THE ROYAL ENGINEERS JOURNAL.

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Abbreviated Notes on MILITARY ENGINEERING.

CONTENTS.

ROPES, SPARS, TACKLES, STRENGTH OF MATERIALS.
BRIDGING. FIELD DEFENCES.
CAMPING ARRANGEMENTS. DEMOLITIONS. ROADS.

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Authors alone are responsible for the statements made and the opinions expressed in their papers.

TEMPORARY GIRDER BRIDGES

By MAJOR O. G. BRANDON.

(The writer requests us to acknowledge the assistance he has received from the articles previously contributed by various officers on the above subject to the *R.E. Journal*, etc.).

As amongst the large number of officers now serving there may be some who have had little experience in dealing with such problems the following tables have been prepared as a guide to anyone who may be called upon to undertake bridge repairs, as also with a view to obviating the necessity of calculation on the spot. A type of girder has been selected which can be quickly and easily made from any material that is available.

Table A shows the sizes of members of girders of all principal spans from 10 ft. to 100 ft.: the requirements for any spans not included in the table can easily be arrived at by inspection.

The bridge in every case is designed for a *single* roadway to carry the heaviest motor lorries and can be built any width desired up to about 13 ft. in the clear. The girders and wheel guides should be arranged so that the load may be borne as far as possible directly on the girders; this will be so if the position of the girders is arranged between the limits shown on plan.

It is recognized that for simplicity of working the same size of material would often be employed throughout, but cases may arise where shortage of time or material might make it desirable to use only what is essential; hence in all cases, the maximum and minimum *sectional areas* of members has been shown, to allow of any size of material being used; in addition, columns have been added showing certain sizes of material which would usually be available, and the quantity required.

Table B gives a rough rule for hasty bridging to carry 3-ton lorries.

Table C gives a formula from which any member of an "N" type girder of any span can be worked out. This formula has been arrived at by analogy from a consideration of results given by the "method of sections."

Table D shows the method of calculation employed applicable to any case, as well as an example worked out for a particular span.

TABLE A.—GIRDER BRIDGES TO CARRY SINGLE ROADWAY FOR HEAVY MOTOR LORRIES.

I.e. up to 17,700 *lbs. on back axle and* 7,100 *lbs. on front axle and crowded* (10 *ft. between back axle of one lorry and front axle of next lorry*).

Span. Feet.	No. of Girders.	Bays. Number.	Bays. Length. Feet.	Bays. Depth. Feet.	Booms. Maxm. Area. Square Inches.	Booms. No. of 9″×3″ in Centre.	Booms. No. of 9″×3″ at End.	Verticals. Maxm. Area. Square Inches.	Verticals. No. of 9″×3″ in Centre.	Verticals. No. of 9″×3″ at End.	Diagonals. Centre. Area. Square Inches.	Diagonals. Centre. Diam. of Bar. Square Inches.	Diagonals. End. Area. Square Inches.	Diagonals. End. Diam. of Bar. Square Inches.	Bolts for Boom Joints. No. each Side of Joint.	Bolts for Boom Joints. Diameter. Inches.	Alternative to Diagonals. *Web Planking each Side. Ins.	Alternative to Diagonals. Per Bay of each Boom. ⅞″ Bolts or 6″ Nails.	Alternative to Diagonals. Per Bay of each Boom.	Remarks.
10	2	4	2 6	2 6	8	13×3	13×3	15	13×3	23×3	·4		·8		4			7	70⁴″	The roadway may be carried on either top or bottom booms, but the former is preferable as it is easier to arrange the roadway. If necessary to have the latter arrangement, cross-bearers should be placed about 1 ft. apart and the roadway laid on top of these and parallel to the bridge: special care must be taken to ensure that the cross-bearers rest evenly on all the girders.
20	2	4	5	5	11	14×3	14×3	22	14×3	24×3	·6		1·2		5			15	100⁴″	
30	2	6	5	5	28	19×3	19×3	38	19×3	29×3	·9		2·2		—	—		17	180⁴″	
40	2	8	5	5	44	2	1	44	1	2	1		2·7	2	10		1	15	88	
50	2	10	5	5	75	3	2	59	1	3	1·2		4		11		1	16	120	
60	4	10	6	6	44	2	1	32	1	2	·4		2·3		10			20	66	
80	4	12	6 8	6	75	3	1	40	1	2	·9		3	2	9	1		18	80	
100	6	14	7 2	7	68	3	1	40	1	2	·8	1	2·2		8	1		20	80	

* If web planking is used (instead of iron diagonals) of the thickness shown, the planks must touch each other at the abutments: in the centre third bays they may be spread their own width apart as "A" in sketch.

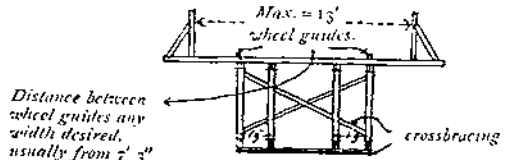
* If planking double the thickness shown is available this may be placed its own width apart at the abutments, and double its width apart in the centre third bays, as "B" in sketch.

If it is desired to make the verticals of iron and the diagonals of timber, the direction of the diagonals must be changed so as to slope UPWARDS towards the centre of the bridge: the sizes of material required in this case can be ascertained from the table as follows:—

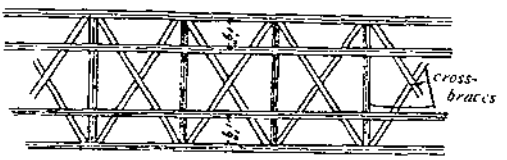
$\frac{1}{10}$ × area of wood vertical in table = area of iron vertical (which is now in tension).

10 × area of iron diagonal in table = area of wood diagonal (which is now in compression).

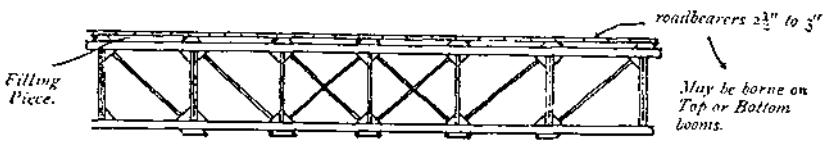
N.B.—This method of conversion can *not* be applied to replace wood by iron unless the direction of the diagonal is changed.



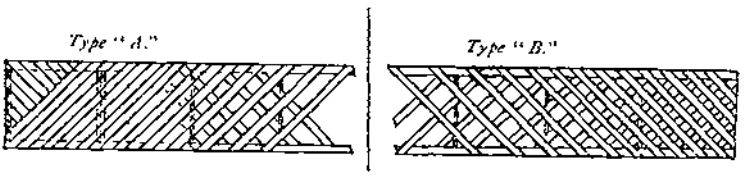
CROSS SECTION.



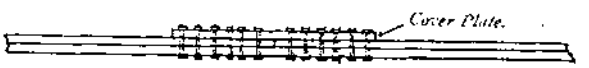
PLAN.



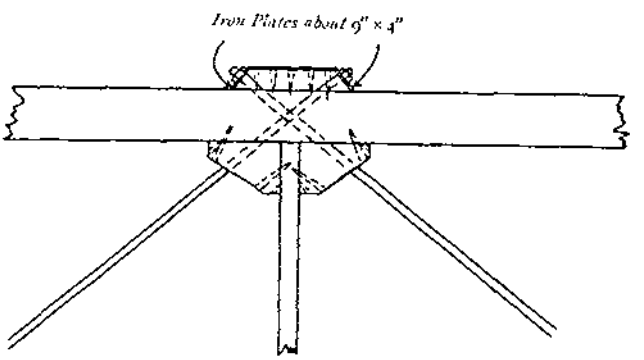
ELEVATION.



ELEVATIONS OF TWO TYPES OF SIX-BAY GIRDERS WITH PLANK WEB.



PLAN OF GIRDER SHOWING JOINT.



DETAIL OF BLOCKS FOR IRON TIES

TABLE B.—ROUGH IMPROVISED BRIDGES TO CARRY SINGLE ROADWAY OF 3-TON LORRIES, CROWDED.

I.e., 10 ft. between rear axle of one lorry and front axle of next lorry.

Span. Feet.	No. of Pieces of 9″ × 3″.	Round Spars. 8″.	W.I. Girders. 9″ × 4″.
5	6	5	2
10	11	9	4
15	16	13	6
20	22	18	9

ROUGH RULE TO CARRY 3-TON LORRIES.

Number of 8-in. diam. spars or number of beams 9 in. × 3 in. = Number of feet span.
Brick or stone arches (with a good rise) up to 20-ft. span. Thickness of arch ring in inches = Number of feet span.
Brick or stone arches (with a good rise) 30 to 50-ft. span. Thickness of arch ring in inches = Half of feet span.

KING "TRUSSES" AS SKETCH.

Span.	No. of Girders.	Each Girder.		Each Girder.
		Boom Pieces 9″ × 3″.	King Beam 9″ × 3″.	Tie. Circ. $1\frac{3}{4}$″ or 2″.
10	2	2	1	6 or 4
15	2	3	1	6 or 4
20	2	4	1	6 or 4

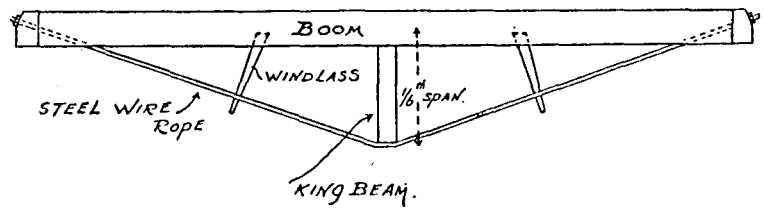


TABLE C.—FORMULÆ FOR STRESS IN MEMBERS OF GIRDERS.

T = compression in top boom.
V = stress in verticals.
D = stress in diagonals.
w = maximum lorry load in lbs. at each panel point.
p = dead load in lbs. at each panel point.
n = number of bays.
d = depth of bay.
b = breadth of bay.
θ = angle between diagonal and boom.

Each type of member of girders is numbered 1, 2, 3, etc., from one abutment towards the centre.

R represents the number of any member.

$$T_R \times d = -(w+p)\, b \times \left\{ \frac{R}{n}[1+2+\ldots(n-1)] - [(R-1)+(R-2)+\ldots+1] \right\}$$

$$V_R = (w+p)\,\frac{1}{n}\left\{1+2+\ldots+(n-R+1)\right\} - \frac{p}{n}\left\{(R-2)+(R-3)+\ldots+1\right\}$$

$$D_R = V_R + 1 \text{ cosec } \theta.$$

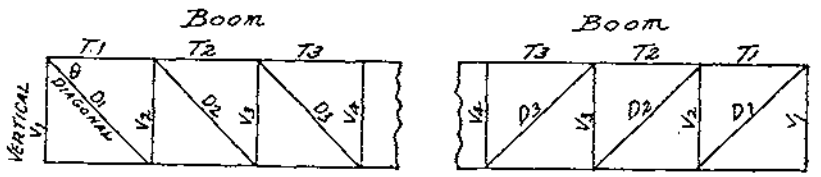
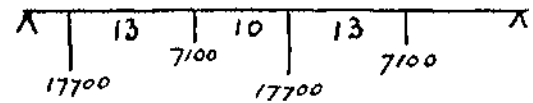


TABLE D.—METHOD OF CALCULATION.	 EXAMPLE WORKED OUT FOR 40 FT. GIRDER LOADED AS ABOVE.
Total live load = W	... ... $2 \times 17700 = 35400$ $2 \times 7100 = 14200$ 49600
Equivalent dead load = 2W ... ... Allow "n" panels of depth "d" ft. and breadth "b" ft.	... ... 99200 Allow 8 panels of depth 5 ft. and breadth 5 ft.
Dead load per panel = $\frac{1}{n} \times 2W = w$	... ... $\frac{1}{8} \times 99200 = 12400$ 800
Weight of panel = p Total weight on each panel = $w + p$	 13200
Boom.—Let "r" be the number of any member in which it is required to find the stress.	To find the stress in top boom panel No. 4.
$T_r \times d = -(w+p)\, b \left\{ \frac{r}{n} [1 + 2 + \ldots\ldots + (n-1)] - [1 + 2 + \ldots\ldots + (r-1)] \right\}$	$T_4 \times 5 = -13200 \times 5 \{\frac{4}{8}[1 + 2 + \ldots + 7] - [3 + 2 + 1]\}$ $T_4 = -13200 \{\frac{1}{2} \times 28 - 6\} = 105600$ lbs.
$T_r = A$ ... ... Allow F. of S. = 5. Safe stress in fir = 1200 lbs. per sq. in.	
Area required = $\frac{A}{1200} - C$ sq. ins.	... ... $\frac{105600}{1200} = 88$ sq. ins.
Allow for Y girders.	Allow for two girders.
Area of boom for each girder = $\frac{C}{Y}$ sq. ins.	... ... $\frac{88}{2} = 44$ sq. ins.
I.e. B. pieces of 9 ins. × 3 ins.	*I.e.* 2 pieces of 9 ins. × 3 ins.

METHOD OF CALCULATION—*cont.*	EXAMPLE WORKED OUT FOR 40 FT.—*cont.* GIRDER LOADED AS ABOVE—*cont.*
Bolts for Boom.—Stress on bolts $= A \times \frac{I}{Y} \times \frac{I}{B}$	... ... $105600 \times \frac{1}{2} \times \frac{1}{2}$
A "t" diam. bolt through 3-in. timber takes stress $= t \times 3 \times 1200 = t \times 3600$ ...	A $\frac{3}{4}$-in. bolt takes stress $= \frac{3}{4} \times 3 \times 1200$.
Number of bolts $= \frac{A}{Y \times B \times t \times 3600}$	... ... $\frac{105600}{2 \times 2 \times \frac{3}{4} \times 3600}$
Verticals.—Total load $= n \times (w + p)$	... ... 8×13200
R_1 at abutment of each girder $= \frac{n \times (w+p)}{2 \times Y} = K$	$\frac{8 \times 13200}{2 \times 2} = 26400$
Since "d" lies usually between $\frac{1}{12} \times L$ and $\frac{1}{24} \times L$ safe stress in fir = 600 lbs. per sq. in.	
Area of vertical at abutment $= \frac{K}{600}$ sq. ins.	... ... $\frac{26400}{600}$ 44 sq. ins.
I.e. S pieces 9 ins. × 3 ins.	*I.e.* 2 pieces 9 ins. × 3 ins.
Diagonals.—Load on panel of each girder $= \frac{w+p}{Y}$	... ... $\frac{13200}{2}$
Now $V_r = \frac{(w+p)}{n} \{1 + 2 + \ldots\ldots (n-r+1)\} - \frac{p}{n} \{(r-2) + (r-1) + \ldots\ldots + 1\}$	$V_2 = \frac{13200}{8} \{1 + 2 + \ldots\ldots + 7\} - \frac{800}{8} \{0\} = 23100.$
Now $D_r = V_{r+1}$ cosec θ.	$D_1 = V_2$ cosec $45° = V_2 \sqrt{2} = 23100 \times 1{\cdot}41 = 32571.$
Since safe stress in W iron = 12000 lbs. per sq. in.	
Area of diagonal $= \frac{D_r}{12000} = \frac{V_{r+1} \text{ cosec } \theta}{12000}$	... ... $\frac{32571}{12000} = 2{\cdot}7$ sq. ins.

METHOD OF CALCULATION—*cont.*	EXAMPLE WORKED OUT FOR 40 FT.—*cont.* GIRDER LOADED AS ABOVE—*cont.*
Web Planking.—Average resistance of fir to shear = 300 lbs. per sq. in. *Thickness "f."*—Then "f" × available depth of girder × 300 = R_1 = K.	Available depth = 60 ins. – 10 ins. (approx. depth of boom) = 50 ins. say. $f \times 50 \times 300 = 26400$. $f = 1\frac{3}{4}$ ins. *I.e.* 1-in. planking on *each* side.
Bolts.—Resistance of fir = 1200 lbs. per sq. in. Hence number of bolts × diameter × f × 1200 = K.	Take $\frac{3}{4}$-in. bolts. Number × $\frac{3}{4}$ in. × (2 × 1) × 1200 = 26400. Number = 15.
Nails.—Assume a 6-in. nail has a holding power of 300 lbs. Number = $\frac{K}{300}$.	$\frac{26400}{300} = 88$.

THE JUNCTION OF THE INDIAN AND RUSSIAN TRIANGULATION WORK IN THE PAMIRS.

(Continued).

THE JOURNEY TO THE PAMIRS.

By LIEUT. (NOW CAPTAIN) K. MASON, R.E., *Assistant Superintendent, Survey of India.*

Though the route to Gilgit is well known, it will be perhaps not out of place to describe our journey which was made at a very early time of year when the conditions were very different to those generally experienced in July. We were compelled to start at the earliest possible date so as to take every advantage of the short season during which triangulation is possible and to ensure the due completion of the work.

The detachment may be said to have commenced its journey to the Pamirs from Rawal Pindi, where it left the railway, and took to the road. The party was not yet fully concentrated as Messrs. Collins and McInnes had permission to join at Bandapur and delay had occurred in obtaining sanction for the employment of military signallers from the 9th Gurkhas stationed at Dehra Dun. The morning of the 13th April was spent in loading up the six bullock carts of kit and equipment, and the carts were despatched on their journey of 164 miles to Baramula the same evening.

The next morning we followed by motor, and completed the 198 miles to Srinagar in two days, halting for one night at Domel. The road is too well known to need description, but the luxury of a motor is a great improvement on the old uncomfortable method of travelling by tonga and adds a great charm to one's appreciation of the scenery.

The days which passed in Srinagar while waiting for the heavy transport were busy ones. There were still many things to be bought, and most of my warm and mountain kit had to be gone through, as I had left it in Srinagar in 1912, and it was an anxious time waiting for sanction for the signallers. On the evening of the 19th, the detachment was joined by two Gurkhas on furlough belonging to the 5th Gurkha Rifles at Abbottabad, kindly placed under my orders by Colonel Bruce. Once before, in 1911, I had had two of this famous regiment of mountaineers with me, Kulbahadur and Logbahadur Gurung, and had always found them indefatigable and untiring, and I had learnt to appreciate their fine qualities. The

two men who now joined me, Kulbir and Hastabir Rana, whom owing to their outstanding characteristics I always connected in my mind with a "rugger" half back and forward respectively, were extremely good and energetic and never once showed the slightest signs of distress or weariness. I can testify that they left an impression of cheerfulness on the whole camp under the most adverse circumstances. Like the men from the 9th Gurkhas, they never failed to set an example of cleanliness and discipline to the motley crowd of mixed races that generally comprised the camp, and one retained the impression throughout, that they were fellow workers and comrades, and that one could treat them as such.

During our stay in Srinagar, Drs. Arthur and Ernest Neve were exceedingly kind in giving us hints, and Mr. Mitchell, who probably knows better than anyone living of the joys and otherwise of the Gilgit Road, having helped to make it some 25 years ago, very kindly made suggestions as to the time we ought to cross the Burzil Pass. We were also the recipients of much kind hospitality from the Resident and Mrs. Stuart Fraser, the former of whom had officially written through to the local authorities requesting them to lend us every support. Without this consideration, it is hardly necessary to add that the progress of the detachment would have been impossible.

On the 25th April, we embarked on *doongahs* and made our way down the Jhelum and across the Wular Lake to Bandapur, which we reached on the following afternoon. Bandapur is the southern terminus of the Gilgit Road, and here all the kit had to be weighed, and arranged into coolie loads. That some forethought was necessary at the start may be gathered from the fact that during the expedition the following methods of transport, ranging from the most modern to the most primitive, were employed; (1) train to Rawal Pindi; (2) bullock carts and ekkas to Baramula; (3) boats to Bandapur; (4) coolies to Gudai; (5) ponies to Gilgit; (6) mules, donkeys, ponies and coolies to Murkushi; (7) yaks over the Mintaka Pass; and (8) yaks, camels and coolies on the Pamirs.

On arrival at Bandapur, we found that our heavy baggage had arrived the same day, and on the following morning we unpacked and laid out everything at the ghât and arranged loads. The same day we were able to send off the heaviest loads in advance, and during the evening Messrs. Collins and McInnes arrived and we made final arrangements for the journey. It had been decided that the detachment should proceed in two main squads, in order to give more room in the huts and bungalows *en route* where the accommodation was very limited and to make it easier to obtain the necessary transport, which was abnormally heavy. The two squads were to be separated by an interval of six days; this would give time for the dismissed coolies returning empty, to help with the transport for the second squad. The deciding factor in the fixing of the

interval was the length of the Gurais to Gudai stages, as the Gurais district is only sparsely inhabited. The other alternative was to take coolies through from Bandapur to Gudai which would have meant rationing them; and it must be remembered that coolies who live within easy reach of a pass like the Burzil are infinitely better than any who come from a distance, and to whom the districts of the Gilgit Road when under snow recall the miseries of the days so well described by Knight in *Where Three Empires Meet*. Hingston and I were to go with the first detachment and McInnes was to bring along the other. Collins was to go on ahead as fast as possible with only his necessaries to Hunza, to commence the purchase of rations for the whole party.

On the 28th, the first detachment left Bandapur. Lieut. R. Blandy, of the 9th Gurkhas, had obtained permission to accompany us as far as the Pamirs, where he intended to shoot ovis poli, and he kindly undertook the charge of the messing during the journey. We were also lucky in being able to engage Abdulla, a Kashmir shikari, who has had great experience in handling coolies. He was trained by Dr. Neve, and is now fairly conversant with rope work on snow and rock. In 1909 he was chief coolie jemadar to the Duke of the Abruzzi and since then had been with me for three years. He was one of the party on the first ascent of Kolahoi, and a man one could trust.

For some three weeks the weather in the north of Kashmir had been very bad, and we had reports and expectations that the passes would be deep in snow. The evening of the 28th found us at Tragbal, and though ready to start at 2.30 a.m. the next morning, we did not get away behind the last coolie until 4 a.m. We were caught in bad weather on the Rajdiāngan Pass, "The Dancing Hall of the Kings," about 12,000 ft. above sea level, and reached Gorai in the afternoon. Owing to the thickness of the falling snow and the impossibility of seeing far ahead on the pass, I was compelled to take off my skis and one was lost by the Gurkha who carried them. He apparently slipped and fell, and the ski disappeared down the snowy slope, where it would have been useless to follow it as it would have been covered up by the snow and lost before anyone could have found it; it had therefore to be abandoned. Being one of my best pair from Switzerland, it was rather a disaster, and I had to fall back on my spare English pair which were much heavier. These afforded some pleasant running down the valley to Gorai, but though I had crossed the pass on six previous occasions, the uncertain and misty light made small inequalities in the ground impossible to define, and I took a fair number of tosses.

On the 30th April, the weather was fine, and we had a very pleasant march to Gurais. After reaching the Kishenganga River and crossing it at Kanzalwān we turned eastwards up the valley. The scenery here was exquisite; the dark pine forests on the opposite

side of the valley were slashed with white streaks of avalanche snow. Every bend in the road brought some fresh loveliness in view, and the idea created in the imagination was the perfect harmony of the lights and shades, the colours of the trees and snow.

On reaching Gurais, we called at the telegraph office for any telegrams that might have arrived, and here learnt that the Gilgit mails had been held up for six days on the Burzil Pass. Shortly after arriving at the bungalow, Lieut. H. Whitaker, of the Rifle Brigade, came in. His intention was to shoot in the Astor district, but he was held up for want of coolies. We arranged to move on together, and now our leading detachment numbered over 180 all told. Before starting on the 1st May, a load which had been left behind in the dark at the Tragbal bungalow, arrived. The coolie's performance is worth recording. The load was not missed till our arrival at Gorai, and one of the coolies was sent back to bring it up. Between the hours of 4 a.m. on the 29th April, and 4 a.m. on the 1st May, he had crossed the Rajdiāngan Pass three times, and marched 54 miles in 48 hours, of which 41 miles were accomplished with a load of 60 lbs.—an admirable performance. Surely this is sufficient testimony that even the despised Kashmiri can rise to an occasion when required.

On this day we marched to Peshwāri, just before reaching which place Whitaker came across a four-horned sheep. I was unfortunate in breaking my thermos flask on this march, which I rather treasured as a memory of gay days at Mürren. In stooping to examine a rock the flask which was slung on my back slipped round and struck the ground.

It snowed most of the night we spent at Peshwāri, and as there was very little room in the rest-house buildings some of the coolies preferred to go to a village some 2 miles away. In the early morning the hills wore a mantle of cloud, and the coolies at first refused to stir. By 5.20, however we were away behind the last coolie load. The clouds had cleared, and everything promised a gorgeous day; the new snow of the night before left an exquisite covering on the trees in the valley, and the delicate softness of the snow-stunted birches called forth our admiration. In the early hours of a perfect day, the sublime loveliness of the lacelike tracery of snowladen birch and pine and the filmy transparency of the ghostly vapour clouds rising on the opposite side of the valley, were indescribably beautiful.

Rounding a bend and glancing back, the eye was caught by a small flame-coloured cloud, tinted with the first rays of the rising sun. Suddenly a snow-covered mountain seemed to rise up behind us, rose-coloured, holding us spellbound. Higher the sun rose, and each glance in every new direction seemed to create new sensations. Never had I seen such an exquisite softness, and never, I hope, shall I lose the impression that it made on me.

We had numerous dead avalanches to cross before reaching Minimarg telegraph station, the highest in the world kept open all the year round. A mile before this the coolies had a narrow escape from an avalanche, which fell between them, cutting off the leading five from the remainder. Owing to our late start, the snow was now getting soft, and as it was deep, there was much plunging amongst the coolies before reaching the shelter of Burzil Chauki. On this occasion my skis were of the greatest assistance to me and prevented me from sinking in, but the numerous avalanche crossings were somewhat tiring.

A night crossing of the Burzil Pass was imperative at this time of the year, particularly as the huge Dam Singh Patthar Avalanche had not yet fallen; and after a short rest the coolies were again moved off at 11.30 p.m. by lantern light. The presence of 180 souls in two huts was not conducive to the height of comfort, so we were all ready for the start. The summit was reached by dawn, the slow progress being attributable to the exhausted state of the coolies who often dropped off to sleep during their frequent halts; this necessitated going round at every halt with a lantern to wake them up and make certain that none were left behind.

My descent of the pass on ski left a lot to be desired, and I came to a bad end at the foot, mainly I prefer to think owing to the hard icy surface of the snow at this early hour. We marched to Chillam Chauki about midday, and most of the coolies arrived the same evening, while the remainder spent the night at Sirdarkōti Dāk Hut. On the 4th we continued the march to Gudai, through a wilderness of white loveliness. Shortly before reaching the bungalow, and after the most impressive scenery imaginable, we had an exquisite glimpse of Nanga Parbat, a sweep of the frailest azure, which even at this distance appeared Lord of the landscape, supreme and unchallenged. On arrival, Hingston attended about 20 cases of minor frostbite among the coolies, the result of crossing the pass with wet feet.

At Gudai we changed transport to ponies and took a day's halt to pay off the coolies and rearrange loads; and on the 6th marched to Astor. After about 3 miles the road crosses to the left bank of the river, and some 5 miles further on recrosses to the right. Up to now the formation had been granite, but just before recrossing we passed some very soft sand rock, finely grained and stratified, evidence of a former life of the Astor River. There were some remarkable alluvial terraces after this, and after again recrossing to the left bank at Gurikōt, we reached Astor about 4 p.m.

The formation here is on a grand scale. Everything is thrown back so that the view is taken in from an immense distance. Astor itself and several patches of cultivation are situated on old levels of the river. The scenery is grand—grander and more rugged and unforgiving than any we had passed till now—savage where before

it had been soft. The people, too, are in agreement, harder featured and less tame than on the Kashmir side of the Burzil,—in fact the passage of the pass had brought us to a new country, different in scale, in beauty, and in its inhabitants.

On the 9th we marched to Dashkin, and on the next day reached Doyan. The road, after Dashkin, winds up a spur, and on rounding it, we had a fine view of the road keeping to a gentle gradient for some miles. The scale was immense, and it was hard to become accustomed to it. Shortly after this, the road entered the Mishkin Forest, which, with its thick shade and breeze of "softest influence" reminded one of Dante's celestial forest on the way to Paradise. The extraordinary contrast of this charming stretch to the barrenness which we had been passing through, made one realize the truth of Colonel Durand's eulogy in *The Making of a Frontier*. Here, too, I heard a pheasant call.

Suddenly a thunderous roar on our right was heard, and on looking across the valley, an immense cloud of dust and débris was seen to rise. A huge fall of rock had occurred, caused by the sun's rays thawing the ice in the rocks. The southern faces of all these mountains must be eroding very fast, as such falls occur very frequently. Later a smaller fall occurred. The roar of these echoes and re-echoes for fully a minute. A little further on our attention was rivetted on a very fine peak, a true peak it seemed, in the sense that even Ruskin would have allowed. We were told that its name was Ditzil.

On crossing a spur, the vastness of the landscape fairly staggered one. Far away to the west one could see the Indus shimmering in a heat-haze. Winding down our side of the river ran our road, with the Doyan bungalow some 3 miles away. This, owing to the immense scale, seemed but a mere stone's throw. One could imagine in the purple distance the great knee bend of the Indus, cutting its way through the Ladakh Range, and far, far away one could faintly trace the Gilgit Valley approaching its giant neighbour. Away to the right of this, suddenly the summit of Rakaposhi or Dumāni, the Mistmaker, came into view, with her perpetual cloud of snow dust—the only cloud on this perfect day.

It is 18 miles from Doyan to Bunji, but some of this is avoided by going straight down to the Astor River and omitting the zigzags of the road. Some 5 miles after leaving the bungalow, the road cuts into the cliffs of the famous Hatu Pir—one of the most expensive portions of the whole route. By a series of seven zigzags, it ascends a nearly perpendicular cliff over this outlying spur of the Nanga Parbat massif, and on the west side again descends in wide sweeping zigzags to the river at Rāmghāt. A fine view is obtainable from all this part of the road, but to appreciate fully the vastness and grandeur of the landscape, and as Major Bruce writes, "to educate one's sense of scale" one should ascend to

the top of the hill behind Doyan, a trek of about three hours on a hot day.

Knight, in *Where Three Empires Meet*, gives an awful picture of the miseries of this portion of the road, before it was completed. He writes of the skeletons he passed and of the terror of the coolies. These days are over now, and a 10-ft. road, the masterpiece of the whole route, takes the place of this Golgotha, and makes the journey as near as possible a pleasure.

Colonel Montgomery mentions that in December, 1840, part of the Hatu Pir fell into the Indus, west of Nanga Parbat and formed a dam 1,000 ft. high. A lake formed behind this dam reaching almost to Gilgit 40 miles away. The lake rose 300 ft., and for six months continued to rise, being held back by this natural dam, which it finally burst, and emptied itself in one day, doing an immense amount of damage down the course of the river. A Sikh army in camp as far down the river as Attock was wiped out, "as an old woman with a wet cloth sweeps away an army of ants"; whole villages were destroyed, and all down the Indus the country was laid desolate.

The gorge of the Astor River where it debouches from the mountains to its confluence with the Indus is very striking, and one crosses it by a fine suspension bridge above Rāmghât or Shaitan Nāra, the Devil's Bridge.

From here to the oasis of Bunji is nothing but a waterless waste —a "crumpled Sahara" as Sir Martin Conway not inaptly calls it. But a fine and wonderful Sahara. Owing to the terror caused by raiding and slave dealing Indus Valley tribesmen, the Bunji Plain has never been repopulated since the disaster of 1841. The new scheme, being carried out by Capt. J. F. Turner, R.E., for bringing a *kul* to irrigate the plains higher up, will turn that part near Safed Parri into a green and fertile land, and if, as has been suggested, the same is done between Bunji and Pertab Pul, and State aid is allowed to returning families, even this stretch of magnificent desolation will become a thing of the past. None of us could grudge a day or two of this, a change in the wonderful scenery of this wonderful road. At Bunji we were handsomely entertained by Lieut. Cole, R.A., who was stationed there.

It was more like the beginning of a good hot weather in the plains than anything else on earth, and we all slept out of doors. Later in the year the Bunji Plain becomes a frightful furnace of almost red-hot sand, which hardly cools at night and on which one cannot bear to rest the hand. On the 10th May, Cole again invited us to breakfast, after which we rode some 6 miles to the Pertab Pul, where we crossed the Indus. Here we said good-bye to Whitaker, as the road to his shooting grounds left our route. He was a great loss to us, and we missed his advice and cheerfulness very much in the days that followed. I could not help wishing that he could have stayed

with us for the whole trip, for he is an ideal traveller, and one who can always see humour in any situation.

We spent the night in the white bungalow of Parri, and on the next day marched to Gilgit. The last few miles which passed through an avenue of willows were very pleasant travelling, and on arrival we found that Major Macpherson, the Political Agent, had kindly pitched tents for us in the Agency Gardens. We halted some days at Gilgit and these were full of work. Collins went on and McInnes came through and also passed on. Equipment, which had been left in store here from last year, had to be taken over, tents and kit repaired and finally a depôt and office established here. A point in the arrangements which we had overlooked, but which was remedied on the suggestion of a local tailor, was the necessity of one of his trade to accompany us to repair tents, etc. We engaged one Shukra, who carried a light load on the march, and about every other day or so kept the tents in repair. This is the only method of keeping them fit for habitation in the sort of climate we had to expect.

We had to dismiss our ponies as Gilgit could not support them even for so short a period as a week, and difficulties were met with in obtaining fresh transport. However, with a mixture of mules, ponies, donkeys and Balti coolies, we moved away on the 17th. Major and Mrs. Macpherson were very kind and hospitable during our stay in Gilgit, but much of their hospitality we were obliged to decline owing to the necessity of pushing on. Our detachment was in camp near the graveyard, below the Treasury, in a delightfully shady garden known as Hayward's Bagh, and we took the opportunity of visiting Harry Bell's grave. He is buried next to Hayward, the intrepid Himalayan traveller, who was murdered in Yasin and finally brought in to Gilgit and buried there. Capt. J. F. Turner, R.E., kindly took charge of the memorial stone, which I had brought from England, and undertook to build the monument desired by his people.

On the 17th May we spent the night at Nomal, and the next day reached Chalt. The road is still wonderful—" a knife-scratch across the harsh face of desolation, whose dominant features of rock and stone and sharply jutting spurs were unredeemed by the least suggestion in outline and tint." Perhaps so, but though slightly wearisome there was always the splendour of some wild crag, or some fascinating virgin peak to engage the attention. It is between these places and in the desolate gorge through the Kailas Range, that the Hunza River cuts its way across the main axis. And now one could realize the extraordinary achievement accomplished during the Hunza-Nagar campaign when a field force was taken through this defile, before this road was completed. One had only to see the road and the numerous discarded remnants of road to realize the anxiety of having to keep this kind of country open for communi-

cations, with enemies on all sides and in rear, and only to glance at the famous Chaichar Parri to realize the key to this defile on the north.

The 19th was another perfect day, and another which will be difficult to forget. Not half a mile from Chalt the attention is rivetted by the spear-shaped summit of Rakaposhi, or Dumāni as it is called on the Kanjūt side. It was unearthly, ethereal, sublime. Miles of glittering ice and snowclad slopes, leading to its sunlit crest, seemed ready to thunder down destruction on anyone daring enough to attempt an ascent.

"Such things are not to be seen lightly, nor would one wish that the toil and the trouble could have been abated. The memory of these wonders of the earth is a priceless possession, none the less precious because one has waited and endured somewhat to obtain it. A lasting regret there is—that one has seen these things, and must remain for ever inarticulate. It is one thing to see a pale white shape, faintly gleaming against the blue sky, and quite another thing to express the grip it takes of the heart and of the imagination. A stony, colourless plain, and, far beyond, a dim shaft of light like a broken spear projecting above the horizon. Yet how much is suggested—a vast bulk hidden from view, long miles of snow-clad slopes, immeasurable cubic yards of green ice, the covering the accumulation of centuries, the thing itself a monument to some convulsion of Nature, dating back into years beyond comprehension. A thing of perfect serenity, looking down on a world with placid calm; yet one knows how the wind rages among its pinnacles, and how the storms of winter howl like wild beasts in its ravines. The mother of rivers that nourish millions of humanity, the progenitor of floods that wipe out human endeavour as if it were writing on a slate. A jewel in the sunlight, and a terror in the darkness. Its head poised in the uttermost limits of the air we breathe, its feet in the bowels of the earth, where are generated the catastrophes that shake the world."

Thus writes David Fraser, and no lines could better apply to the entrancing vision we beheld that morning.

It is difficult to believe that until some 20 years ago this romantic valley was the scene of perpetual strife and petty wars, Hunza and Nagar always at war with each other or combined against some common foe, in protection of their lands. If only the Mistmaker could tell us of the horrors, of the murders, and of the miseries of the old slave days, we should hear a history of tears and weeping. Then came the Russian tentacles, Capt. Gromchevtsky and his Cossacks, and the "slamming of the door"; the British advance, the storming and taking of Nilt Fortress and of the almost impregnable position beyond.

We made a long détour up the Burdelas Nala and down again by its left bank. For a time our "jewel in the sunlight" was hidden

and then we had one perfect view as the mistladen vapours rose and covered her.

Crossing the river at Sikanderabad to the Nagar side, one immediately enters the land of forts. That of Sikanderabad itself crowns the *parri* guarding the bridge. Under the shadow of this we passed, and some 3 miles further on came suddenly on the historic fortress of Nilt.* Kulbir and Hastabir were very interested in the deeds of their fathers, and I tried to explain to them the part the 5th Gurkhas took in the capture of the stronghold. The remains of the blown-up gate are still visible and the rabbit warren of dwellings within still inhabited. After Nilt Fortress came Thōl Fort, and then Gulmat —every village a regular stockade. Yāl Fort and that of Pisan follow in close succession, both at the foot of glacier valleys sweeping down from Rakaposhi. Lastly we arrived at Minapin after a march of 21 miles, and put up at the bungalow.

The 20th was a busy day. After sending off the camp to Aliabad, we visited the Minapin Glacier, which had been measured by Mr. H. H. Hayden, of the Geological Survey, in 1906. This was remeasured and the results will be found in Chapter VII. The march on this day rather lacked shade until we crossed the Hunza River to the right bank, after which the views became indescribably beautiful. Shortly before reaching Aliabad, we diverged up the Hassanabad Valley and examined the snout of this glacier and Mr. Hayden's marks.

The Mir of Hunza and his retinue of scallywags were awaiting us at Aliabad, where for the first time the whole detachment was concentrated. Two busy days followed, sorting out the various kit, and distributing the equipment to the three detachments, and on the 22nd a visit was paid to the Mir in his castle at Baltit.

The enormous amount of energy and skill spent on the original laying out of the cultivable terraces of Hunza strikes the traveller at once, the whole consisting of small fields of land, built up and retained by carefully made and picturesque walls. It must have taken centuries to retrieve all this land for cultivation, and an engineer of no mean powers to lay out the fields and plan their irrigation. Two canals were originally made, but that which took off from the Hassanabad Glacier below Aliabad, and which was brought back some miles along the cliff, has been put out of action by the sudden advance of the glacier some years ago, and it is almost heartrending to see the remains of the old terraces, built up with such care, now lying desolate.

The Hunzakūts were very short of agricultural implements, and I was tempted to write for sanction to sell our large stock when the work was finished, as their actual worth would not really balance

* For an official history of this campaign, see *Frontier and Overseas Expeditions from India*, Vol. I.

the cost of their carriage down the road, while if left here they would be of great use and highly appreciated.

At Aliabad we decided on the strength of each squad, and enlisted the permanent coolies. Amongst those I took with me to the Pamirs, I included 25 Baltis, selected men, whom I knew I could trust. The Balti, being Shiah Mahomedan, does not employ the Ladakhi custom of polyandry to check the increase of his population, but on the other hand has decided polygamous tendencies, with the result that his poor country cannot afford to support the entire population, and emigration is the only alternative. They are the most faithful and trustworthy coolies in the world, will do anything they are told to do, unless fear takes hold of them; and they are extremely hardy and can withstand an enormous amount of cold. They are a race of children, and look on their employer as their father; and it is easiest to get them to work well if one treats them as such and looks after them carefully. The Kashmiri coolie requires a totally different treatment; he is a servant, knows he is a servant, and must be treated as a servant, or else he will impose on his master, sham illness on every possible occasion, and will give endless trouble. Again, the Kanjūti of Hunza has to be treated differently. He believes in Liberty, Equality, and, if it pays him, Fraternity. He requires it to be known that his master places implicit trust in him, admires his manly qualities and bearing, and treats him as one on a higher social plane than the rest. He will then live up to the standard required of him; he is a wonderful mountaineer on rock, and the best of them would probably never own defeat in this particular form of climbing, though they are not so reliable on snow and ice.

On the 23rd, after some preliminary troubles, the Pamir squad moved off. As has been mentioned in Chapter I., the arrangement was that I should travel straight to the Russian stations, and from there work back to the Kilik Pass; for Collins to work up the Hunza and Chapursān Valleys, while McInnes commenced by reconnoitring the country between us. The road ceases at Hunza: beyond it degenerates into a rough track impassable to ponies. In places it consists of stones laid on pegs driven into the face of the cliffs, but after passing Mahommedabad, we found that we were still able to use the winter route and to come down to the river bed. The gorge is very grand and rugged, and we occasionally had to climb *parris* or cliffs to avoid stretches of the river. A few of these with which to finish the march brought us again to the river bed below Atabad, where camp was pitched for the night.

The next day the detachment marched to Gulmit. For part of the way we were able to keep to the valley, as the Hunza River had not yet risen to its summer dimensions, and we were able to avoid the appalling *parri* at the beginning of this march, which greeted us on the return journey. Several of the strips of the "road" were

however distinctly interesting, but none quite so nerve-shattering as we had been led to expect. Near Bulchidas and opposite the Brondibār Nala, the track rises steeply over the Salāmitas Parri, and in places barely exists; from the summit of this *parri*, a very imposing view was obtained of the Shoonuk Mountains beyond Pasu.

At Gulmit I was able to obtain Harry Bell's ovis poli head, which had been brought down during the cold weather, and which I eventually despatched to his father in England. Here also the Mir had a large storehouse, where we had arranged to take over 60 maunds of *ata*. After weighing out and sealing up the bags, we left on the 25th for Pasu, and passed the snout of the Sasaini Glacier, which at present approaches to within about 300 yards of the left bank of the Hunza River. The track here climbs on to a tongue of land on which is situated the village of Sasaini, and then crosses a broad belt of slates at the top of which is Baurit. From here one sees a long lateral moraine placed high on a solid cliff foundation, which must have been formed when the Pasu Glacier advanced far into the bed of the Hunza River.

The next day's march took us across the large Batūra Glacier, which is said to be about 20 miles long and 1½ miles broad. We did not have time to go down to the snout, which we were told runs well down into the Hunza River. The track crosses it about three-quarters of a mile from the snout and the glacier is here cut up somewhat by transverse crevasses, which, however, were closed up and presented no difficulties.

Almost directly opposite the Batūra Glacier the famous Shingshal River meets the Hunza. This was one of the main raiding routes of the Kanjūtis in the days when they used to raid for slaves into the Valley of Raskam, which they completely depopulated. We reached Khaibar about 3.15 p.m., and found the lumbadar and his very old father awaiting us. The latter, who gave his age at 100, was easy to draw out on the subject of his wild youth. Four times, he said, he had raided for women, but though his eyes glistened at the memory of the good old days, he admitted that he was glad of the Pax Britannica in his old age.

The village of Khaibar is seemingly quite impregnable. A stream has cut its way down the mountain side to the south, and a zigzag path winds up to the fan on which the village is situated. At the top of this track, there is a gate with a mud citadel called the "*Darband*." In former days the garrison used to drop down rocks from here on to the heads of intrepid attackers below. This is the defence on the south side. On the east the fan drops sheer down to the river beneath, forming an unscalable wall on this side. On the west the hillside is fairly difficult, and on the north there is a *darband* similar to that on the south. Our centenarian friend said that he could not remember on how many people's heads he had

rolled stones, as he had not kept a *hissab*, but certainly very many. Here we managed to purchase six more maunds of *ata*.

On the following day we marched to Gircha. About a mile after leaving Khaibar we crossed to the left bank of the Hunza River by a fairly substantial bridge. The march from here to Gircha was easy, a total of only 10 or 11 miles. During the afternoon the signallers showed their mates how to show a steady light for observations, and I put in some time cleaning and adjusting the theodolite. Hingston went off to look for fossils, but without success, and in the evening we weighed out and sealed up another 60 maunds of *ata*.

On the 28th May the march was somewhat more tiring. After an easy march to Sōst, we dropped down to the river bed, and were able to avoid some bad *parris*. Here the Chapursān River joins the Hunza, which above the junction is much smaller. Between here and Misgar, we had to ford the river ten times in all. The men of Hunza and Little Gujhāl are the most powerful forders I have ever met. I was not a little surprised that the men, though Mahommedans, "girt up their loins" to above the waist, took off their bifurcated habiliments and crossed very nearly in a state of nature; but I see in Colonel Durand's *The Making of a Frontier* that the Chitrali footmen shocked his Pathans very much "by rolling up their voluminous skirts, taking off their *paijamas* and fording stark naked." Colonel Durand adds that they are the only Mahommedans he has ever met with who will do so unashamed.

The first seven fords were comparatively simple, though one pony fell and gave a Hunza levy a ducking. The eighth was more difficult, the Hunza River running swiftly through vertical walls, the gorge being cut by the combined influence of the Kilik and Khūnjerab Rivers which join just above. Two more easy fords after this, with the intermediate road near the river bed brought us to a large conglomerate flat, after traversing which the track wound down to the river and crossed by a bridge a mile short of Misgar. It then winds up to the corresponding flat on the other side, and on this is situated the village. The level of these flats evidences the top of the deposit laid down formerly by the Kilik River, which has since been rejuvenated, and has cut its bed down again through a depth of some 360 ft.

Shortly after our arrival in camp, we were visited by a cyclone of terrific violence. One double-fly tent and two of the khalassie's tents were levelled and one coolie "wigwam" in the course of being erected was blown inside out, and the framework was smashed. The cyclone was followed by heavy rain.

High up in the cliffs above Misgar, there are some curious old caves. Hingston visited these by being hauled up on the rope; he found them to be of artificial construction, and though he dug up the floor he could find nothing of any interest. They were of enormous size and were capable of containing 100 men with ease. They

appear to have been used as hiding places during the old inter-tribal raids. Anyone trying to reach the entrance had a stone flung at his head, and they were probably quite impregnable so long as rations lasted.

On the 29th May we marched to Murkushi, the road gradually descending to near the river bed. A very cold wind was blowing as we reached Tōpkhāna, near which place the Derdi stream enters by the right bank. Tōpkhāna consists of a single small square look-out, again reminiscent of the old fighting days.

Strictly speaking, the Chapursān River, and not the Kilik or Mintaka should be considered as the head-waters of the Hunza. The Chapursān lies in the longitudinal trough between the Karakoram and the Northern Hindu Kush, which latter range has been cut back into by the Kilik and Mintaka, and the Chapursān is longer by many miles than either of these two streams, which should be properly considered as only subsidiary tributaries. The Ghūjerab and Khūnjerab, though only very imperfectly explored, lie also in this trough to the east. A curious point about the nomenclature of the rivers in this district must be mentioned to avoid confusion. On both sides of the Kilik Pass, the rivers flowing from the watershed are called the Kilik River, that on the Pamir side being generally designated "Jilga." Similarly at the Mintaka, Kharchanai, and Khūnjerab Passes.

Considering the Chapursān as the source of the Hunza River, geographically speaking it possesses one of the most curious attributes of all rivers of the globe. Its waters cut through seven ranges. Rising south of the Northern Hindu Kush and Northern Karakoram Ranges it flows eastwards in a longitudinal trough till it meets the Khūnjerab, flowing in the opposite direction, and in the same trough. At this point it bends southwards at right angles, and the combined waters attack the great Karakoram and cut their way successfully through the solid granite of this stupendous range, in one of those magnificent gorges so typical of this great barrier scenery. South of the Karakoram axis, on being joined by the Hispar, which drains the longitudinal trough between this range and the Kailas Range to the south, the river flows westwards of Chalt, where it again bends south through a right angle, and attacks the Kailas Range, cutting it at the striking gorge of Chaichar, 9 miles west of Rakaposhi, 25,550 ft., the bed of the river being at a height of only 6,000 ft. above sea level. The Hunza River continues southwards through this range to within a few miles east of Gilgit, where it is joined by the river of that name, which has drained the westerly trough between the Kailas and the Ladāk Ranges. The combined waters of these two rivers now flow for some 30 miles in an easterly direction, where they meet the great Indus, which, as becomes a river of this magnitude, has undergone two successive struggles with the Ladāk Range already, and which now, with the aid of the Hunza

and Gilgit Rivers, attacks the range for the third time. South of the Ladāk Range, and below Bunji, the Indus is joined by the Astor River, draining the Ladāk–Himalaya trough, and cutting its tortuous way through the Himalaya, west of the mighty Nanga Parbat, and through the lesser ranges to the south, it flows unconcernedly to the sea.

The march to Murkushi was desolate in the extreme. A few—very few—trees, and for the rest, huge granite boulders and river-cut conglomerate, possibly the remains of an ancient Pamir. At Rumhil 11,680 ft. above sea level, another oasis of trees near the river bed was passed, which scarcely merits a place on the map. Murkushi itself is more deserving of honour, though one scarcely realizes this fact on the outward journey, but only when one has been without the sight of a tree for a couple of months.

At this place we had the pleasure of renewing our acquaintance with M. Reweliotty, the Russian Consul-General, who was passing through on his way to Russia by way of the Pamirs, and with whom we had a hare shoot. Here we were delayed by trouble with the yak-transport, and on the 30th May spent the day paying off coolies and making up accounts to the end of the month.

The following day, we completed the short half march to Boihil, while our permanent coolies made the journey from Murkushi twice to bring up the remainder of the equipment. At last some very tired yaks arrived and took some of our kit another short half march to Gulquāja, at the snout of the Gulquāja Glacier, where there is a stone dāk hut. Some of the kit had already gone on here by coolies, but some of the *ata* had still to be left at Boihil.

On the 3rd June, at last we crossed the Mintaka Pass on to the Taghdumbash Pamir. As we ascended the pass, Mahomed Beg, the British representative, accompanied by more yaks, was met with, descending on our side, and with these animals most of the remaining kit could be brought up, only leaving some loads of *ata* to be brought up later.

The crossing of the easy Mintaka Pass, some 15,000 odd feet, marked the end of the first stage of the work; and nothing could have been more pleasant than the wonderful scenery we had passed through. It appeared as though Nature had been asserting herself for some final and supreme effort of magnitude, and had failed, and the desolation of the Pamirs was her revenge. We completed the longish march to Mintaka Akhsai, where Mahomed's camp was located, and were soon comfortably installed in his guest khourga—a substantial building of skins and mats laid on a framework of wood, the floor being spread with carpets from Yarkand.

On the following day we established a depôt here, and ascended our first station to reconnoitre.

REVIEWS.

HISTORY OF UNDERGROUND WARFARE.

Being a Review of the book by A. GENEZ, Captain of Engineers, French Army.—(Librarie Militaire Berger Levrault, Paris, Rue Des Beaux-Arts 5–7, 1914. Price 5 francs).

(Continued).

THIRD PERIOD.

The Siege of Candia demonstrated the importance of subterranean defence outside the fortress, and from 1670 all new fortresses had systems of countermines under the glacis, with listening galleries in masonry. Numerous systems were devised, but so far there was no rule for determining the weight of the charge with reference to the direction of its explosion, and to the weight and nature of the material to be moved. With Vauban a scientific spirit was introduced, and under his directions Mesgrigny undertook various experiments at the Siege of Tournai.

From these experiments it was wrongly deduced that however much the charge was increased the radius of rupture was always the same as that of a common mine, the only difference being that the materials were expelled with greater force. This error prevailed for half a century, when Belidor demonstrated the properties of overcharged mines; possibly the effects produced by large mines at Luxembourg and Turin suggested to him the need for further experiments.

At Luxembourg (1684) Vauban directed the siege works, assisted by several Engineers. The principal attack was directed against the Barlemont Bastion, which was itself protected by a counterguard, the escarp wall of which was 13 ft. thick at the base. Behind it was a masonry gallery 10 ft. high and 10 ft. wide. The whole was demolished by 22 charges of 440 lbs. each placed 4 ft. from the exterior face of the wall, and 15 charges of 385 lbs. each placed in the earth behind the inner wall of the gallery, which was 4 ft. thick. These charges must have been 12 ft. to 16 ft. below the top of the parapet, and 25 ft. to 30 ft. apart. The width of the breach opened was about 500 ft., the largest hitherto made by mines.

In 1706, during the Wars of the Spanish Succession, the French besieged Turin, which was held for the Duke of Savoy. The garrison was strong, the inhabitants were devoted to Savoy, and the fortifications had been improved by Vauban, to whom the King wished to entrust the conduct of the siege, but Mme. de Maintenon secured it for her son-in-law, the Duke de la Feuillade. Vauban would first have taken the Capucin Heights, on the east, or right bank, of the Po. They commanded the city, which was situated on the left bank. His scheme was sent to

la Feuillade, but the latter preferred his own, which was to capture the Citadel on the West Front. He had attempted to do so once before, and the Duke of Savoy, forewarned, had recently constructed lunettes in front of the citadel with a countermined glacis in front, had divided the citadel into two parts by a retrenchment, and protected the bastions by counterguards.

The French sent a fine army, with a numerous artillery, eight brigades of Engineers commanded by Tardif, and four strong companies of miners. From right to left the front attacked comprised the Amédée and St. Maurice Bastions of the citadel, with the demilune de Secours opposite the curtain between them covering the Secours Gate, then the Royal Bastion, the demilune of the Susine Gate, and a hornwork protected by a flèche, the last three being a part of the defences of the town itself. The countermines of the defence in front of the citadel were of masonry in two tiers, the upper tier being on a level with and entered from the ditch. There was also an improvised system, constructed since the siege had been threatened, in front of the other works mentioned. Every precaution was taken to organize a system of listeners, arrangements for firing mines, and materials for repairing damages.

On the twenty-fourth night of the siege the French commenced a gallery 50 yards from the Amédée Bastion. Progress was only 4 yards a day owing to the sandy ground and to damage caused by shells, and on 5th July a mine was fired, which did no damage to the countermines, but formed a crater which was crowned. On 21st July another mine was fired 10 yards from the salient of the flèche in front of the bastion, the flèche was carried, and the powder hose leading to the defenders' countermines was cut. Next day the defenders fired a mine, which they had prepared low down in the flèche, and drove off their assailants who, however, recovered the flèche by a counter-attack.

Here the 4th parallel was opened, and shafts sunk to 38 ft., the level of the defenders' lower tier of countermine galleries, which were broken into on 4th August, and the powder hose severed. The defenders erected a barricade which was blown down on the 8th, and the further progress of the besiegers was only prevented by throwing earth and bombs down a ventilator and so blocking the gallery. On the 16th and 27th August the defenders blew up batteries placed to fire on the demilune de Secours, but, compelled gradually to retreat, they prepared countermines under the position of the expected breach, and fougasses in the ditch.

By the advice of Vallières, Commandant of the Miners, the French had commenced two galleries with the intention of blowing in the flèche of the demilune de Secours, but these were discovered, and on the 14th July the Piedmontese fired a countermine which broke up both galleries and buried miners and grenadiers. The air in the galleries was so bad for some days afterwards that they could not be entered again until fresh air had been pumped in by forge bellows connected to tin tubes.

On the 21st July the French blew up a palisade and captured the flèche, and next day discovered a ventilator which appeared to lead to the defenders' lower countermine gallery. Careful investigation showed the possibility of excavating a channel and bringing water about 1,200

yards to flood this gallery. This work was finished on the 3rd August, and the water turned on. On the 9th the lower gallery was opened, and it was found that the inundation had prevented the firing of several mines. However, the defenders had blocked the gallery and not much progress was made.

On the 13th July, before capturing the flèche of the demilune de Secours, the French had managed to find and break into the defenders' upper countermine gallery. They were on a higher level, and lowered three men one after the other, who were shot at once. A man with a shield then went down and managed to place some sandbags to cover the descent of others, and a hot fire was carried on until the smoke made the gallery uninhabitable.

The French had now reached the gorge of the flèche and, after a few mines had been fired by the defenders with little effect, were lulled to a false sense of security in the hope that their inundation of the lower gallery had produced the desired effect. They forgot the upper tier of galleries to which the Piedmontese still had access from the counterscarp gallery of the demilune de Secours. A battery of 16 guns and some mortars was established on the flèche, whereupon the defenders drove four branches under it, on the level of the ditch, from the counterscarp gallery. On the morning of the 24th the French were firing their first salvos, and looking for the early fall of the walls, when the four mines were fired, and destroyed all but three of the guns. The attackers fled, many falling under the fire from the walls. Some of the damage was repaired that night, and on 25th four guns opened fire, two of which were destroyed by a fresh mine. On the night of the 26th an assault was made on the demilune and the two bastions, the counterscarp was blown down, but the escarp had hardly been touched, and the attack failed.

It has been said that the upper countermine gallery was entered from the ditch. A ladder led to the lower gallery. On 29th August four French miners with shields descended into the ditch, and managed to reach the entrance to the gallery. They were killed by the guard, and three more met the same fate. A dozen more followed, and overcoming the guard, obtained possession of the entrance. A mine had been prepared in case of need, and as the guard retired by the lower gallery, the last of them, Pierre Mica, set fire to the hose. The explosion killed him, but also killed all the assailants. A monument was afterwards raised to his memory in the arsenal.

On the 31st August a second general assault was attempted and again failed. During the action the defenders fired a mine under the re-entering place of arms, between the Amédée Bastion and the demilune de Secours, destroying two guns of a 4-gun battery, and almost annihilating two companies of grenadiers, the survivors of whom fled. The remaining two guns were destroyed by the Piedmontese, and one gun which had been blown into the ditch was recovered and mounted in front of the Governor's residence. One of the defenders' mines under the place of arms had failed to explode. This was rectified, and the mine was fired on the 5th September, when two guns which had recently been brought into action were destroyed.

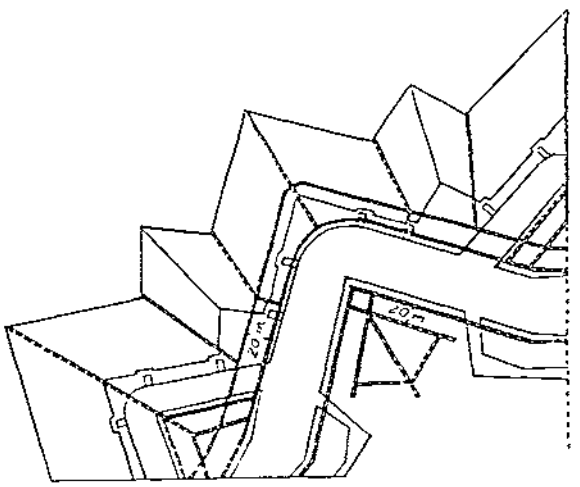
The subterranean battle in front of the Amédée Bastion proceeded

all through the siege, but presents no interesting features. It was less vigorous in front of the Susine Gate and the hornwork. Some mines of the defenders had delayed the attackers' works there, and they concentrated all their efforts against the citadel, which was the key of the position.

At the end of August a French field army, under the Duke of Orleans and Marsin, took refuge in the besiegers' lines, but la Feuillade would not attempt a general assault, and gave time to Prince Eugène and the Duke of Savoy to cross the Po, and attack the field army, which was defeated. la Feuillade tried to intervene, but in vain, and was forced to raise the siege, after destroying his magazines and abandoning his artillery.

It is undeniable that the system of countermines prepared beforehand saved Turin, and although the defenders were short of powder they used their resources to the best advantage. la Feuillade's plan had been anticipated and provided for, and though several engineers besought him to accept Vauban's scheme, he was too proud to do so. His engineers deserve all praise. They sacrificed themselves to secure the success of a plan in which they had no confidence. Vauban himself offered to serve under la Feuillade, but Louis XIV. would not permit him to do so.

Count de Mesgrigny, who had served as an engineer in numerous sieges, was appointed in 1668 King's Lieutenant of the Citadel of Tournai, which was then being constructed. He there carried out the system of countermines which bears his name. The town was defended by a simple enciente, with the addition of a citadel of five bastioned fronts, having demilunes between the bastions, and tenailles in front of the curtains.



System of Countermines of a Front of the Citadel of Tournai.

de Mesgrigny employed two escarp galleries, one close behind the revetment wall from which to advance to meet the enemy and dispute the passage of the ditch. This gallery was prolonged under the tenailles

to prevent the system from being turned. The second gallery was 25 yards in rear, and was intended to facilitate blowing up lodgments formed in the breaches. There were other galleries in the bastions for a step-by-step defence.

In the demilunes were two similar escarp galleries, and the mine defence of the interior was secured by prolonging the main counterscarp galleries. One of these ran under the covered way and the gorges of the demilunes, the second was 25 yards in front of it, and there were listening galleries running out under the exterior and interior angles of the glacis. No bastion or demilune could be taken without being breached, and to effect that the covered way must first be crowned; the second, or outer gallery, was to prevent this crowning. When that gallery was destroyed, the gallery under the covered way would enable the batteries overhead to be blown up, delay the breaching operations, and prevent a descent into the ditch. The only defect worth mentioning was the want of a counterscarp gallery in front of the demilunes.

Tournai was invested at the end of June, 1709, by Prince Eugène and Marlborough. Favart directed the engineering operations. There was no reserve of provisions in the fortress, the garrison of 6,000 men existed on what they could extract from the inhabitants, which was only grain, and the necessity of using water for grinding it prevented the ditches being flooded. The Allies were 50,000 strong with numerous artillery. Trenches were opened on the night of the 7th of July, on the 29th the town capitulated. The citadel held out longer in order to keep a besieging army occupied, and prevent it from joining the field army.

de Mesgrigny was 80 years old, but insisted on directing the operations. He had only 52 miners; the besiegers, under Count de Lottum, had 200 of the Piedmontese who had all served at the defence of Turin. The attack was directed against one front, and half the two adjacent fronts. Early in August the defenders made a sortie, and remaining in the covered way enticed the besiegers over three mines in the glacis, which were fired, and shortly afterwards some of the besiegers' works were damaged by mines.

On the 8th another body of troops under General Schulembourg arrived and attacked the citadel on the opposite side. The countermine defence was so active that neither attack could make much headway. On 13th August de Lottun's troops carried the covered way and managed to enter one of the countermines, where they found, and destroyed or removed, 4 tons of powder, but, in spite of this, explosions of other mines compelled them to vacate the covered way. A similar attempt on the 15th met with the same result. On the 16th the Allies on the opposite front managed to penetrate a countermine gallery and establish themselves there, but were checked by a barricade. This was their first real advance, for not being able to secure the covered way, they were unable to breach the escarp, of which the edge only was visible from their batteries. Their mines had hitherto been of little effect.

On the 19th two battalions were annihilated in their trenches by countermines, and on the 20th several soldiers and miners were crushed in the ditch by the blowing up of part of the wall of the town. On the 23rd the gallery which had been captured by the Allies was blown in.

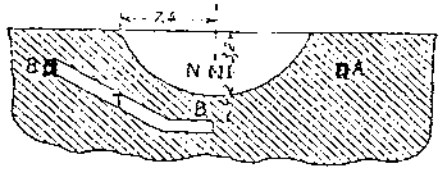
and several miners were suffocated in it. A battery of mortars erected by the assailants between the town and the citadel was next blown up, but a sortie following on this success was repulsed, and the besiegers were only prevented from entering the citadel by the explosion of another mine, which however also killed a number of Hanoverians.

On Schulembourg's side the besiegers now established a battery on the covered way, and as they had previously exploded a mine on the site of their lodgment, considered themselves secure. However on the 24th a portion of the guard in the trenches was blown up. On the 26th the bursting of a mine exposed several countermines, but the defenders blew up part of the ditch on the town side where 800 of the besiegers had assembled. Many of the besiegers' miners deserted, and were sheltered by the inhabitants in spite of the dire penalties which were threatened for such behaviour.

Failure of provisions led to the capitulation of the citadel, and the garrison on the 3rd of September was allowed to depart with the honours of war. The underground war had lasted 51 days, and this lengthy defence, in the face of famine, was entirely due to de Mesgrigny's counter-mines.

Amongst the engineers who have made the corps of miners famous, Belidor is the most celebrated by his efforts to uproot the "invariable crater" myth. He was professor of mathematics at the school of La Fère, and evolved the theory that increasing the charge of a mine increased almost indefinitely the radius of the crater. He called his mines "globes of compression" and in 1725 commenced experiments to prove his theory, which had been vehemently attacked by many engineers led by Vallières, Director-General of the Artillery College.

He dug four shafts, C, D, E, F, 10 ft., 11 ft., 12 ft., and 13 ft. deep respectively at the angles of a square of 24 metres side, and joined their



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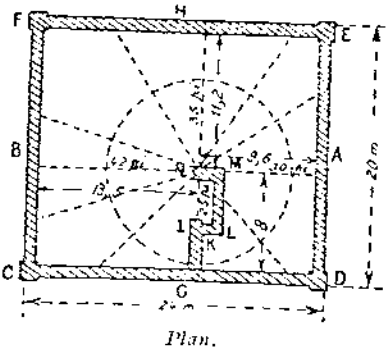

Plan.

bases by four sloping galleries each 1 m. wide by 1·44 m. high. These were lined with oak, and had been excavated in compact clay, except that the bottom of Shaft C was in a wide and deep bed of hard marl. A mine N, 10 ft. deep, was placed at the end of a cranked gallery. The centre of the charge was 8 m. from the gallery CD, 9·6 m. from DE, 11·2 m. from EF, and 13·5 m. from FC. A branch ramped gallery T was excavated having its top 4·2 m. below the centre N. According to Belidor the charge for a common mine should be 100 lbs. of powder; he fired 13,200 lbs. The radius of the crater was 24½ ft., more than double the line of least resistance. All the galleries were staved in for lengths "almost in inverse proportion to their distances from the mine." The gallery beneath was broken in, also the two shafts D and E nearest to the explosion.

The success of this experiment did not convince his opponents, and in 1753 Louis XV. directed that official trials should be made at Bizy. These were carried out, in the presence of many distinguished officers, practically on the same lines as Belidor's, except that the galleries were lined with masonry. The mine was 13 ft. below ground, the crater was 17 ft. deep, and 66 ft. in diameter. The charge had been 3,000 lbs. The galleries were all shattered for nearly their whole length. Little impression was made in France by these experiments, and the celebrated engineer, Delorme, did not profit by them at the Siege of Berg-op-Zoom, but abroad, especially in Germany, the results were received with enthusiasm. Lefevre, who was in service with the Great Frederic, repeated them with like results at Potsdam, and applied them at the Siege of Schweidnitz.

In 1747 a French army under Count de Lowendhal laid siege to Berg-op-Zoom, which had been fortified by Cohorn, and was reputed impregnable. The attack was directed against the front from the Cohorn Bastion to the Pucelle Bastion. Opposite the curtain was a large demilune, flanked by two lunettes. There was a covered way 22 yards wide in front of all these works, which were revetted and had dry ditches. The countermine system consisted of a main counterscarp gallery from which led four listeners about 45 yards long. It was reached by gates opening on the ditch, and by two galleries from the demilune, passing under the ditch. Cut stone troughs had been provided for the powder hose.

The underground warfare presents few features of interest. It began on the night of 26th July (thirtieth of the siege) and by 16th September the counterscarp walls opposite the right flank of the Pucelle Bastion, the left flank of the Cohorn Bastion, and in front of the demilune, had been blown into the ditch, both lunettes had been captured, and there were two breaches in the escarp walls of each bastion, and one in the escarp on the right of the demilune. A general assault through the breaches, by escalading, and by the postern gate, was delivered on that day, and the place was captured.

Four-fifths of the total length of the siege was occupied in crossing the glacis, and as during all that time a violent fire of musketry, guns, and mortars had been maintained, a large proportion of the fatalities of the besiegers may be attributed to the slowness of their works, due to the defenders' countermines. At the same time the sandy nature of the soil presented almost insuperable difficulties to the engineers of the

attack, from a great deal of which the defenders were saved by their masonry galleries. The latter do not seem to have extended their galleries at all until after the commencement of the siege, but, knowing the treacherous nature of the soil, had collected large stores of oak mining cases of a pattern which afterwards came into general use under the name of Dutch cases. It is worthy of note that at this siege the French did not repeat the error they committed at Turin, but took care to clear the enemy out of the ground beneath before they established their breaching batteries. Only the epaulment of one of their batteries was damaged by mines.

A rapid method of sinking shafts introduced by a Capt. Boule was made great use of for reaching the base of the counterscarp walls and blowing them down. A shaft of about 18-in. side is excavated by means of spades, or scoops, shaped like a hoe, with handles from 3 ft. to 18 ft. in length. The earth is dragged out by baskets attached to a rope. When at the required depth a box is lowered filled with 150 lbs. to 200 lbs. of powder, the hose is fixed to one side of the shaft, the earth is thrown back and rammed to tamp the charge, and the mine is ready to fire.

In 1762 a Prussian army under Frederic the Great arrived to recapture Schweidnitz, which had been taken by surprise by the Austrians the year before. Trenches were opened on 7th August. The attack was directed against three of the exterior forts, that against No. 2 being the principal. The forts were of star trace, with dry revetted ditches, and the intervals were organized for defence. A covered way, with a wall outside it, ran continuously along the front of forts and intervals.

Five countermine galleries ran from the three front salients of Fort 2, and from the two re-entrants between them, reaching to beyond the toe of the glacis. Each gallery from the salients branched into three, each of which ended in a tee, and the galleries from the re-entrants also ended in tees. By this means the whole front was embraced. The mine attack was limited to the ground round the central salient system of galleries only.

Under the direction of Lefevre mining began from the third parallel on the 22nd of August, and on the 28th had advanced about 85 ft. when the defenders made a sortie, discovered the entrance to the mine which they filled with bombs, stink balls, and barrels of powder, and blew up. The sortie then retired with several prisoners, from whom details of the mine scheme were obtained. It was calculated that the galleries would pass about 7½ ft. below the countermine galleries, and measures were taken accordingly. The besiegers repaired their damaged gallery, but on the 30th having advanced about 100 ft. had to stop for want of air. It was decided to charge a mine chamber with 5,500 lbs. of powder with L.L.R. of 17½ ft. Tamping was completed on the 1st of September, and the first "globe of compression" was fired. A crater 20 ft. deep with a radius of 42½ ft. was formed. No damage was done to the Austrians, but the crater was crowned, and next day a fresh gallery from it was put in hand. On the 4th of September a small countermine of 165 lbs. powder was fired, but had no effect except to make the Prussians more wary.

The happy idea now struck the Austrians of joining up the T-heads

of their countermine galleries. This much improved the ventilation, and enabled them to work towards the flanks of the besiegers' mines without fear of their retreat being cut off. The Prussians now came across water, and had to abandon their gallery from the first crater and begin a second. On the 9th the Austrians damaged this with 150 lbs. powder with L.L.R. of 20 ft. and 30 ft. of tamping.

Next day the Prussians repaired their gallery, and when they had advanced about 80 ft., came across a branch of the defenders, who, however, contrived to explode a small mine, and destroyed about 65 ft. of the attackers' gallery. Thus 10 days after their first explosion, the attackers had to begin a third gallery from their crater. On the 16th the air in this gallery was so bad that it was decided to charge a second globe of compression of 2,200 lbs. of powder. 40 ft. of tamping was given, the crater was 16 ft. deep, and had a radius of 33 ft., but only one of the defenders' branches was damaged.

From their second crater the Prussians now commenced a new gallery, which was broken up by two camouflets each of 50 lbs. of powder. It was repaired, and another gallery parallel to it was started. These were both destroyed by camouflets on the 18th. Two new galleries met the same fate on the 19th and 20th.

Lefevre now almost lost heart, but Frederic ordered him to proceed again, and drive a gallery under the countermines for a large globe of compression, and a higher gallery to attack the countermines by camouflets. The higher gallery was discovered and damaged by a camouflet of 150 lbs. powder on 22nd, but was recommenced to distract attention from the lower and more important gallery. The latter was only 23 ft. long when countermining was heard on both sides of it. In spite of the short length available for tamping Frederic ordered a return to be excavated and 4,000 lbs. powder to be placed in it. This was successfully accomplished, and on 24th September the third globe of compression was fired, producing a crater 20 ft. deep with a radius of 33 ft. Some of the defenders' branches were damaged, and two of their miners killed, but neither the palisade nor covered way were touched. A great deal of the effect took place backwards, owing to the short length available for tamping.

Excavation was again put in hand, but by the 26th of September the defenders were threatening No. 3 Crater with five mines on the left, and one on the right. At midnight the firing of the latter gave the signal for a sortie, which was pressed with such vigour that the besiegers were driven back into No. 1 Crater, and to their third parallel. No. 2 Crater was crowned against them and all their works between that and the fort were destroyed. The defenders then retired from No. 2 Crater, and on 28th the besiegers began to drive a gallery from it under No. 3. A camouflet fired against this gallery left it unharmed, but a miner was suffocated by the fumes.

On the 8th of October when this gallery was 105 ft. long the Prussians observed a high column of smoke burst from the fort. A small magazine had been accidentally blown up. The only profit the Prussians drew from this mishap was time to charge their fourth globe of compression, which was 25 ft. deep, with 5,500 lbs. powder. The defenders then fired a small camouflet of 60 lbs. of powder which they had already prepared,

but it was too high above the attackers' mine, and did no damage. A larger charge might have breached the palisade of the covered way. The fourth globe of compression was tamped for 52 ft. (twice the L.L.R.) and made a crater 39 ft. in diameter, threw down the salient, and completely demolished the countermine system. The ditch was so filled with débris as to allow of an assault being delivered. Next day the place capitulated.

What especially characterizes this siege is the open and direct advance of the mine attack on one line. The first globe was evidently fired at too great a distance from the fort. It would probably have been better, if, instead of a series of successive discharges, several globes had been prepared at short lateral intervals. There would not then have been the same risk of failure. However this may be, Belidor's globe of compression did not emerge from this test absolutely triumphant, and the reputation of countermines augmented to such an extent that, if the attackers knew that countermine galleries existed on any front, they preferred to confine their efforts to another front, and replace subterranean war by bombardment or blockade.

Besides the systematic establishment of permanent countermine galleries a characteristic of the third period of subterranean warfare is the close tactical connection between the miner and the artillery. Breaching batteries were of short range, and to be of any use at all had to be established as close as possible to the ditch. The certainty of having command over the subsoil was therefore of paramount importance. Neglect of this principle led to various disasters at Turin, while at Berg-op-Zoom the activity of the attackers' miner allowed the breaching batteries to be established in safety. The miner was therefore at this stage an indispensable auxiliary to the siege artillery.

A.R.R.

(To be continued).

THE YEAR-BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1916.—(London: The Wireless Press, Strand, W.C. Price, 3s. 6d.).

The *Year-Book of Wireless Telegraphy and Telephony* is a volume which makes an equal appeal to the general and technical reader. It marks a distinct epoch in the advancement of the practical application of a new science that such a work should be called for, and should experience an ever-increasing demand for each succeeding annual issue. The present is the fourth occasion of its appearance, and the volume has been produced under all the disadvantageous conditions imposed by world-wide war.

Standard information, like the "Progress of Radio-Telegraphy," chronologically arranged, lists and particulars of ship and land stations, laws and regulations of the various countries in which radio-telegraphy is developed, etc., have all been—as far as possible—carefully revised and brought up to date. The text of the International Radio Convention of July, 1912, and the "Safety of Life at Sea" Convention of 1914 are both

reprinted. An important addition has, however, been made to the summarized laws and regulations laid down in the various countries. This addition consists of a well-planned index immensely facilitating ready reference to the sections covered by it. The alphabetical list of call letters allotted to land and ship stations contributes similar valuable aid to ready reference for its own important division of the book.

The practical worker and experimenter have been even more adequately catered for than in former editions of the same work. The Dictionary (in five languages) and Glossary of Technical Terms is, this year, supplemented by a reprint of the Report of the Committee on Standardization which sets forth a list of definitions indicating the sense in which the various terms are employed upon the other side of the Atlantic. A large amount of useful data, selected in accordance with the unique wireless experience possessed by the Marconi Company, figure in the volume, and it is not insignificant of the unstinted care bestowed upon the matter here printed that the pages devoted to "Useful Formulæ and Equations" have been revised and brought up to date by Dr. J. Erskine Murray.

For the general reader, a large proportion of the interest is centred round the admirable series of essays upon those branches of wireless telegraphy which most arouse current interest. These vary in each edition of the Year-Book. The present volume contains a delightful comparison between past and present methods of naval war tactics as governed by means of communication. This essay which figures under the title of "Intelligence in Naval Warfare" has been specially contributed by Mr. Archibald Hurd, the well-known expert writer on such subjects. Colonel Maude supplies "The Allies' Strategy in 1915." Amongst these essays will be found a number of technical papers. Dr. J. A. Fleming discourses with all the charm of his accustomed lucidity upon the subject of "Photo-Electric Phenomena," whilst Dr. W. H. Eccles takes as his subject:—"Capacitance, Inductance and Wave Lengths of Antennæ," accompanying his text with an original series of abacs of extreme interest and utility. Two of the technical articles come from the United States, and deal—one with the "Progress of Radio-Telephony in the U.S.A. during 1915"—and the other with the "Measurement of Signal Intensity." The latter is from the pen of Mr. John L. Hogan, Junior, Vice-President of the Institute of Radio Engineers.

Many other articles which here find a place will appeal to quite a wide circle of readers. A *résumé* of some of the exploits of wireless, anecdotally narrated, appears under the title of "Wireless Waves in the World's War." The paper on "Problems of Interference" will prove highly informative to anyone with the most elementary idea of the general principles of radio-telegraphy. The possibilities and limitations of "jambing" besides other obstacles intentional and unintentional to the correct transmission and reading of messages find here a sober and authoritative elucidation.

NOTICES OF MAGAZINES.

REVUE MILITAIRE SUISSE.

No. 4.—April, 1916.

The Two Neutralities.

The writer of the *Revue* article fears that an extraordinary and disquieting feeling of discredit attaches to the word "neutral." No one seems desirous to acknowledge himself a neutral, although perforce he is actually numbered amongst those to whom the appellation is applicable; even those who hold the status in respect will scarcely acknowledge as much. It is said that Belgium is prepared to disclose the whole of the facts relating to the circumstances under which she was compelled to renounce her neutrality; Greece vilifies her neutral state, and soon, both in Europe and on other continents, neutrals will be as difficult to find as the philosopher's stone.

There are countries which are neutral and must remain so without the remotest probability of a change being made in their attitude. Belligerents may not, it is said, be able to appreciate the necessity for the adoption of such an attitude, but the interests of Switzerland are so closely bound up with the maintenance on her part of the status of a neutral that her people can by no means regard with equanimity the prospect of any departure from her time-honoured policy. It is pointed out that the ancestors of the Swiss people did not, on the morrow of the Battle of Marignan,—early in the XVI. century—deliberately adopt a policy of neutrality without weighty reasons, a policy which succeeding generations continued to adhere to for the three long centuries preceding the period of the French Revolution and the Congress of Vienna. This neutrality was no doubt of a special brand, since the cantons individually were not forbidden thereby either to participate in warlike operations, or to deal directly with belligerent nations. To the form which this neutrality took is ascribed the fact that the Confederation continued to exist as a political institution and that it remained unaffected by the great European conflagrations which raged from the time of Francis I. to that of the great Corsican.

In view of the economic situation of Switzerland, her geographical position, her racial problems and her moral obligations, at no time has the wisdom of the progenitors of the Swiss nation in adopting a policy of neutrality stood out so conspicuously as at the present time. It is urged that four centuries ago the founders of the Swiss Republic sized up the situation with great penetration and, therefore, it is not for the present generation, however much they may wish to do so, to reverse the policy which has answered so well for many ages, particularly in view of the fact that the circumstances have not altered in the meantime.

The question of Swiss neutrality was on one occasion at least brought before the Swiss people in all its bearings. This was in connection with the Congress of Vienna. Swiss territority had very recently been violated, and a rearrangement of frontiers was in contemplation in

Europe at that time. Switzerland formulated a demand to the Great Powers with regard to the territorial concessions she desired should be made to her in order to provide for the continuity of the existence of the Republic and the security of the Swiss frontiers. At that time, the Great Powers were inclined to regard Switzerland as being a vassal State under the domination of the great Napoleon, and they therefore expected something in the nature of compensation, and also guarantees for the purpose of safeguarding their future interests, in return for any territorial concessions which might be made. The Swiss plenipotentiaries therefore offered Europe an assurance, in legal form, of the policy of their country, that is to say, Switzerland undertook to maintain an attitude of "perpetual neutrality," under the guarantee of the Powers. The Great Powers considered this a suitable consideration for the purpose of binding the contract under the terms of which Switzerland was to remain for ever outside the influence of each and every one of the European states.

In 1831, on the initiative of Talleyrand, a similar artifice was adopted to bring about a pacific solution of the Belgian-Dutch conflict which threatened not only to undo the work of the Vienna Congress, but which also jeopardized the political equilibrium on the continent of Europe. Although the Swiss people had agreed with a good grace to the status of a neutral state offered to them, not so the Belgian nation, and consequently "perpetual neutrality" was imposed upon Belgium against the wishes of her people.

If the question be asked—"What is the difference between 'perpetual neutrality' and 'ordinary neutrality'?" The answer seems to be that, in theory, there is no difference since the legal definition is the same in both cases. However, in practice, a State which is under an obligation to regulate its relations with other States so as to conform to the requirements implied by the expression "perpetual neutrality" is bound so to act at all times as not to involve itself in a war. Further, it must so conduct its own affairs that in the event of other nations becoming involved in a war with one another, such a State must continue under an obligation to maintain its neutrality. It follows that a neutral state may enter neither into an Alliance nor into a Customs Union. Again, it has not a free hand even in relation to its own military affairs; for example, strictly speaking Belgium should not have put up a single fort within her territories without at the same time fortifying the whole of her frontiers on every side.

It may be urged that the above requirements are theoretical only and lack juridical sanction. There exist, however, in juridical treatises and in diplomatic correspondence clear expressions of opinion to counter any such suggestion. In Conventions relating to neutrality, the positive declarations of the Great Powers are confined to a statement that perpetual neutrality is, in such and such a case, guaranteed and it is, therefore, instructive to examine the value of such a declaration.

The doctrine on this subject is understood to mean that the Great Powers jointly and severally promise not only to respect the "perpetual neutrality" of the State to which the guarantee is given and to cause third parties to do the same, but they further undertake to compel this State to remain neutral towards all other States. It amounts to this: the Guaranteeing Powers enter into an obligation to keep a discreet but

efficient watch on the conduct of the neutral State. This responsibility is by no means a theoretical one, as can be easily ascertained by reference to the history of either Switzerland or Belgium; for example, in 1889 Bismarck claimed, in the interests of Swiss neutrality, to establish control over the police in Switzerland; in 1842, Great Britain forbade Belgium to enter into a Customs Union, even of a limited nature, with France. Many other examples could be quoted of similar interference in the affairs of neutral States by one or other Guaranteeing Power.

The writer of the *Revue* article states that the guarantee of the Powers is really ineffective and does not completely safeguard a State against aggression. This is not only abundantly clear from the fate of Belgium in 1914, but its doubtful value has long been recognized by all publicists and statesmen who have given thought to the subject.

The writer of the *Revue* article is of opinion that so far as Belgium is concerned Great Britain, apart from Treaty obligations, was compelled to intervene to protect that country against the German invaders. He is of opinion that International Treaties in no way protect a neutral State, but only compromise its political liberty and, in a word, its sovereignty.

Swiss publicists have urged that their country enjoys a self-imposed neutrality which has been *recognized but not guaranteed*; and that the status of Switzerland differs from that of Belgium. But if it is not difficult to distinguish, from a legal point of view, the differences between the neutrality of Belgium and that of Switzerland, it is not so easy to ascertain how far the distinctions urged by jurists have been recognized by the Great Powers, and indeed, whether these distinctions involve a difference possessing practical importance. Opinions on the subject are all very well for use as arguments in diplomatic correspondence, but neutral States remain unfortunately at the mercy of powerful neighbours with regard to the extent that their neutrality will be respected. It was not Belgium, but Germany, that ultimately defined the limits of the former's neutrality.

The writer of the *Revue* article enquires whether the Swiss people still desire to live in the state of "perpetual neutrality" now so familiar to them. He states that it is not possible to enumerate the advantages of the "perpetual neutrality" under which his country has existed for so many centuries, for these advantages are not discernible; indeed, he considers that there is no superiority in "perpetual neutrality" as against a policy of *voluntary neutrality*. He continues, "neither is it possible to enumerate the inconveniences of 'perpetual neutrality'; such an enumeration would fill the pages of a considerable tome."

There seems to be a strong feeling that on the termination of the present war, there should be a *rapprochement* of neutral countries, a *rapprochement* having for its object the securing of the independence of these countries; but to the adoption of this course, there stands in the way one serious obstacle so far as Switzerland is concerned, namely, the international obligation under which she continues to maintain "perpetual neutrality." The writer of the *Revue* article urges that when the time comes to discuss peace terms the Swiss Government should endeavour to persuade the Great Powers to release the Republic from this obligation, an obligation which, at the present time, saps the liberty of the Swiss people.

FIRE ACTION AGAINST AEROPLANES.

The *Revue* article deals with the factors which must be taken into consideration in directing fire against aeroplanes.

Since the graduations on the back-sight of a rifle or gun are intended for use against targets approximately on the same horizontal plane with the point from which such rifle or gun must be fired, these sights are of little value for aiming purposes in cases where the target is situated at some considerable altitude above the earth. Aeroplanes in flight are very difficult targets to hit; further, even when they are hit it is largely a matter of luck whether any serious damage is done to them or not. Some 6 to 8 per cent. of the surface of an aeroplane is alone vulnerable. The only sure method of putting an aeroplane out of action is by hitting the pilot, which is not an easy thing to do, since the walls and bottom of his seat are, as a rule, armoured with chrome-steel plates, 4 mm. thick, capable of resisting rifle bullets at ranges in excess of 600 to 700 yards, and shrapnel fragments at ranges in excess of 1,000 yards. To damage an aeroplane seriously it is necessary either to smash the propeller, or to pierce the petrol tank, or to put the motor out of gear, or to break an essential part of the motor, or to sever the stays, or to cut the connections of the rudder. A single projectile can by a lucky hit do sufficient damage in the cases just enumerated to bring an aeroplane to earth.

A machine gun mounted so as to be able rapidly to follow the movements of an aeroplane in flight is the most suitable weapon to use against these aerial machines; rifle-fire is of little value for such purposes. Under certain circumstances shrapnel fire may be usefully employed against aeroplanes.

Weapons for use against aircraft require to be equipped with special sights provided with automatic regulation. Two points call for consideration in this matter: the *range of the target* and *the angle of sight*.

From the point of view of taking aim at aeroplanes the *angle of sight* is as important a factor as the *range*, and varies exceedingly rapidly in the case of a fast moving target such as an aeroplane; for example, if in the case of an aeroplane flying directly towards an observer, let it be supposed that:—

α=angle of sight when aeroplane first sighted.
β=angle of sight one minute later.
h=the altitude in feet above the observer's position of the track of the aeroplane.
l=horizontal distance in feet traversed by the aeroplane in one minute.

Then
$$\tan \beta = \frac{h}{h \cot \alpha - l}.$$

So that in the case where $\alpha = 30°$, h=6,000 ft. and l=5,280 ft. β will be approximately equal to 60°; that is to say, during an interval of one minute the *angle of sight* will have increased to double its original value. During the same period the *range* of the target will decrease from about 4,000 yards to about 2,300 yards. The above calculations

give some idea of the rate at which the *angle of sight* and the *range* of such a target as an aeroplane in flight vary.

So far as the projectile is concerned, the points for special consideration are those connected with the *influence of the altitude of the target* and the *action of the wind*.

In the case of a projectile fired at a target on the same horizontal plane as the weapon from which the projectile is fired, as is well known, not only the resistance of the air but the force of gravity both have a retarding effect on the velocity of the projectile during the period of flight along its parabolic path as far as the culminating point; after the point last mentioned is passed, although the resistance of the air continues to act as a retarding force, on the other hand gravity now acts as an accelerating force, and therefore tends to restore a part of the kinetic energy lost by the projectile whilst traversing the ascending part of its parabolic path. Where targets are situated in planes at certain altitudes above the earth the path of the projectile between the point of discharge of the projectile and the target ascends continuously and in such a case gravity does not act as an accelerating force until after the target is either hit or the projectile has passed beyond its mark. The writer of the *Revue* article points out that the variations in the velocities of the projectiles, though small, nevertheless have an influence on their range and allow highly mobile targets to keep out of danger zones with some ease.

In taking aim at targets at considerable altitudes above the earth, the refraction of the image forming light rays causes some inconvenience to gun layers and rifle shots; but the trouble experienced in this matter, it is said, has not been so great as some expected it would be. Another phenomenon to which attention has been drawn by those who have watched the evolutions of aeroplanes in flight is the invisibility of the machines, even on a very clear day, at altitudes varying from 6,000 to 7,500 ft.; under such circumstances, it is difficult to pick up aeroplanes with the best of field glasses, but once the machines are located they are easily followed.

In the case of projectiles fired at targets at a great altitude above the earth, a wind directly opposing or directly following the projectile has little effect in accelerating or retarding its flight; but on the other hand, a wind blowing across the path of a projectile causes a very considerable lateral deviation; this deviation, which naturally depends on the velocity of the wind, varies in inverse ratio to the mass and velocity of the projectile. Owing to the fact that in the case of fire aimed at elevated targets the projectile traverses various layers of the atmosphere in which the wind currents are blowing with varying force and in different directions it is very difficult, if not impossible, to make any correction for the wind in aiming at such targets.

The velocity of the wind and its direction naturally affect the resultant velocity at which an aeroplane progresses in a particular direction with any given number of revolutions per minute of its propeller. The drift and the resultant velocity produced by air currents under certain circumstances, in the case of an aeroplane travelling at a speed of 67 miles per hour (*i.e.*, 30 metres per sec.), is given in tabular form in the *Revue* and is reproduced here.

Speed of Aeroplane, 30 Metres per Second.

Velocity of Wind. Metres per Sec.	Horizontal Angle between Direct Path of Aeroplane and Direction of Wind.									
	30°.		60°.		90°.		120°.		150°.	
	β.	V.	β.	V.	β.	V.	β.	V.	β.	V.
10	13·3°	22·0	19·2°	26·4	18·4°	31·6	13·9°	36·0	7·4°	39·0
20	38·3°	16·2	40·9°	26·4	33·7°	36·1	23·4°	43·5	12·0°	48·4
30	75°	15·5	60°	30·0	45°	42·0	30°	52·0	15·0°	57·9

β = Angle of drift. V = Resultant velocity in metres per second.

The fact that an aeroplane in flight is exceedingly mobile, and possesses great freedom with regard to the alteration of its course vertically as well as horizontally, renders it an extremely difficult target to hit. Aim should naturally be taken well in front of an aeroplane. The Swiss *provisional regulations for rifle and machine-gun fire against aeroplanes* (December, 1914) provide a rough-and-ready guide as to the distance in front of an aeroplane that aim should be taken; the following table gives approximate data for directing fire at aeroplanes in flight (assumed average length = 10 metres):—

Range of Target. Metres.	Machine Lengths in Front, that Aim should be taken.
300	1
500	2
700	5
1,000	7
1,200	9
1,500	12
2,000	17

A table (based on calculations) is published in the *Revue* showing the exact distances (in metres) in front of an aeroplane that aim should be taken at various ranges, from 500 to 2,500 metres; figures are given for a machine flying at speeds of 80, 100, 110, 120 and 150 kms. per hour. The approximate data given in the table above agrees very closely with the calculated data published in the *Revue* article in the cases of aeroplanes flying at a speed of 120 to 150 kms. per hour.

The *Revue* article also contains a table in which are set out particulars, including dimensions, of the different types of aeroplanes in use in the British, French and German naval and military services.

It is practically impossible to estimate by eye, with sufficient accuracy, the range of an aeroplane in flight; resort therefore must be had to rangefinders to obtain even approximate ranges. Owing to the great speed at which aeroplanes in flight travel rangefinders built on the "coincidence" system are alone of any use. Binoculars, in which one eye-piece is provided with a glass diaphram with graticules engraved thereon, form a very convenient and rapid means of obtaining the range of an aeroplane in flight. A very simple piece of apparatus for obtaining approximate ranges rapidly consists of a metal or cardboard sheet along one side of which notches or steps of various lengths are cut. The lengths of these notches or steps are calculated, by the well-known formula relating to similar triangles, and each notch or step is cut of such a length as to represent different apparent lengths of the target at some fixed distance from the eye, at some particular range.

If the card is then held, at the distance from the eye for which the "apparent length" of the target was calculated, and adjusted so as to ascertain into which of the notches or steps the target exactly or most nearly fits, its approximate range will be at once apparent.—(*To be continued*).

SOME OF THE PRECEPTS OF THE WAR.

"Skill will beat mere brute strength."

Introduction.

"Woe to him who despairs."

The writer of the article points out that a terrible war is in progress on the very borders of Switzerland and that her people are standing to arms awaiting the final issue of the great struggle.

Dangerous doctrines are being preached which are having a most pernicious influence on the Swiss people; in consequence, some there are who have been lulled into a false sense of security, whilst others there are who have sunk into a state of despair. Yet at no time has it been more necessary than at the present for the public to be on their guard; on the one hand, against a too easily satisfied optimism, and, on the other hand, against a too exaggerated pessimism.

The optimists who now cry aloud: "Let us disarm! Let us demobilize!" are requested to take heed of Sven Hedin's words in *Un peuple en armes* where he says: "Woe to the people who have not set their houses in order in good time, but who have trusted to alliances and 'scraps of paper,' 'tis the Strong Arm which decides the destinies of nations, *Watchfulness* and *Force* alone inspire respect on every side."

The optimists are further asked to take note of an order published by the Headquarters of the 2nd (Swiss) Division in February, 1915, which states clearly enough that "the present war is far from being over," and in continuation draws attention to the probability that "the longer it lasts, the greater is the likelihood that the complications following in its train will increase."

"Take nothing on trust: be at all times on your guard" is the moral preached to optimists.

It is stated that the doctrines of the pessimists are, if anything, still more unhealthy than those of the optimists, since they cause in people's minds a distrust of themselves. These pessimists wish people to believe that victory accrues always to big battalions, to things material and to machines. Thus it is that they hastily run to the conclusion: "Switzerland is defeated even before she comes to grips."

The author is of opinion that it still remains to be proved that "Might is Right"; on the other hand, he claims that Skill will, to-day as in former times, always eventually defeat mere Brute Strength. The "Chiefs" of the Swiss Army are reminded that an all *imperious* obligation rests upon them to make a study of the experiences of the belligerents waging war on the borders of Switzerland, in order to draw all the profit they can from them for the benefit of the Swiss Army. They are recommended particularly to examine what those who have participated actively in the present war have to say regarding the part they and their brothers in arms have played on the battlefields of to-day.

Many of the ideas contained in the literature dealing with the present

war are considered in the article to contain lessons of value for the Swiss Army, and he has extracted several of these ideas from the original publications and embodied them in his own article.

Experiences of the War.

The Paramount Importance of Fire Effect.—Fire effect has come by its own, so says Major d'André in his *Le Tir pour Vaincre*. And yet, at one time, faith was pinned exclusively in tactical evolutions as the deciding factor on the battlefield. The hecatombs for which fire effect was responsible at the beginning of the campaign of 1914 has caused the scales to fall from the eyes of those who were blind.

The writer of the *Revue* article points out that the experiences of the War bear out the principles contained in the Swiss "*Instruction de Tir.*" Major d'André states: "*Fire intended to kill* is in evidence very much to-day"; at the beginning of the War *fire effect intended to demoralize* the enemy loomed largest in view.

It is suggested that the French rifle fire has been decidedly inefficient and quotations are given from French and German documents to support this view; these quotations indicate that the French infantry have invariably fired at too great an elevation in the present war. History is but repeating itself, and the "Hochschuss" so frequently spoken of in relation to preceding wars occupies a very prominent place in the accounts of the present war. The musketry training of the French infantryman is said to have been at fault; steps have never been taken to convince him that it is necessary for him to become a good shot. On the contrary, it has been dinned into his ears that "in an engagement it is better that he should not take aim. Fire can thus be better distributed." And this in spite of the practical teachings of the Boer and the Russo-Japanese Wars.

In Austria, Germany and Italy, on the other hand, the correct principles of rifle fire were understood and applied in the training of the soldier. Happily, it was not necessary, it is said, for Switzerland to await the experiences of the present war, in order to put musketry training on to right lines.

The War of Evolutions.

In a vein of sarcasm Major d'André writes: "Everyone wishes to manœuvre, no one wishes to fight." He further points out that the training of the French infantry was based on the requirements of a war in which the manœuvring of troops was expected to play the most prominent *rôle*.

That the French General Staff misjudged the requirements in relation to the coming war now upon them is evident to everyone who makes but a very cursory examination of the progress of the War; the war of manœuvre gave way to trench warfare within a few weeks of the opening battles of 1914.

The following extracts reproduced from the French and Swiss Regulations show how widely the views on the subject differed in France and Switzerland.

Swiss Regulations: "The object of a fight is the destruction of the enemy. Fire effect is the chief consideration on the battlefield; manœuvre, since it enables the distance separating a body of troops from the enemy to be diminished, is the means of rendering fire effect more telling."

French Regulations: "Fire action has one object alone: that of facilitating evolutions."

It is suggested that in France the "tactics of instilling fear" were preferred to the "tactics of killing"; both at manœuvres and in the solution of "Kriegspiel" schemes too little attention was paid to the man, his weapons and the terrain. General Cherfils sums up the situation in the sentence: "Too many skirmishers, not enough sharpshooters."

In the *Echo de Paris* of 4th February, 1915, it is pointed out that modern war has brought about a profound modification in the ancient formula for obtaining victory. Formerly, in order to conquer, it was sufficient *if the soldier was not afraid of being killed.* With the modern arms of precision fire is so accurate that *the soldier, if he can, ought to be afraid of being killed.* It is no longer a case of allowing one's self to be killed, but of killing one's enemy.

The French paid, it is said, a big price for the experience gained during the early days of the present War.

The Offensive or the Defensive?

Much is said at the present time of "the bankruptcy of the offensive." Whether the offensive or the defensive is the superior of the two is a question not yet fully ripe for decision.

If, at the beginning of the War, the success which crowned the application of the doctrine of the offensive was dazzling, not less remarkable were the checks which later went to destroy faith in the infallibility of the principles that have been so universally accepted. What is certain is that both in the case where success has been obtained as where failure has been the result, as a consequence of the adoption of offensive warfare, the armies of Germany as well as of France have suffered serious losses. There are obstacles which no offensive can break through; of this fact the War provides many examples. A proper utilization of the terrain and field fortifications have conferred on the defensive a power which was quite unsuspected. The lesson which stands out most prominently is that now more than ever is it necessary to teach the soldier *to make the best use of his firearms and the tools of the pioneer.* It is recommended that whilst the spirit of the pure offensive should still be inculcated in troops, yet it is as well to familiarize them with the principles of the stubborn defensive which may have to be resorted to. These principles are summed up as follows:—

(*a*). A good rifle-shot must never permit the enemy to get within easy reach of the position he is holding nor must he allow the enemy to turn him out of it.

(*b*). All positions are impregnable when defended by soldiers worthy of the name.

It has been said that the defensive power of Switzerland is so great that she can hold at bay an enemy possessing fourfold the numerical strength of the army she can put into the field. The Swiss are recommended to take note of this, since it is a reassuring statement.

Everything for the Guns: Nothing for Others.

Major d'André states: "Artillery comes in for all the drudgery, and infantry only advances when the former announces that the repast is ready." The opinion now prevails very widely that only the guns, big and small, and machine guns are alone doing real work in the present

war. The infantry, some think, has now only the final task left to it of clearing the enemy out by a bayonet attack; to it has been assigned the honour of being a target for the enemy's fire. False impressions are likely to be created by the dissemination of views similar to the foregoing. The attempt to draw distinctions with regard to the utility of the different arms of the Service is futile; on the modern battlefield the solidarity of the various arms is complete; the most intimate and absolute co-operation, on the part of the troops of every branch, is the chief consideration making for success.

The Bayonet.

In his *Le Tir pour Vaincre* Major d'André has pointed out that: "It is the bayonet that is fixed to the rifle . . . and not the rifle to the bayonet." The view that bayonet fighting has first place and musketry second savours much of the ideas of very old times.

The *Revue Militaire Suisse* in its number for March, 1913, sounded a note of warning in relation to the marked tendency shown in France to make the bayonet the principal weapon of the infantryman. An extract from the article is reproduced, its concluding sentence is as follows: "All these instructions regulating bayonet exercises are eye-wash at most, 'tis not thus that armies can be prepared for war."

At the beginning of the War the French infantry made some brilliant bayonet charges, but only to suffer cruel losses for no purpose. Now, grenade attacks have taken the place of bayonet charges to a large extent. It must not be supposed that the experience of the present war teaches that the *arme blanche* of the infantry, the bayonet, is of no use in modern war; far is this from being the case. The bayonet is still useful for fighting at night, in fogs, in woods, etc. Bayonet exercises are still a valuable form of gymnastic training.

Quantity or Quality?

An oft-quoted phrase has it that "Providence takes the side of the big battalions." The predominant influence of masses and materials in a modern war is now universally admitted. The cry is for more big guns, for more big battalions. If, however, in war it was a mere question of numbers deciding, and nothing more, then the small Powers would be wise if they at once ordered their troops to pile arms, fold their arms and to accept with resignation the cruel fate of becoming the subjects of a State no longer free but the vassal of a hostile power.

The writer of the *Revue* article energetically repudiates the correctness of the foregoing assumption. "The dogma is false," he says. "Appearances are deceptive, nothing must be taken for granted." The factor which dominates the situation is after all *the man*.

In his *Études sur le Combat* Ardant du Picq has stated: "The theory of big battalions is a shameful theory. Both the most obscure and the best known orators, who to-day talk of things military, speak only of masses. The man has ceased to be visible in these masses. Numbers alone are visible; quality is quite lost sight of, and yet, to-day as of yore, quality is alone worth considering, indeed, the real source of all action."

In the *Journal de Genève* of the 26th January, 1916, Colonel Feyler, in an article entitled: "The German Doctrine in Relation to Strategy and the German General Staff," states that quality is a more important factor than quantity, and points out that this is, in brief, the view also

of Bernhardi. Those who will take the trouble to search the pages of history will find therein convincing records to satisfy them that from the time that little David slew the giant Goliath right up to the present time, Quality has times out of number obtained a brilliant triumph over Quantity.

The Masses.

In accounts of the fighting which has taken place in the present war mention is frequently made of attacks in mass formation, and in deep columns. In an article which appeared in the *Revue Militaire Suisse* for August, 1915 (*vide R.E. Journal* for December, 1915, p. 307), it was explicitly denied that the Germans had employed mass formations for the attack and an attempt was made to explain away the newspaper references to attacks in deep formation. Nevertheless, the belief prevails very widely that the German troops have been in the habit of advancing to the attack in mass formations. In the earlier battles a large proportion of the highly trained soldiers of the German Active Army was wiped out and had to be replaced by less highly trained men; and it may well be that deep-column formations were resorted to by the German Commanders to give confidence to the latter. Ardant du Picq points out in his *Études sur le Combat* that "when generals conclude that they can no longer get young soldiers to push attacks home in normal tactical formations, they attempt to do so in mass formation, which is a return to the infancy of the art, a kind of makeshift prompted by despair."

Major d'André makes, in reference to the same subject, the laconic remark: "Can it be that the enemy had so little respect for the marksmanship of our infantry that he dared to assault the positions held by our 'poilus' in such vulnerable formations?"

Naturally, an advance in any formation would succeed against troops that shoot badly. On the other hand, a few marksmen and a few machine guns, in the hands of well-trained and collected men, would mean the immediate destruction of troops in mass formation, a victory complete in every respect of Quality over Quantity!—(*To be continued*).

NOTES AND NEWS.

Switzerland.—A correspondent contributing an article to this number of the *Revue* makes a passing reference to the scandal with which the names of Colonels Egli and De Wattenwyl are associated, and states that, however regrettable it may be, yet the fact remains that the sympathies of the Swiss people and army are widely divided in relation to the Great War. The majority of the French Swiss profoundly wish that the Western Allies will be victorious in the campaign now in progress; a large proportion of the German Swiss, on the other hand, are praying for success to the arms of the Central Powers. Under these circumstances, the Federal Authorities are finding it difficult to maintain an attitude of absolute neutrality.

Dealing with another matter, the correspondent states that the Swiss military tribunals are greatly in disfavour just now, particularly with the French Swiss. He suggests that the law governing these institutions is out of date and urges that the Federal Authorities should, without delay, put matters in relation to military tribunals on a satisfactory footing by passing an amending act.

A matter of greater delicacy with which he deals relates to bombs which the dear "Kameraden" of the German Army dropped on Porren-

truy; he hopes that this is the last bombardment that Swiss territory will suffer at the hands of German aviators. The incident appears to have led to severe criticisms, on the part of the Press, on the conduct of the military authorities. Fortunately, the temper of the Swiss Army remains unruffled by these newspaper attacks upon it, and the greatest harmony, it is said, prevails between the officers of French and German descent.

Among matters of particular interest at the moment is the fact that the Government has re-established the Central Schools of Instruction for Officers which were suppressed in 1914 and 1915.

Another matter which has created some interest is the census which has been prepared in Switzerland of all men, between 16 and 60 years of age, not liable to military service, who either possess a rifle or know how to use one

France.—A special correspondent calls attention to the fact that the Portfolio of the Ministry of War has been transferred once more; this time into the hands of General Roques, who is the fourth Minister of War France has had since the War began. Roques, who succeeds General Gallieni, had a command in the Woevre; his military career has been a brilliant one, but he is new to political life. High praise is given to General Gallieni for the measures adopted by him during the early days of the War; it is to these measures that France owes her escape from the desperate position she found herself in when the Germans were closing on Paris. General Gallieni's predecessor, Millerand, was unpopular in Parliament, owing to the fact that he put great powers into the hands of the military authorities.

General Gallieni has come in for a good deal of criticism in connection with his tenure of office as War Minister. He has been accused, *inter alia*, of persistent jealousy and of thwarting the French generalissimo, his *soi-disant* rival. He is a man of wide experience, and seized the opportunity which presented itself of introducing far-reaching reforms into the French Army; he has, in the opinion of the writer of the *Revue* article, played his part with skill, energy and promptitude, and has not hesitated to remove high-placed officers who have proved themselves incompetent.

This number of the *Revue* concludes with a short bibliography.

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RIVISTA DI ARTIGLIERIA E GENIO.

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OBSERVATIONS ON THE STUDY OF HEAVY CUPOLAS.

By Colonel Marullier, of the Engineers.—"The Captain of Engineers, Sig. Tomaso Volpe, in an article written for the May number of this *Rivista*, refers to an inexactness of calculation in a note at the foot of a page in my *Studio di Cupola Pesante* relative to the penetration of projectiles, drawing thence an argument sustaining that the principle on which my above-mentioned study is based does not fulfil all the advantages which at the first view they would seem to possess. Although an assertion

of this kind may be interpreted as a condemnation of the proposed system I am unable to exempt it from confutation."

In substance the author of the article says: Since the part of the force of the projectiles absorbed by the cupola owing to the combined movement is small, very little usefulness can be drawn from the said movement on which our study is founded.

The advantages attributed to the proposed system do not follow from the circumstance that the movement of the cupola transforms in part into mechanical work the energy of the projectile, but essentially from the indisputable fact that whatever may be the mass or the violence of the shock owing to the direct action of the projectile, this may be circumscribed between certain well-defined limits, the force and the conflicting resistance thus rendering the strife or action between the projectile and the cupola always sustainable.

There are two phases to be considered. In the first, the action of a projectile striking the cupola only produces a diminished restraint in the latter, and during this movement the machinery devised to sustain the cupola and which causes it to rotate, together with its guns, would not work if not subject to the simple compression resulting from the contrast between the reaction of the restraint and the force equal and contrary which causes the descent of the cupola. In the second phase, since the portions of the machinery cease to be disturbed by the force of the shock they would evidently remain uninfluenced by causes intended to change their normal state. So now there being no external action which has an exclusive effect on the armour it is clear that by assigning to the parts indicated a sufficient thickness it will always be possible to realize the protection required.

France.

French Anti-Aerial Gun.—A German review makes mention of the following notice of an anti-aerial gun adopted in France:—The anti-aerial automobile gun has a calibre of 7·5 cm.; it is mounted on a platform, which during the fire is supported on the ground. In other automobile guns of a different pattern the supports or jacks applied to the platform are four, and liberate the wheels of the autocar from the strain caused by the fire. France also possesses a special cannon with a calibre of 10 cm. and a projectile weighing 10 kg. and having an initial velocity of 613 m. The machinery and the supports for this gun are similar to that of the cannon of 7·5 cm. Its total weight including the protecting shields is about 2½ tons.

New Dirigibles.—The same review observes that in France while so much attention was devoted to aviation previous to the outbreak of the war there was a decided diminution of interest in the construction of dirigibles, and that the result has been unfavourable. The number of dirigibles was limited, and their practical use was disputed. It was only when the political situation became strained that attention was seriously given to the creation of an aerial fleet.

A little before the war orders were given to the three well-known constructors, Lebaudy, Clèment-Bayard, and Astra Torres for a few dirigibles; one with a semi-rigid system was from the firm Lebaudy with nine motors of a total force of 1,350 h.p. and two other non-rigid airships

were ordered from the firm Clèment-Bayard. These had a length of 130 m. with a car 50 m. in length; four motors each of 250 h.p. and four screws; for initial ascension a subsidiary screw with a suitable motor was provided. For the new airships a velocity of 75 km. with a useful portage of 11 tons. A third system was placed with the firm Astra Torres of similar dimensions and h.p. to that of the Clèment-Bayard.

The German periodical alleges that although a year has passed nothing is yet known regarding the complete preparation of this new aerial fleet.

Mechanical Excavation of Trenches.—According to quotations from the periodical cited France has under consideration the employment of mechanical means in actual warfare for the excavation of trenches. The operation would take place by means of a plough and motor. The invention is suitable for loose soil which can be thrown on one side forming a parapet at once utilizable. The power of the apparatus is remarkable. The heavy ploughshare working at very great velocity (about 1,000 revolutions per minute) and is such that it may be found useful even in the excavation of ground of great compactness.

GERMANY.

Special Projectiles against Airships.—From the review *Le Génie Civil* of the 29th January the following notices are extracted on some types of projectiles adopted in the German Army against airships:—

The common characteristic is the breaking up of the projectile in the act of explosion in a manner that the falling fragments are not a source of danger to the friendly troops.

One type of projectile constructed at the Rheinische Metallwaren-und Maschinenfabrik of Düsseldorf is a shrapnel which does not differ from ordinary shrapnels except in its construction. This made like a shell which explodes either by percussion, or by a time fuze to the match of which is given ignition at the same moment as the match of the principal fuze of the shrapnel. The small bullets are projected along a cone with an aperture from 12° to 14° and the fragments of the shell along an angle of 200° in all directions at distances varying from 200 m. to 300 m. The projectile will then be effective over a space of 700 m. in depth by 300 m. in width. The shell in addition to the explosive charge contains an incendiary mixture which also produces at the moment of explosion a cloud of smoke which assists the observers of the fire. Another type only differs from the preceding one because the projectile contains an incendiary charge in place of the bullets.

Another type constructed at Krupp's manufactories is devised on other ideas. In front of the projectile there is a metal plate for percussion with a spiral spring. To the metal plate are attached two small points tipped with flint. When the projectile strikes the envelope of a dirigible the spring on the percussion plate becomes compressed and sparks are produced from the flint and steel arrangement which ignites the hydrogen of the balloon. The same phenomenon is repeated when the projectile passes through the envelope on its exit.

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