour, without making any important alteration in the amount or value of the information to be obtained.

II. Comparisons and Conclusions.

Even a cursory glance at the results of this practice gives the impression that the effect of the wide-bursting projectiles of artillery increases with the depth of the target, and only partially with the width; it is worth while to go a little more into this question.

The foregoing results are certainly the first which we have obtained, while a satisfactory conclusion can be derived only from a series of trials with similar factors; it is, therefore, not merely a matter of interest, but one of duty, to repeat and complete such practice; but to do this would need a great expenditure of ammunition, and this must be spread over several years and courses. An immediate and approximate judgment is, however, desirable, and it is possible to make a comparison of the results if we use a process which is perhaps rather arbitrary.

In order to compare the question of formations, similar bodies of troops must be taken together, and in combination with the three factors: number of rounds, range, and size of the target or of the number of targets.

The first factor may be arrived at with sufficient accuracy, if the six first rounds be deducted from each series, and if the number of hits be divided by the remaining number of rounds, which will give the number of hits for each effective round; this proportional number should then, for each series or formation, be multiplied by some common number of rounds, say 72.

This corrected number of hits must then be fairly adjusted as regards the range; a correct computation must have for its basis the length of the dangerous zone which corresponds with the particular size and range of the target. Since, however, an approximate comparison only is possible, it will be sufficient to take account of the most important factor—the angle of descent—and to multiply the corrected number of hits by the tangent of this angle. A comparison of the actual number of hits with the same when corrected by the angle of descent will enable us to judge whether this mode of proceeding may lead us to expect to thus make an approximate estimate of value.¹

¹ It may perhaps be well to explain the system pursued in the following tables a little more fully.

We must, finally, endeavour to assimilate the targets by means of a factor, which shall in a simple manner correct their several ratios; thus a fire which is directed on 4 guns can be compared with one carried out on 6 by multiplying the number of hits by 1·5.

With respect to infantry, the following points may be deduced :—

1. The best formation for a battalion.
2. The best formation for a company.
3. The thickness of men in the firing line.
4. A comparison between standing and kneeling targets.

Owing to the insufficiency of the amount of practice, we have not sufficient data for the cavalry; at the most we can only compare the column of sections and the half column.

With regard to the artillery, we may learn—

1. The proper position for the wagons.
2. That for the limbers.
3. The effect of column formations.
4. What is the risk of movement within range of the enemy.

It is not the object of this paper to bring to notice every point which might be of value, since for this we must first obtain further information; it is merely as it were a provisional sign-post, pointing out in which direction we should seek for further experience, and make a further comparison: the present work is only the first effort and the first contribution towards the solution of this important question.

If we compare the results given above, we shall arrive at the following data :—

a. *Against Infantry Targets.*—1. The formations of the battalion (320 dummies) are as follows :—

30. A battalion in double column.
32. A battalion in line four deep.
34. A battalion in line of columns.
43. A battalion in company columns.
- 55 and 56. A battalion in the act of extending.
- 59 to 61. A battalion extended.

The first column gives the number of the practice which is to be considered.

The second column gives the number of rounds actually fired in that practice.

The third number shows this number minus six rounds deducted as ranging rounds.

The fourth column gives the total number of hits obtained in the practice.

The fifth column shows the quotient of the fourth column divided by the third, giving average of hits for each round.

The sixth column is the fifth column multiplied by 72, showing the hits which would have been made had 72 rounds been fired at each target.

The seventh column gives the range in yards for each practice, and the eighth the tangent of the consequent angle of descent multiplied by 1,000.

The ninth column shows the product of the sixth multiplied by the eighth.

It is considered that the varying conditions of the several practices are thus reduced to a common standard for the purpose of comparison.—N. L. W.

TABLE I.

No. of target.	No. of rounds.	Effective rounds.	Hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Ratio.
30	24	18	404	22.4	1,616	2,840	149	240,784
32	24	18	210	11.7	840	2,100	98	28,320
34	30	24	1,194	49.7	3,582	2,190	98	351,036
43	36	30	568	18.9	1,136	2,350	109	123,824
{ 55 56 }	48	42	91	2.1	151	3,060	168	23,668
	48	42	144	3.4	245	2,620	131	32,095
{ 59 60 61 }	42	36	925	25.7	925	2,020	86	70,550
	24	18	268	14.9	268	1,800	72	19,290
	24	18	97	5.4	97	1,640	63	6,111

¹ The natural tangent of the angle of descent $\times 1,000$.—N. L. W.

Thus the effect stands in the following order :--

1. 34. Battalion in line of columns.
2. 30. Battalion in double column.
3. 43. Battalion in company column.
4. 59 to 61. Battalion extended.
5. 32. Battalion in line four deep.
6. 55 and 56. Battalion in act of extending.

If the range be taken as the factor in place of the angle of descent, the table of effect will stand exactly in the same order.

The above table shows at once that the most crowded targets are the most dangerous. The fact that the line of columns receives more hits than the double column can be explained by the circumstance that with the former the fronts of all four columns are at the same distance, and that it is thus easy to carry out the distribution of fire, while the target is deep enough to catch all shell that are too high to hit the front rank, which is the true target.

A double column is twice as wide as a section column, and it is very improbable that many shell will fall to the right or left of it; if it shows fewer hits than a line of columns at half deploying interval, this is due to the fact that the guns are laid on the front rank, and that normal rounds produce an effect only as far as the third or fourth rank; only a few shell, which fly too high, will strike the rearmost ranks.

It would seem as if greater effect should be obtained on the double column; but to do this would entail a change in elevation. Such a proceeding, however, can be used for fixed targets only, and we are thus brought to the conclusion that a battalion which, when within sight of the enemy, advances in line of columns runs more risk than if it were formed in double column. Target No. 43 shows what a difference it makes if all parts of the target are at the same distance from the guns. For it is rarely possible to decide from the battery as to which are the leading companies, unless all four companies can be observed directly from the front, and it can thus be determined that the flank companies are the foremost; as a rule, those which stand highest are taken to be the foremost, and *vice versa*. This circumstance makes the distribution of fire exceedingly difficult, especially when all four companies are also in movement. It thus seems that an advance in company columns is advantageous, when the enemy's artillery does not occupy a higher level than our infantry; but we further learn, from target No. 32, that another formation, the line four deep, is yet more advantageous.

The fact that the effect on the line four deep stands in the table between the results obtained on the extended formations of the battalion is not solely to be ascribed to the particular practice (though the burst of the shell was too short, 176 to 187 yards short), since the target stood exposed on good even ground, on which the breadth of the burst must have been advantageous, and on which even ricochet hits might be expected. It arises rather from the small depth of the target; this is clearly shown in Targets 59 to 61, where the percentage of hits increases not with the number, but with the closeness of the targets, that is to say, with the depth of target. If we remember that a line of two or four ranks will not suffer at all from such shell as pass over it, while, on the other hand, troops when extended according to regulation, will find that such shell as are too high to hit the foremost rank will strike the supports or the reserve, it becomes a very serious question whether infantry, who are within reach of hostile artillery fire, may not be best formed for the advance, either with the battalion in four closed ranks, or as a line of companies two deep. It is also a matter for consideration whether the advantage of easily

finding cover is of such great importance, that with this object the desirability of the mutual support and the close connection of the lines can be disregarded. With extended and, as is the case in practice, close and strong lines of skirmishers, experience teaches us that the use of small cover afforded by the ground is often neglected; deep well-marked cover is always taken advantage of; the lines are sure to get crowded there, and often to such an extent that we find them in four or more ranks, but in no sort of order. If we take account of the effect of infantry fire on such formations, we may theorize on the advisability of the adoption of a formation compounded of that of Frederick the Great with that of Napoleon, including the occupation of the front with thin lines of skirmishers, the advance of the reserves under artillery fire in two or four closed ranks, an extension into two ranks when within the zone of infantry fire, the skirmishers being absorbed (on the flanks, as is now the case), and, finally, the assault on a serried line.

In comparison with the effect against a whole battalion, let us take those against a single company.

2. The formations of a company are as follows :—

22. Column of sections.

24. Column of sections, broken up.

33. Column of files.

45. Do. do.

47. Column of sections.

55 and 56. Company extended.

57. Column of sections (at a long range).

60. Two subdivisions in column of sections.

61. Company in groups.

TABLE II.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Ratio.
22	30	24	1,250	52.1	3,750	2,300	106	397,500
24	30	24	134	5.6	402	2,400	114	45,828
33	24	18	417	23.1	1,668	2,620	131	218,508
45	24	18	253	14.0	1,012	2,620	131	132,572
47	30	24	1,146	47.7	3,498	1,970	83	285,354
{ 55 56	48	42	91	2.1	151	3,060	168	23,668
	48	42	144	3.4	245	2,620	131	32,005
57	24	18	4	0.2	16	4,040	262	4,192
60	24	18	208	14.9	1,072	1,800	72	77,084
61	24	18	97	5.4	388	1,640	63	24,444

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.

Thus the effect stands in the following order :—

1. 22. Column of sections.
2. 47. Do. do.
3. 33. Column of fours.
4. 45. Do. do.
5. 60. Two subdivisions in column of sections.
6. 55 and 56. Company extended.
7. 24. Column of sections, broken up.
8. 61. Company in groups.
9. 57. Column of sections (at a long range).

Target No. 57 may be struck out of the foregoing table, on account of the long range and the fact that common shell only were used, since these projectiles struck the soft ground at a high angle and buried themselves.

After the comparison which has already been made, it is not surprising to find that the column of sections of the entire company is the most unfavourable for safety ; following the theory of the effect of the depth of a column, the column of fours holds with a company almost the same position as does the double column in the case of a battalion ; it is indeed closer, but on the other hand it is smaller. It must also be observed that in the instances quoted the columns of fours did not move directly against the battery which was firing on them, while they were, moreover, at a varying distance from it. Many shell must also have fallen to one side of them, many must have been short, while there were, so to speak, no ricochet hits ; both results warn us again against a deep formation.

The results against the four other company targets, viz., that in subdivisions (each being in column of sections) and those when fully extended, give very nearly the same effect. Even when the difference of range of one half of the company is so insignificant, as was the case with Target No. 24, it is obvious how difficult it is to distribute the fire ; the fact that No. 24 target showed less effect than the widely divided Target No. 60 is accounted for by the more easy observation of fire which was possible with the latter, owing to the higher station of the battery when firing at it : under similar circumstances Target No. 24 must have received more hits than Target No. 60.

If then targets divided into two parts, with small intervals and distances between those parts (each of these consisting of two ranks at ten paces distance), are not more unfavourable to safety than a complete extension, nothing prevents our arriving at the conclusion that the advance of a company under artillery fire in two subdivisions in column of sections (which are less than a musket-shot apart), while it has great advantages as regards the conduct of masses of troops, is not more dangerous with respect to the effect of fire than would be the case with the normal extension into groups and supports, or into groups and reserve. There is no doubt that even this effect can be still more diminished if the rear sections open out while advancing, or if the two sections, each four deep, place themselves side by side, while this latter formation gives an even smaller depth.

The difference between the results on Targets Nos. 60 and 61, which were fired at under very similar conditions, compels us to make some reference to the effect of the close nature of the target ; in doing this we must take into account the number of men in the skirmishing line.

3. Closeness of kneeling skirmisher lines.

38.	6 groups,	60 kneeling men,	factor 1.66	} To compare effect on a company of 100 men.
54.	4 "	40 "	" "	
56.	6 "	60 "	" "	
61.	10 "	100 "	" "	

TABLE III.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Factor. ²	Ratio.
33	30	30	98	3.2	235	2,020	86	1.00	33,548
54	36	30	56	1.8	132	3,170	178	2.30	63,740
56	48	42	51	1.2	87	2,020	131	1.00	18,919
61	24	18	97	5.4	388	1,640	63	1.00	24,444

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.² Proportion of company of 100 men to the number of dummys.—N. L. W.

Thus the effect stands in the following order :—

1. 54. 4 groups kneeling.
2. 38. 6 " "
3. 61. 10 " "
4. 56. 6 " "

One would have thought that the number of hits would have been considerably increased, when a larger number of men stood on the same space; and in a certain sense this must be true. But against this supposition is the fact that it is easier to distribute the fire over a broken line of groups than when the whole of the visible target shows as a complete line.

The above unexpected results show that a thickening of the lines of skirmishers on a given front, or a closer concentration of them towards one spot, does not expose them to any greatly increased danger from artillery fire; in any case that danger is not, under any circumstances, subject to such an increase as would be given by a deep formation. This statement assumes, however, that the height of the target is not such as to give the effect of depth. The following figures show what a difference the height of the target will make :—Targets Nos. 32 and 55 have each a front rank kneeling and a rear rank standing; the percentage of hits on the kneeling are 45 and 12, while those on the standing are 55 and 88. Taking the mean, we find that under an equal fire the kneeling line will receive three-tenths of the hits, and the standing seven-tenths; in other words, the effect on the standing is more than double that on the kneeling line. This comparison further informs us that the effect of bursting shell is but little increased by the breadth or the closeness of the target, but that the height or the corresponding depth are the real factors which increase effect, and which must be considered when selecting tactical formations to be used under artillery fire.

b. *Against Cavalry Targets.*—The limited practice against cavalry gives the following results :—

4. The formations of cavalry were as follows :—

35. Column of sections, 54 files ; prop., 9'6 ; factor, 1'0	} To compare with
a squadron of
54 files.
40. Half column, ditto, 30 do. ; do. 5'6 ; do. 1'8	
42. Ditto, ditto, 54 do. ; do. 9'6 ; do. 1'0	
63. Column of sections, 36 do. ; do. 6'6 ; do. 1'5	

TABLE IV.

No. of target.	No. of rounds.	Effective rounds.	Hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Factor. ²	Ratio.
35	30	24	564	27.7	1,692	2,620	131	1.0	221,652
40	13	13	119	9.1	655	330	0	1.8	3,834
42	30	24	371	15.4	1,133	2,620	131	1.0	148,423
63	19	13	20	1.5	108	4,150	273	1.5	44,226

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.² Proportion of a squadron of 54 files to the actual number of dumniees.—N. L. W.

Thus the effect stands in the following order :—

1. 35. Column of sections.
2. 42. Half-column.
3. 63. Column of sections.
4. 40. Half-column (at 320 yards with case).

Of these only 35 and 42 are of use to enable us to form an opinion ; the depth of both targets is the same, but the half-column of target 42 becomes less close as the width increases ; thus the results must be nearly the same. This would not be the case with a squadron in line, if such a comparison could be made ; from what we have already learnt, we may conclude that in this latter formation the risk of loss under artillery fire, especially on the move, would be very small, probably even less than would be the case if the same front were covered by an attack in swarms, since this would imply a greater number of targets in depth.

This opinion is strengthened by the effect on Target 40, where the second (that is to say, the centre) rank shows the greatest number of hits by case. This description of projectile, when used against broad fronts and at a short range, gives the best distributed, and, therefore, the greatest, effect ; the difficulty is for the artillery to give proper attention to the distribution of fire at moments of intense excitement ; if this could be done, it might be possible to use also shrapnel with the time fuze carefully set ; with regard to the last period of the charge, the effect will depend mainly upon one thing, viz., whether the line of charging cavalry is in open or close order ; but even in this case the depth of the formation will act prejudicially.

c. Against Artillery Targets.—The third group of records concerns fire against artillery targets, composed of either the whole battery or of the guns and limbers only. In order to compare 4-gun batteries with 6-gun, the hits on the former must be multiplied by 1·5.

5. The formations of artillery are as follows :—

The whole battery.

27. With wagons at 80 yards distance.

31. With wagons at 330 yards distance, on either flank.

36 and 37. With wagons under cover (4 guns and 4 wagons).

51a and 51b. 6 guns unlimbered, 6 wagons in column of sections, 360 yards to the left rear of the guns.

TABLE V.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Factor. ²	Ratio.
27	30	24	282	11.7	846	1,530	57	..	48,222
31	30	24	421	17.5	1,263	1,910	79	..	99,777
36	30	24	358	14.9	1,074	2,080	90	1.5	144,990
37	24	18	142	8.0	568	2,190	93	1.5	224,226 79,236
51a	18	12	23	1.9	138	3,390	198	..	27,324
51b	18	12	3	0.2	18	3,770	234	..	4,212 31,536

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.² The proportion of 6 guns to the number actually fired on.—N. L. W.

Thus the effect stands in the following order :—

1. 36 and 37. Wagons under cover.
2. 31. Wagons at 330 yards distance, on either flank.
3. 27. Wagons at 80 yards distance.
4. 51a and 51b. Guns in action, wagons in column of sections 360 yards to the left rear.

The above can be compared with the following percentages of effect on the whole battery :—

No. of target.	Guns and detachments.	Limbers and teams.	Wagons and teams.
27	42	21	37
31	26	63	6
36 and 37	29	43	23
51a and 51b	46	43	11

Thus Target No. 31 suffered the least, having its wagons on the flanks 330 yards in rear of the limbers, though 6 rounds out of 30 were specially directed on the former. But the distance of burst was about 220 yards in front of the wagons, which brings us to the statement which has already been made, that shrapnel shell has no effect beyond a fixed depth; in this case the rear dummies were about 269 yards from the point of burst, which was only about 19 feet above plane. The greatest proportional effect was on Target No. 27, when no special fire was delivered on the wagons, and when the burst of the shell was 220 yards in front of the guns, and thus nearly 300 yards from the rearmost dummies. The strikingly contradictory results given by these two examples can only be explained by the fact that with Target No. 27 the bullets could ricochet as far as the wagons, which with Target No. 31 was not the case; thus with Target No. 27 the number of hits was greater, and the effect of each bullet less, while with Target No. 31 only direct hits were counted.

In the first table the Target Nos. 36 and 37 is at the head of the list; the reason for this is, that the wagons received 23 per cent. of the hits, although they stood behind a covering mass and a screen, though certainly close up to the latter and very near together. The lesson to be learnt from this is again not new, viz., that cover does not shelter deep targets which are on the same level, and that screens are only of value when the object to be hidden stands far in rear of them. The above experience shows us that the distance between them should be at least 320 yards.

When the wagons were placed in line 60 yards in rear of the front of the guns, they received too many accidental hits; even 320 yards distance did not prevent this; a separate position, as in Target No. 51b, is evidently equally dangerous as one in rear of the battery, if it implies a considerable depth. The best formation is to place the wagons parallel to the line of the battery, and in column of route, taking care that they are as far as possible concealed from view; unquestionably the most dangerous screens are such as can be clearly seen, and these again become worse as they are nearer to the battery.

If both the above tables be taken into consideration, the order of the targets, as regards danger, is as follows :—

Nos. 37, 27, 31, 51b.

6. Battery without wagons.

The following formations were tested :—

21. 6 guns and limbers, teams facing the rear.
23. Ditto, limbers on the flanks.
27. Ditto, limber teams unhooked (wagons not counted).
31. Ditto, normal formation.
36. 4 guns, ditto, ditto.
39. 6 guns, in column of sections at full interval.
44. Ditto, column of sections at half interval.
46. Ditto, with 3 limbers on each flank.
- 51a. Limbers in front of guns, teams hooked in.
- 58a and 58b. 6 guns, limbers in column of sections, in flank and rear of the guns.

TABLE VI.

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Factor. ²	Ratio.
21	24	18	461	25.6	1844	2190	98	..	180,712
23	24	18	644	25.7	2576	2130	93	..	230,568
27	30	24	180	7.5	570	1530	57	..	32,490
31	30	24	396	16.6	1188	1910	79	..	93,852
36	30	24	358	14.9	1074	2080	90	1.5	144,990
39	29	23	991	43.1	3102	2080	90	..	279,180
44	30	24	918	36.2	2754	2210	99	..	272,646
46	30	24	721	30.0	2163	1750	69	..	149,247
51a	26	30	23	0.8	55	3390	108	..	10,890
{ 56a	48	42	70	1.7	122	2900	153	..	18,666
{ 56b	18	12	120	10.0	720	3000	188	..	185,360

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.
² Proportion of 6 guns to the number actually fired on.—N. L. W.

154,026
 185,360

Thus the effect stands in the following order :—

1. 39. Column of sections, full interval.
2. 44. Column of sections, half interval.
3. 23. Battery with limbers on the flanks.
4. 21. Battery with limbers and teams, normal.
5. 58a and 58b. Limbers in column of sections, in flank and rear of the guns.
6. 46. As with Target No. 23.
7. 36. Normal formation.
8. 31. Normal formation.
9. 27. Normal formation.
10. 51a. With horsed guns.

This comparison gives more certain results than that with the wagons. If we compare the three formations fired at, we find, as we did before, that the line at full interval is the safest and the best formation for movement. The two columns of sections prove themselves to be very dangerous formations, and, since both were fired on under the same conditions, that at full interval was more dangerous than that at half-interval. The apparent contradiction which may be observed, is explained, if we remember the double column of infantry as compared with the line of columns, while not forgetting that the columns of sections of artillery are half as high again as those of the infantry (9 feet to 6 feet), and if we recollect what a great difference the height of the target made in the comparison between the effect on kneeling and standing lines. In the case of the column of sections at full interval even the very highest bullets of the cone of burst are not lost, as they may well be in the case of a close column. The columns of sections are really bullet-traps.

With regard to the position for the limbers, we have here more information, for, with the exception of series No. 58b, the limbers were not specially fired at; since Target No. 21 comes between Targets Nos. 23 and 46 (where the limbers were on the flanks), we may see that the normal position, 11 yards in rear of each gun, is not so dangerous as an uncovered position showing depth. If we take the percentage for each practice, we find :—

No. of target.	Limbers.	Guns.	Limbers.
21	Normal	41	59
27	do.	65	35
31	do.	30	70
36	do.	33	67
23	massed	40	60
46	do.	19	81
58	do.	40	60
Mean of the 4 first.....		42	53
Mean of 3 last		33	67

Thus the limbers will be better posted in rear of the guns, giving a small depth, than in long columns on the flanks.

It is worthy of notice that the limbers receive from three-fifths to two-thirds of the hits, a circumstance which can only be ascribed to the large target offered by the teams; this may be observed also with Target No. 51a, where the limbers, which were then in front of the guns, received 52 and the guns only 48 per cent. of the hits; it is therefore certain that, given the present shell and the present formations, the horses will be killed

before the gunners, and that after the first few rounds the mobility of the battery will be at an end, unless it be accepted as a principle to govern all tactical formations, that the limbers shall be separated altogether from the guns, or at least that the teams shall be unhooked. Target No. 586 shows that they are by no means safer when they are massed outside of the battery, and still remain visible; even in this case the wisest thing to do would be to place the limbers or their teams under cover, or at some distance in rear of screens; they must not, however, when in rear of cover, be posted so as to offer a deep target, but must be on a broad front, either in line with large intervals (11 yards), or in column of route along the line of cover; when behind mere screens they must be at least 320 yards from them, if it be in any way possible to obtain so much distance.

If we endeavour to express the results obtained on the moving targets in terms of those obtained on standing targets, we may assume that the effective fronts of the latter are, taking the moving target as unity, as follows :—

The front of a section of infantry—2.

The front of a section of cavalry—4 or at least 3·5.

It must be further remembered that the moving target represents only the front rank. If we take the stationary Target No. 60 for comparison, we find that the front rank received 144 hits, while the same front with Targets Nos. 25 and 41 (moving targets) received 142 hits, and thus very nearly the same number; there would be the same proportion of hits on the second rank; if we increase the pace a little and allow the infantry to pass over the same space in four-fifths of the time, the number of hits will be diminished by one-fifth only.

Passing on to the cavalry we may take fire on a column of sections in movement to be represented by Target No. 35.

	1st rank.	2nd rank.	3rd rank.	Total.
Standing target, 30 rounds	184	179	201	564
Ditto, 24 rounds	138	135	150	423
Moving target	71	(69	77	217) ¹
Ditto, per section, ratio 3.....	213	207	231	651
In movement, walk, three-fourths of time	160	155	194	499
Trot, one-fifth of the time	43	41	46	130

Target No. 29 is of great interest; the moving carriages could be fired on for a space of 185 yards; the battery was ranged on the centre of this space; the time required for a column of 6 carriages to pass it was:—

The centre space at a walk	60 seconds.
" at a trot	22
The whole space at a walk	2 min. 53 secs.
" at a trot	1 min. 5 secs.

The length of column was two-fifths of a column of 6 guns.

¹ The numbers within brackets are estimated on the ratio of the 1st column, viz.: 71 to 138.—N. L. W.

The hits received in 30 seconds were 14 ; this gives for 6 guns at a walk 35 hits, at a trot 13 hits.

It follows that a space of about 220 yards can be passed by the flank march of a battery at a walk without any considerable risk, even when the enemy's battery is ranged ; but it must be possible for the rear carriages to be able to pass any carriage which may break down ; at a trot there is very little risk. If the space where the column is visible to the enemy is very short, the danger is still more reduced ; for example, if it be only 18 yards, there will be but 3·5 hits at a walk and 1·3 at a trot. The lesson taught by the other targets was also true of this, viz., that not the length, but the depth in the direction of the line of fire, of any formation is a measure of its risky character.

It remains to make a few observations which may be of value with regard to the conduct of fire.

The "rate of fire" is always slower against artillery targets, since the laying must be more exact ; the greatest rapidity was 16 seconds between rounds, the least, owing to bad light and long range, 31 seconds ; mean, 23 seconds. Cavalry is easier to see even at long ranges ; the rate of fire was from 16 to 20 ; mean, 19 seconds between rounds. Infantry, when near, is easier to lay on than cavalry, but at a distance somewhat more difficult on account of its smaller height ; rate from 11 to 32, mean 20 seconds.

At long-continued practice it is found that as a mean, even when the brakes were used, the average pace did not exceed 22·3 seconds between rounds ; the limits were from 11 to 31 seconds between rounds. After 30 successive rounds from each gun the detachment begin to tire ; after 40 rounds there must be a pause ; fire should not be kept up for more than 90 minutes at this rate since the consequent fatigue very much diminishes the trustworthiness of the detachment. When the guns have no brakes two hours must be allowed for 40 rounds, or even sometimes for 30 ; otherwise the detachment will tire very soon and the service of the gun will deteriorate.

The greatest pace for rapid fire, if the guns are to be fired more than once, is 4 seconds between rounds ; as a rule, the last round will have an interval of 2 seconds ; a whole series of 24 to 30 rounds will have a mean of from 10 to 15 seconds instead of from 18 to 25 seconds between rounds. Setting the fuzes of shrapnel beforehand accelerates only the first round, and this very little, since of all the processes included in loading the setting of the fuze is that which takes up the least time.

With regard to the behaviour of the guns, only two disadvantages show themselves after continued firing. One is, that by opening and closing the breech-wedge a certain amount of powder residue is always collected, which lies at one point of the lands (about 25 degrees right of under) ; this point must therefore be always looked after, though this can be done only when the screw is loosened and the breech-block withdrawn. On this account, and in order not to injure the gun, not more than 20 consecutive rounds ought to be fired without cleaning the gun ; any convenient moment may be utilized for this purpose.

If this be neglected the gun does not indeed become unserviceable, for it can fire 80 rounds or, if necessary, even more ; the only consequence will be that the ring and the surface of the bore will be so scored that they will have to be faced. With smokeless powder there is no such defect.

The other disadvantage concerns the lever of the elevating gear, which is crushed by the recoil at the spot where the outer ring grasps it, with the result that a regular ring of disintegrated wood about 1 centimetre thick is formed on it ; finally the sound part of the lever becomes too weak and breaks at this particular place. Fractures at other points are rare, and are to be attributed to bad workmanship when making the lever.

When the brakes are used the point of the trail buries itself less in wet ground than is the case when there are no brakes; the carriage is not injured, if the brakes do not act by jerks. On the other hand, some attention must be paid to the wheels; it is not certain, but it is probable, that the plate of a metal nave gets a set when the brakes are put on hard; after long continued shooting, therefore, the metal naves must be looked to, although even if the plate be bent the wheel is still serviceable.

Another fact to which attention should be drawn is, that with the present ammunition the observation of percussion shrapnel is easier than that of common shell; when the ground is soft or at long ranges neither percussion shell is of much use; it should not, therefore, become a habit to range a battery exclusively with percussion shrapnel, since with targets which are visible for but a short time, common or shrapnel with time fuzes give a quicker effect. We may indeed ask whether common shell might not, as a rule, be dispensed with in the field, except in peculiar cases, and shrapnel be thus employed for almost all purposes. This would allow us to give yet more attention to the different ways of ranging a battery with shrapnel. There would, moreover, then be no necessity to give the order for a change of projectile, which necessity is at present the cause that the Officer directing the fire is pre-occupied, and that the "shrapnel-pauses," which can rarely be avoided, constantly take place. If only one kind of projectile were used, it would give better results than the two we now have; while the conduct of fire would be facilitated, and would be simpler, if only for the reason that it would not be necessary to count the rounds as they were fired.

It is again a question whether the corrections ordered for successive guns should be calculated from the last correction given or from the original elevation. Mistakes are more likely to occur if the correction be continuous, both on account of the elevating gear, and of errors which may be made; as soon as the system of firing by rounds throughout the battery¹ is given up, there is no reason why the correction should not be given from the original elevation; it is quite as quick and much more easy for the observer.

With respect to the use of guns at long ranges, the difference in the effect obtained is not a consequence of any failing in the material, which is quite sufficiently good. The reason why long-range fire is considered undesirable is on account of the difficulty of observation and of laying, when the atmosphere is at all misty or there is much smoke. A comparison of the results against the same targets, as follow:

Targets 12 and 16 at 1,900 yards, with 56 at 2,620 yards.

Target 59 at 2,020 against 22 at 2,300 yards.

Target 60 at 1,800 with 24 at 2,400.

Target 27 at 1,560 with 58 at 2,900 and 3,060 yards,

show that we can get good results at long ranges; but Targets 52 and 57 show also that there is a limit to this in practice.

Good effect should always be produced at ranges under 2,200 yards, and within this distance any visible or known target ought to be destroyed with certainty.

A quite sufficient effect may, in case of necessity, be expected up to 2,620 (see Targets 33, 35, 42, 45, 56); if the view be good, the service of the gun quiet, and the observation correct, this may be extended to 3,050; as regards ranges beyond this, many chances may intervene: in peace ammunition is too costly for such practice, in war it can too seldom be spared; see Targets 51, 52, 57, and 63.

The foregoing paper offers no final proof of the opinions given in it, as it is

¹ "Lagenweise;" firing by complete rounds, all the guns having the same elevation.—N. L. W.

not sufficiently complete to show entirely convincing results; it is but a beginning and a finger-post, to point out where certainty can be obtained, though it offers welcome material for this. The effect of artillery lies only in their shooting; it is therefore the only right way to consider all tactical formations from the point of view of fire-effect, judging them with reference to their good and bad influence on the shooting.

Supplement.

Further conclusions with regard to practice against recognized tactical formations may be derived from the following record, which forms a supplement to the tactical results of the course of practice for field artillery of 1890.

Practice of the 2nd September. At Thun.—A battery of 6 guns in position is fired on and is silenced (1). After a time a section of cavalry on reconnaissance shows itself (2); while these are under fire, some infantry appear, and are fired on as they extend, first the main body (3a), then the closed bodies of the first line (3b), and, lastly, the groups of skirmishers (3c).

1. 6 guns with detachments, at 16 yards interval, with the limbers 11 yards in rear of each gun, teams facing the rear. Range, 2,400 yards. 18 common and 18 shrapnel. Time, 15 minutes; interval between rounds, 25 seconds; battery ranged on No. 4 gun; distribution of fire, by sections after the small bracket had been found, by guns when shrapnel fire commenced.

Results.

	1 gun.	2 gun.	3 gun.	4 gun.	5 gun.	6 gun.	Total.
Limbers	24	52	51	42	10	166	345
Guns	15	39	16	53	9	40	172
Total	39	91	67	95	19	206	517

67 per cent. of the hits on the limbers, 33 per cent. on the guns.

Mean burst of common, 16 yards over.

Ditto of shrapnel, 55 yards short, 10 feet above plane.

87 dummies hit out of 96.

2. 24 cavalry dummies in swarm, half on a slope, the leading half under cover on level ground. Range, 2,460 yards. 10 common shell. Time, 3 minutes 30 seconds; interval between rounds, 21 seconds. 58 hits on 21 dummies.

Mean burst of common, 11 yards over.

3a. 3 companies of infantry in line of columns; each company in column of sections: each section two ranks of standing infantry dummies, and each 40 men; distance of rear ranks, 4 yards; interval between sections, 22 yards; 240 dummies. Range, 1,640 yards. 8 common and 14 shrapnel. Time, 9 minutes 30 seconds; interval between rounds, 26 seconds. Battery ranged on the centre company, and fire distributed when the small bracket had been found.

3b. 220 yards in front of Target 3a, No. 4 company with 3 sections at 4 yards distance; each section of 20 dummies in close order, kneeling and half under cover. Range, 1,420 yards. 13 shrapnel. Time, 5 minutes 45 seconds; interval between rounds, 26 seconds.

3c. 220 yards in front of Target 3b, the 4th section of No. 4 company, extended in 4 groups, each group of 10 kneeling dummies and 13 to 16 yards wide; in rear of each group an Officer standing; total breadth of the 4 groups about 66 yards. Range, 1,200 yards. 15 shrapnel. Time, 3 minutes 50 seconds; interval between rounds, 16 seconds. Fire distributed from the first.

Mean burst of shrapnel, Target 3a, 83 yards short, 10 feet above plane.

Ditto Target 3b, 107 yards short, 13 feet above plane.

Ditto Target 3c, 137 yards short, 11·5 feet above plane.

Of 240 dummies in Target 3a, 213 hit.

Of 60 ditto, Target 3b, 59 hit.

Of 15 ditto, Target 3c, 42 hit.

The light was good throughout.

Distribution of Hits.

220 yds.	3a.	{	$\frac{208}{208}$	$\frac{210}{127}$	$\frac{127}{136}$	515
						<u>471</u>
						1,016
		3b.	{	$\frac{235}{92}$	$\frac{92}{92}$	
					<u>419</u>	419
						18
220 yds.	3c.		$\frac{25}{25}$	$\frac{36}{36}$	$\frac{29}{29}$	$\frac{12}{102}$
						<u>102</u>
						1,555

Of the 1,555 hits the reserve, which contained three-fourths of the dummies (standing), received 65 per cent., the supports 27 per cent., and the groups 8 per cent.

If, in order to compare these results with those obtained in March (given in the former part), we calculate the danger of the several formations in the same manner, but, eliminating only the first 6 rounds of the entire 50 (since the fire was directed on the one battalion), we find—

No. of target.	No. of rounds.	Effective rounds.	No. of hits.	Hits per round.	Hits per 72 rounds.	Range in yards.	Angle of descent. ¹	Ratio.
1	36	30	517	17.2	1,238	2,400	114	141,177
2	10	4	58	14.5	1,014	2,400	118	123,102
3a	22	16	1,016	63.4	4,572	1,640	64	292,608
3b	13	13	419	32.3	2,321	1,420	51	118,371
3c	15	15	120	8.0	576	1,200	40	23,040
3 (a, b, c)	50	44	1,555	35.3	7,496	above	..	434,019

¹ The natural tangent of the angle $\times 1,000$.—N. L. W.

141,411
23,040

If we compare first the result on Target No. 1 with that given in the table on p. 178, it falls between the ratios of Targets Nos. 31 and 36, which were in the same formation; we may, therefore, conclude that our method of calculation of effect gives fairly useful and approximate results.

The proportion of hits on guns and limbers respectively corresponds also to the results on Target No. 31 (p. 149), and we may thus consider the approximate proportion of from 30 to 40 per cent. of the hits on the guns and from 60 to 70 per cent. on the limbers and teams as constant.

If we compare the fire on cavalry, we find that the ratio of Target No. 2 lies between Target No. 42, the half-column and Target No. 63, the column of sections (p. 157), a position which, considering the fairly considerable depth (22 yards) of the swarms, and the relative closeness of the formations, appears to be probably correct.

The greatest interest is attached to the comparison of Target No. 3 with the tables referring to infantry targets. Taking, first, the whole battalion, the total is in excess of any in Table I (p. 159). This excess is to be ascribed to the fact that the formation given to the target has a considerable depth in the centre and is also relatively close. Of the 1,555 hits, 56 per cent. are on the centre, including skirmishers, supports, and the centre reserve company, while the flanks of the reserve received only 44 per cent., and this, although the front half of the centre consisted of kneeling dummies only, while the leading eighth part has considerable intervals. Since the flank reserve companies are in the same line as the centre company, the fire can be easily distributed along that line; it is owing to this circumstance that, as has already been shown, the line of columns is the most dangerous formation. The depth of the sections, though only 4 yards, is sufficient to make them a very unfavourable target, as was also evident in the case of the closed double line of Target No. 32, where the distance was only 1 yard. From this practice we may also draw the conclusion, that in all cases where infantry stand in line, and the fire of artillery can thus be easily distributed along it, the depth of the formation should be as small as possible, as soon as the troops are halted; when they are moving, in which case the risk will always be less, the distance between ranks or lines must be a minimum.

If the ratio of effect on Targets Nos. 3b and 3c be compared to those in Table II (p. 162), we shall find that it falls between Target No. 45, the column of fours of the company, and Target No. 60, two separate subdivisions in columns of sections, and thus above those company targets in which at most two sections were held in reserve, and in which the reserve and the supports were not on the same line. Whilst in Targets Nos. 55 and 56 of the above 38 per cent. of hits fall on the two reserve sections, 39 per cent. on the section in support, and 23 per cent. on the skirmishers, in Targets Nos. 3b and 3c we find 78 per cent. on the 3 supporting sections, and 22 per cent. on the skirmishers; this result is derived solely from the depth and closeness of the formation of those supports, and confirms the conclusions which have been already stated with regard to the progressive increase of danger with each increase of depth of formation.

Target No. 3c, taken alone, may be compared with Table III (p. 164), and falls, if multiplied by 2.5 (giving 57,600), between Targets Nos. 54 and 38; this good effect may be ascribed to the circumstance that the four groups formed distinctly separate targets, on which the distribution of fire was easy and exact.

It would be very advantageous if, during the service practice at the schools of instruction, and especially during the advanced course, other formations could be submitted to actual trial under artillery fire; theoretical formations would then prove their efficiency or the reverse, after having been literally "tried in the fire."