THE ROYAL ENGINEERS JOURNAL.

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CONTENTS.

Abbreviated Notes on MILITARY ENGINEERING.

CONTENTS.

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

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CONTENTS.

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

TEMPORARY GIRDER BRIDGES.

THE tables A and D published in the July number of the *R.E. Journal* are cancelled, having been prepared last September for panel point loading only. Corrected tables given below have been kindly furnished by the writer of the article, Major O. G. Brandon.

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.
10	2	4	26	26	33	2	2	15	1	2	·4	⅝	·8	⅝	4	⅝	7	70
20	2	4	5	5	61	2	2	22	1	2	·6	¾	1·2	1	5	⅝	15	100
30	2	6	5	5	78	3	3	38	1	2	·9	1	2·2	1⅛	10	1	17	180
40	2	8	5	5	94	4	3	44	1	2	1	1⅛	2·7	2	10	⅝	15	88
50	2	10	5	5	125	4	3	59	1	3	1·2	1⅛	4	2½	11	⅝	16	120
60	4	10	6	6	74	3	2	32	1	2	·4	⅝	2·3	1¼	10	⅝	20	66
80	4	12	6 8	6	110	4	2	40	1	2	·9	1	3	2	9	1	18	80
100	6	14	7 2	7	91	4	2	40	1	3	·8	1	2·2	1⅜	8	1	20	80

REMARKS.—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, 9″ × 3″ cross-bearers should be placed about 3 ins. 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.

* 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 (see July *R.E. Journal*).

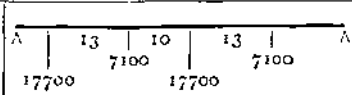
* If planking double the thickness shown is available this may be placed its own width apart at the abutments, and double its width apart in the centre third bays, as "B" in sketch (see July *R.E. Journal*).

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:—

½ × area of wood vertical in table = area of iron vertical (which is now in tension).

1½ × 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.

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	 99200
Allow "n" panels of depth "d" ft. and breadth "b" ft.	Allow 8 panels of depth 5 ft. and breadth 5 ft.
Dead load per panel = $\frac{1}{n} \times 2W = w$	.. .. $\frac{1}{8} \times 99200 = 12400$
Weight of panel = p	800
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.
$T_r \times d = -(w+p)\,b \left\{ \frac{r}{n}[1+2+\ldots\ldots+(n-1)] - [1+2+\ldots\ldots+(r-1)] \right\}$	$T_4 \times 5 = -13200 \times 5 \left\{ \frac{4}{8}[1+2+\ldots+7] - [3+2+1] \right\}$
$T_r = A$	$T_4 = -13200 \{\frac{1}{2} \times 28 - 6\} = 105600$ lbs.
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.
Local Bending Moment.	
W_1 = weight on any bay = $\frac{2 \times \text{Axle Load}}{Y} = \frac{2w_1}{Y}$	
As end of girders are fixed and weight partially distributed,	
M_l may be taken = $\frac{W_1 l}{12}$	Axle load = 17700.
$\frac{1}{6} r b d^2 = M_l = \frac{W_1 l}{12}$	
Assume $d = 9$ ins.	
$bd = \frac{W_1 l}{12} \times \frac{6}{1200 \times 9} = \frac{2w_1 b \times 12 \times 6}{Y \times 12 \times 1200 \times 9} = \frac{w_1 b}{900 Y} = \frac{E}{Y}$ ...	$bd = \frac{17700 \times 5}{900 \times 2} = \frac{88}{2}$.
Total area of boom for each girder = $\frac{C}{Y} + \frac{E}{Y}$ sq. ins.	$= \frac{88}{2} + \frac{93}{2} = 93$ sq. ins.
I.e. B pieces of 9 ins. × 3 ins.	*I.e.* 4 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 $= A \times \frac{1}{Y} \times \frac{1}{B}$ ...	... ... $105600 \times \frac{1}{2} \times \frac{1}{2}$
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 $= \frac{A}{Y \times B \times t \times 3600}$	... ... $\frac{105600}{2 \times 2 \times \frac{3}{4} \times 3600}$
	I.e. 10 bolts on each side.
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 $\frac{1}{8} \times L$ and $\frac{1}{4} \times L$ 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. 8 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 $D_r = V_{r+1} \operatorname{cosec} \theta$.	$D_1 = V_2 \operatorname{cosec} 45° = V_2\sqrt{2}$ $= 23100 \times 1.41 = 32571.$
Since safe stress in W iron = 1200 lbs. per sq. in.	
Area of diagonal $= \frac{D_r}{12000} = \frac{V_{r+1} \operatorname{cosec} \theta}{12000}$	... ... $\frac{32571}{12000} = 2.7$ sq. ins.
Web Planking.—Average resistance of fir to shear = 300 lbs. per sq. in.	Available depth = 60 ins. − 10 ins. (approx. depth of boom) = 50 ins. say.
Thickness "f."—Then "f" × available depth of girder × 300 = $R_1 = K$.	$f \times 50 \times 300 = 26400$.
	$f = 1\frac{3}{4}$ ins. *I.e.* 1-in. planking on *each* side.

METHOD OF CALCULATION—*cont.*	EXAMPLE WORKED OUT FOR 40 FT.—*cont.* GIRDER LOADED AS ABOVE—*cont.*
Bolts.—Resistance of fir = 1200 lbs. per sq. in. Hence number of bolts × diameter × f × 1200 = K.	Take $\frac{7}{4}$-in. bolts. Number × $\frac{7}{4}$ 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.

[From The Records of the Survey of India.]

(*Continued*).

THE LINK BETWEEN THE CHAPURSAN AND THE KILIK PASS.

By C. S. McInnes, *Extra Assistant Superintendent, Survey of India.*

By the end of the 1912 season, an approximate series had been carried from Hunza northwards as far as Khodabad Village in the Hunza Valley, and a reconnaissance had also been effected from the Russian stations on either side of the Beyik Pass to the Kilik Pass. It remained to reconnoitre the country between Khodabad and the Kilik.

Khodabad is situated at the junction of the Kilik River, flowing from the pass of that name, approximately from north to south, and the Chapursān River, which flows from the Afghan border on the west. This latter is the main branch of the Hunza River. During the previous season it had been found impracticable to carry the series by the direct route *viâ* Murkushi and the Kilik Valley to the Kilik Pass, and it had been decided to try and force a connection westwards up the Chapursān and then to strike northwards across the mountains and join up with the Kilik stations.

I shall here give a very brief description of the lower Chapursān, between Khodabad and Spinje, which was the only portion of this valley over which we worked. On leaving the former place, one enters a valley more open and less striking than the Hunza Gorge, and it is pleasing to find that instead of steep pathways hung on galleries and pegs driven into the cliffs, a comparatively smooth and level track over which ponies can travel, is met with. Sixteen miles from Khodabad there is a small jungle of willows, which is known by the name of Spandrinj; the whole of these sixteen miles are extremely barren, and almost unbearable in the summer months owing to the heat. Between Spandrinj and Spinje, a distance of some 15 miles, there are two small villages, Kil and Reshit, the only two in the whole valley. The combined population only amounts to 35 inhabitants. On either side of the river the banks are thickly clothed with willows, but the hillsides on either hand are bare to the last degree throughout the entire length of the valley. The height of the River at Reshit is about 10,000 ft. and the mountains on both sides rise to a height of some 20,000 ft., the ascent being gradual for the lower portions, after which the mountains become precipitous and rocky.

In order to carry out the reconnaissance, a detachment was formed in Hunza, consisting of the writer, Goharayah Havildar of the Hunza levies, six Garhwali khalassies, who were to carry instruments, and who had been enlisted in Dehra Dun, and one levy who was in charge of fifty permanent coolies enlisted in Hunza. Besides this permanent establishment, a hundred extra temporary coolies were engaged to carry rations as far as Khodabad, which had been decided on as our depôt during the season. All arrangements were completed by the 25th May, and early the next morning my whole detachment left Hunza for the first march up the valley, and arrived at Khodabad five days later.

On the 1st June I made my first ascent to a peak due west of Khodabad, accompanied by the havildar and a local guide obtained in the village, and after deciding on the first figure with which to extend the series, we returned to Khodabad. On our way back we came across the tracks of a snow leopard on the snow, and further down the hill we found the remains of a large ibex, which had evidently been killed the previous night. On the following day I set out for a peak on the Kilik-Chapursān watershed, due north of Khodabad, and sent my camp to the foot of the peak. After a very fatiguing climb, mostly over shale, and lasting eight hours, I arrived at the summit and made a station, after which I returned to camp. The following day the detachment marched to Spandrinj, and from here on two consecutive days, I visited the two peaks called Spandrinj Sar and Sumayar Sar, situated above the right and left banks of the river respectively; on both these hills stations were built, their heights being 15,640 and 17,249 feet respectively. We started for Sumayar Sar at 6 a.m., and after fording the Chapursān River ascended the Kermin Pass and, continuing westwards along the ridge, reached the peak at about 2 p.m., after having been climbing for five hours over snow in a bitterly cold wind. I may here remark that the high winds for which the Pamirs are noted, terminate at the ridge above the left bank of the Chapursān.

We had been very curious to see what the country north of the valley was like, and from Sumayar Sar we had an extensive view of this land of peaks, which lay between us and the Kilik Pass. The scene was anything but reassuring. We saw numerous peaks ranging to over 18,000 and 19,000 ft., and shaped like a series of pinnacles. The more rounded and lower ones were under a thick layer of permanent snow, and the approaches to these seemed to be blocked by much-crevassed glaciers which appeared to render them inaccessible. Below us flowed the Derdi, a large stream which enters the Kilik River above Misgar, and the sides of the mountains above and beyond the Derdi looked inaccessible in most places. We returned to camp below the station at 8 p.m. and on the following day made a short march to Reshit, from which place I ascended on the 9th June a peak south of the village, built a station and returned.

The weather which had up till now been brilliant, suddenly changed, and we awoke on the morning of the 10th to find that it was raining heavily, and all the hills round hidden by low clouds. This spell of vile weather lasted for nine days, with brief intervals of fine weather which continued for a few hours, and which I utilized by attempting to climb a peak north of Reshit, but without any success. On the 19th, however, the weather at last cleared, and accompanied by Goharayah, the levy and several coolies, I set out determined to fix my last station in the Chapursān Valley before rain came on again, of which there appeared every prospect. For the first 1,500 ft. the climb was simple, and there was only a little snow on the ground, but beyond this the ascent became stiffer, for about 2 ft. of new snow had fallen. The wind had risen considerably, so that we had to climb from this point in a cloud of snow dust. The coolies, too, began to complain, although the heaviest load was only a plane table, and after every 500 yards an argument ensued between the havildar and levy on one side and the coolies on the other. However, chiefly owing to the firmness of the two former, we arrived at the summit of the station, known as Reshitipūr Sar, height 17,734 ft., after a climb lasting 10 hours, and everyone was as miserable as they could be. Fortunately the site was suitable for a station, and we returned to camp at 8 p.m. thoroughly exhausted, after experiencing one of the worst days of the whole season.

The Chapursān stations were now complete, and the next three days were spent in marching to the Derdi, to a point below Sumayar Sar on the north. We had now reached the country that had looked so formidable, and in reality it turned out to be as difficult as it had appeared on first impressions. All the nalas are piled with heaps of rocks which have fallen from the neighbouring hillsides, and almost continuously throughout the day one hears the sound of falling boulders, which reverberates and re-echoes for miles round. These falling stones are a constant source of danger, as the hills are so precipitous that one cannot step aside to avoid a stone, and on one occasion in particular we very narrowly escaped. I had climbed halfway up a peak with a dozen coolies, and we had reached the foot of a waterfall about 30 ft. high, when a huge boulder struck the head of the fall and bounded a few yards over our heads, and two coolies were badly cut by splinters.

In order to save time I had sent the havildar, on whom I could depend, with some coolies to see whether certain peaks were climbable, while I tried to get up other peaks. For three days neither of us came across an accessible peak, but on the fourth I managed to ascend to a point, known as Lupjangal Sar, from which I thought the Kilik stations were just visible, but later, when helios were used, it was discovered that this point could not be seen from either of the Kilik stations, and I had to return to this part again.

Some idea of the difficulty of the country may be formed from the fact that of eight peaks which were attempted, only one was climbed to the summit, and as stated above, this turned out to be of no value. I had next to fix a station above the Derdi, north of Reshitipur Sar, but after my recent experiences, I did not think that there was any likelihood of my being able to ascend from the Derdi, and I decided to try from the north. Accordingly, I marched round *viâ* the Kilik Valley to the Hark stream which flows from west to east and enters the Kilik at a spot known as Bun-i-kotal, about 5 miles south of the Kilik Pass. Our efforts on the following two days, the 29th and the 30th June, proved that the summit of the ridge was inaccessible beyond doubt from the Hark stream, owing to the numerous hanging glaciers, cut up by crevasses which lay between us and the summit. We had no alternative now but to return to the Derdi and attempt an ascent from the south, and before returning I moved the two Kilik stations south of the pass.

On the evening of the 1st July, Lieut. Mason and Capt. Hingston arrived at the Kilik Pass with a mixed crowd of Sarikōlis, Gurkhas, Hunzakūts, Kashmiris, Baltis and Garhwalis, and I went over to their camp the next day and discussed the work with Lieut. Mason, after which I returned to my camp at Bun-i-kotal in the evening. The day had been cloudy and windy, and snow fell during the night. My thermometers showed a minimum temperature of 35 degrees for the day, and a minimum of 16 degrees for the night. These were the lowest temperatures registered by my thermometers during the season.

On the morning of the 3rd July I commenced marching to the Derdi stream and five days later camped near the snout of a glacier at its source. During the next week I reconnoitred every day for a suitable site for a station, and at length I managed to climb to a high peak, called Tong-i-tuk, which proved satisfactory. Tong-i-tuk is the highest station of the entire series, being 19,135 ft. above sea level. Before returning to the Utwashk nala below Lupjangal Sar, I intended to observe to the surrounding stations from Tong-i-tuk, and I moved to the peak with a very light camp consisting of three light tents. I expected to finish the work in a day and a half, but owing to the signallers at Kilik East station not being sufficiently wideawake, I was forced to spend five days at the station, during which we had several falls of snow and the coolies had to live on very short rations.

Having completed the observations here, I returned to the Utwashk nala, where I spent five of the most strenuous days of my life, during which I was away from the camp and reconnoitring for an accessible peak on an average of 12 hours a day. When I did eventually climb to the summit of a peak called Murkushi Sar and fix a station there, I had been out from 5 a.m. and did not

get back to my camp till 9 p.m. I should never have been able to reach the summit of this peak, of which the height was 18,322 ft., had it not been for my Hunza coolies, who are famous for their mountaineering accomplishments, and who assisted me over the more precipitous portions of the ascent. All the stations were now selected, and at last on the 3rd August the completion of the link with the Russian triangulation hove in sight. The observations in this portion were simple compared with the fatigue of constantly climbing and searching for feasible mountains, even though I had to observe under unfavourable conditions. The signals I had to observe to were mostly bell-tents, and the khalassies whom Collins had sent to place these signals at my stations had pitched them with the white side of the cloth outermost, instead of the blue side as they had been instructed. The result was that it was only with the utmost difficulty that I could identify even the nearer signals, while those further away were quite invisible. The stations, too, were all placed on rocky knife-edged ridges, so that it was impossible to make the theodolite stand correctly and truly rigid, while the space round the instrument was so limited that I had to move round by stepping over the legs of the stand. The weather, too, was very unsettled and the signals were constantly obscured by mist. This appears to me to be the reason why the error rose in this section of the work for a short distance.

I finished work at Murkushi Sar on the 5th August, and as I had only to take observations to this point from Tong-i-tuk, I took only a few coolies lightly laden to this latter peak, sending the main portion of my camp to the Chapursān. I arrived at a spot below the peak on the 7th August, and made preparations to ascend the station, finish the remaining work and return to the valley during the next day, but on the following morning we found ourselves in a dense driving mist, while snow was falling. This bad weather lasted for five days without a break, but on the sixth it cleared, and after a desperate effort we climbed to the station, knowing that a few more snowy days would render the peak absolutely impossible. I finished the observations and returned to camp the same evening.

The remaining portion of the work had to be somewhat rushed through as the season was by now far advanced. The recent five days' snow saved me from the necessity of marching round by Khodabad into the Chapursān Valley, as the Derdi stream was now fordable, and I could cross into the Chapursān Valley *viâ* the Kermin Pass. I commenced work on the Chapursān stations on the 15th August, and completed my last station on the 22nd, just in time to avoid a spell of bad weather which set in the following morning and which continued beyond the 5th September, which was the date of my departure from Hunza on the return journey to Kashmir.

SOME GEOGRAPHICAL IMPRESSIONS OF THE PAMIRS AND THE NORTHERN KARAKORAM MOUNTAINS.

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

Perhaps it is wrong to get geographical impressions of a district. But when one is dealing with a complicated puzzle like the Pamirs, it is so difficult to be certain of anything, that practically the only way to set about unravelling the puzzle is to let impressions strike one on the spot and then try and find proof or otherwise. To illustrate the initial difficulty one has only to quote the following passage :—

"Humboldt's conception of the Pamir was a great meridional range connecting the Tibetan and Thian Shan systems, and this view was supported subsequently by Hayward; but Severtsoff and Fedchenko contended that the fundamental mass of the Pamir Plateau was a series of parallel ranges running from east to west. From the plains of Kashgar, Hayward saw a snowy range on the east of the Pamir running north and south. Fedchenko argued that this so-called range consisted only of the ends of the parallel ranges which were running east and west." *

When opinion is so divided as to the *direction* of ranges one is inclined to hesitate with an impression.

Undoubtedly the range that Hayward saw from the plains of Kashgar, was what is now generally known to geographers as the "Kashgar Range," and on Stolickza's authority, this range is a continuation of the Kuen Lun. This Kashgar Range is a higher one than the Sarikōl, which rises behind it and which Hayward therefore could not see. Severtsoff and Fedchenko were more acquainted with the Russian Pamirs, which consist of high glacial valleys, running approximately east and west, and connected on the east with the Sarikōl Range.

We did not have the opportunity of visiting the Great or Little Pamirs, and so our impressions of these have been largely borrowed from the Report on the Proceedings of the Pamir Boundary Commission, 1896, and we started out with the idea that the Sarikōl or Kashgar Ranges were the eastern boundary of the Pamir mass and that the former somehow or other joined up with Sir Francis Younghusband's Aghil Range.† Owing to the decided advantage of high trigonometrical stations, we hoped to be able to get a continuous series of points on this supposed continuation of the Sarikōl Range to show at any rate some present-day range connection with the Aghil. We were met by a difficulty almost at once. All the main spurs and mountains are so much the same height that it was extremely hard to recognize the same point from different stations,

* Burrard and Hayden: *Geography and Geology of the Himalaya Mountains and Tibet*, page 68. † *Op. Cit.*, page 69.

and to separate in one's mind the different spurs from ranges. And one's first impression was of a gigantic game of noughts and crosses or of a jig-saw puzzle upset in the toy department of the Army and Navy Stores.

Gradually, however, impressions began to grow, and the first point one became aware of was the apparent termination of the Sarikōl Range on the northern side of the Taghdumbash. There appeared to be no continuation or connection on the southern side. From the Russian station of Sarblock, and from our high station of Tomtek we could see the so-called Sarikōl Range trending more or less northwards, but there appeared to be no continuation to the south. From Takhtakhūn hill station and from Tomtek we could see far to the south the main Karakoram Range in all its snowy beauty, and much nearer and a good deal lower there appeared due south of Takhtakhūn another range, less grand and imposing, since it seemed lost in the magnificence of the vast waves of this sea of mountain splendour. This appeared as a line of snow-capped peaks, with depressions between them; but still it seemed to us undoubtedly a distinct range, whose highest slopes and peaks were clothed with eternal snow. This range seemed to trend roughly east and west, but how far in the former direction we were unable to estimate, as the view in that direction was cut out by a series of peaks and spurs of about the same height as our station of observation. The photographic survey has since indicated that these peaks lie on a snow-covered range of which the highest points are between 19,000 and 21,000 ft.

It seemed to us then that this southern boundary range of the Pamir Plateau was the possible extension of the Northern Hindu Kush on the west, and later in the season we saw what we assumed to be the latter range approaching the country south of the Kilik Pass, and from our stations on each side of this pass we tried to follow a connection between the two. The country between the Kilik and the Chapursān is a mass of granite peaks; there is a high peak, $\left(\frac{\text{Pk. } 31}{42\ \text{K}}\right)$, south-east of the Kilik Pass, and south of the Mintaka there is a huge dome-shaped peak over 21,000 ft. in height, $\left(\frac{\text{Pk. } 57}{42\ \text{L}}\right)$. Between Misgar and the Kilik and Mintaka Passes practically the whole structure is granite, excepting some striking recent river terraces between Misgar and Murkushi. It appeared to us that there had been an original connection between the range we had seen from Takhtakhūn h.s., and the Northern Hindu Kush, and that this connection used to run south of the present watershed. It seems, too, that this idea would be caused by the forces of denudation at work. Assuming that the Taghdumbash Pamir was at a comparatively recent date covered with a glacial cap, the lower depth to which the Hunza River has cut its bed to the south would

give the latter great power to cut its course back into the dividing range, which would be practically protected by its ice-covering on the northern side. The glaciers on this side would have no chance of equalizing matters and of keeping the watershed true to its axis. This seems to have been the case, and it seems that the connection between the ranges mentioned above extended to a point about 5 miles east of the Mintaka Pass, and then practically followed the present watershed, and possibly joined on to the Aghil Range.

In connection with this southern alignment, we again had an opportunity of observing the neighbourhood of the Mintaka Pass on our return journey. During our march up the Mintaka River on the Pamir side, we came on many erratic boulders of granite which could never have been brought down by the present river, and it seems doubtful whether any Pamir *river* could have transported them. They could not have fallen from the neighbouring hills, which are composed of shales and slates, and therefore they must have been derived from the old Northern Karakoram Range. On leaving the Mintaka River, opposite the snout of the Mintaka Glacier, which may be taken as the present source, one ascends a moraine which appears to be a terminal one, formed by the retreating Mintaka Glacier when it reached the bend and changed its direction from south-east to north. At the top of this moraine near the dâk hut, appear a series of what seem to be the lateral moraines of a glacier which originally came from the direction of the pass. Large granite boulders appear in this moraine, but the formation on either side is still shale. These glaciated granite boulders continue to the summit of the pass, which is now much covered by granite blocks which appear to have fallen from the granite cliffs above, which now line the summit of the pass on either side. These cliffs are extremely steep and the pass is very narrow. From near the top of the pass on looking up the Mintaka Glacier, the crest of the watershed at its head seems to run back in a south-westerly direction, and to join on to the main lines of higher granite peaks, south of the Gulquāja Glacier, which is one of the sources of the Hunza River; it looks as though the present watershed between the Mintaka and the Gulquāja Glaciers is only a spur from this original range, and that the latter glacier originally drained through the gorge which is now the Mintaka Pass. This pass has been formed by the retreat of the Gulquāja Glacier and the closing of its outlet to the north by the granite débris fallen from the cliff walls. Certainly the Gulquāja Glacier must have been at some higher level than it now is; but it seems that this is the only solution that will account for the polished nature of the granite and the high lateral moraines near the top of the pass, which could never have been formed by any diminutive glacier descending from the present pass. This glacier must have been the Gulquāja; the forces at work in these regions are colossal, and one has only to watch the Hunza

River in autumn with its thick pea-soup-like whirl of waters to realize where the cutting power comes from. When the old outlet became choked, the river had a tremendous task before it, but it is probable that by this time the Hunza River had nearly cut its way back and captured the waters of the Gulquāja. The present watershed, as mentioned above, has still on its northern side a covering of shales, while this rock is not met with on the south till below Misgar, and though there is little now in the alignment of ridges and spurs that can be designated by the term *range*, which denotes length and continuity, the high granite peaks south of the passes, one of them rising to over 21,000 ft., seem to confirm the original axis of continuous elevation.

It is perhaps more difficult to trace the width of this range than its continuity, and it now appears more in the nature of a big step on to the Pamir mass. But the fact that the slates on the north of the passes dip approximately to the south-west, at a very high angle, may mean that the original fold was in the form of an inverted anticline to the north-east. It may be a solution that the Sarikōl Range is a long southerly extension of the Trans-Alai or Thian Shan and that with the "rucking up" of the mountains, the crust has become highly compressed in the angle between the Sarikōl and the Trans-Alai. If this were so, it would be natural to assume the crust as "bunded up" against this angle and one would expect the long parallel systems of drainage running from east to west, which is a feature of Pamir topography.

A possible extension of this idea might account for the Kashgar Range to the east. Suppose the Pamir crust to be exerting its pressure against the Sarikōl-Trans-Alai angle, a pressure in the Sarikōl crust from the west would be induced, and this would stand as a buttress in the way of advancing waves of crust from the north or north-east. The Kashgar Range would be the result. There is some evidence that the Sarikōl is older than the Kashgar in the fact that the Tashkurghān River has kept its channel open through a gorge in the Kashgar Range, during the elevation of the latter.*

Appearance of a Portion of the Karakoram Range from the North.

Only a small length, comparatively speaking, of the Karakoram or Hindu Kush Range could be seen at one time from any one station on the Pamir, and this portion lay in the extension of the Karakoram Range, west of the Hunza Gorge. Perhaps the best station of observation was Kilik East h.s., though we seldom had a day clear from haze or clouds from here.

The easternmost point triangulated on this range was $\frac{\text{Pk. } 33}{42 \text{ L}}$. This appears from the north as a large detached peak, the highest

* *Manual of the Geology of India*, 1st Edition, 676 (1879).

thousand feet or so being scarred with rock precipice too steep for much snow to rest upon. Two main arêtes are visible and these meet at a right angle at the summit of the peak and appear to carry slopes of névé on the southern faces. A smaller northern arête abuts the scarred northern face but does not reach the summit. The eastern arête appears to throw out a long buttress toward the north some 3,000 ft. from the top.

Between this peak and $\frac{\text{Pk. } 55}{42\text{ L}}$ there is a marked depression. $\frac{\text{Pk. } 55}{42\text{ L}}$ appears from the north to be a snow pyramid situated on an extensive field of névé, which is almost level, but has a slight gradient upwards to the south-west, where it appears to culminate in a massive dome of eternal snow, which is probably higher than $\frac{\text{Pk. } 55}{42\text{ L}}$, but which offered no point for triangulation. The névé field finishes abruptly on the northern side in an extensive icefall, from which the range appears to fall steeply into the Batūra Glacier valley.

To the west of this dome, the range is depressed to a saddle and then rises and forms a huge massif for which I could as usual obtain no name. The whole was covered with a glittering icecap and presented very few outcrops of rock for many thousands of feet, and contained few points suitable for triangulation. $\frac{\text{Pk. } 32}{42\text{ L}}$, 25,540 ft., is on this massif and appeared approximately the highest point, but there were several rounded domes of snow, some nearer some further off, which made distinction impossible. I considered it advisable to make certain of what appeared to be approximately the highest point of this massif, rather than confuse at so great a distance the work with useless observations.

$\frac{\text{Pk. } 31}{42\text{ L}}$ lies some 2 miles north-west of $\frac{\text{Pk. } 32}{42\text{ L}}$ but was not re-observed, and west-north-west of this another peak, $\frac{\text{Pk. } 48}{42\text{ L}}$, was observed by Mr. McInnes.

$\frac{\text{Pk. } 24}{42\text{ L}}$ is still further to the west and is a true peak, with an outline somewhat similar to Rakaposhi, except that it presented a series of alternate rock arêtes and snow couloirs. This peak could be likened to a head placed on two fairly symmetrical shoulders, the latter being represented by two long sloping arêtes, east and west respectively.

This line of peaks $\frac{\text{Pks. } 24,\ 25,\ 48,\ 31,\ 32,\ 55,\ 33,\ 34,\ 35,\ 67}{42\text{ L}}$ indicates the axis of the Hindu Kush or westerly extension of the Karakoram Range, for a distance of some 35 miles.

SCIENCE AND INDUSTRY.

THE value, and indeed the necessity, of research work as a factor in industrial progress is now becoming generally recognized in this country. This recognition has been somewhat tardy, but it is none the less gratifying, and its ultimate effect cannot fail to be far-reaching.

Especially is research work of importance in connection with our vast engineering industries. It is therefore of great interest that the North East Coast Institution of Engineers and Shipbuilders has recently appointed a Research Committee, and that the latter has already made a start with its work by acceding to the request of a well-known firm in the north to investigate and carry out exhaustive tests of apparatus having for its object the more economical production of power by marine steam engines. By its action it will be the first of the influential technical institutions actively to promote the progress of the industries with which its members are associated by officially making and recording tests of new apparatus developed by them.

A fresh and most valuable field has thus been opened up, and the Institution may also have inaugurated the commencement of a new era in the history of similar institutions—an era in which the application of science to all branches of industry will be immensely extended. For instance, in the introduction and development of improved apparatus much depends on an authoritative pronouncement concerning the results claimed, and this can best be secured through the verdict of independent bodies who are not influenced by commercial considerations.

These bodies already exist in the shape of institutions such as the North East Coast Institution of Engineers and Shipbuilders, and, as the result of their findings would be at the disposal of all, a spirit of industrial co-operation would be engendered that would not only be to the advantage of the industry immediately concerned but for the good of the nation as a whole. Furthermore, an ever-increasing mass of important data would be accumulated, representing the collective knowledge of each industry, and from the publication of this data would result the incidental but highly important effect that much overlapping of experimental work would be avoided. Lack of such data causes experimental work to be undertaken by individual manufacturers in ignorance of, and without opportunity for, ascertaining what has been done in the past

on precisely the same lines. This, of course, involves unnecessary and heavy expenditure and as a consequence, experiments which do not appear to promise any definite result are too often broken off before an ultimate conclusion is reached. It is quite conceivable that in many such cases new discoveries—together with the practicable applications of which such discoveries are susceptible—are missed by us and rediscovered later by our competitors abroad.

It may be stated that the necessity for the establishment of some measure of ordered and systematic research has recently been recognized by the manufacturers in certain trades. Previous to the War both the Institution of Mechanical Engineers and the Institution of Electrical Engineers gave official recognition to the value of research organization by appointing research committees. It was not, however, until war had broken out and we had unpleasant proofs of the dependence upon foreign research of many of our industries—the chemical industry for example—that definite action was taken to meet the demand for closer co-operation between science and manufacture. A notable sequel was the appointment by the Government, in July, 1915, of a Scientific and Industrial Research Committee. Little is as yet known of the actual work carried out during the year by this Committee. It may be that the work will prove of national value, but the existence of such a committee by no means closes the door to research work such as that which has been so promisingly begun by the North East Coast Institution of Engineers and Shipbuilders. Increased efficiency in production is now generally recognized to be the essential factor if the many and complex industrial problems that will inevitably present themselves after the War are to be coped with successfully. The decision of the Institution will certainly prove of the utmost assistance in achieving this end, and is particularly noteworthy in that it is the first practical step towards the joint effort by science and industry to reach a desired goal.

SOCIETY OF ENGINEERS.

Visits to Engineering Works.

We are informed that the Society of Engineers is experiencing considerable difficulty this year in arranging its usual visits to engineering works during the summer. Recently, however, Messrs. Johnson & Phillips were able to show them a portion of their works at Charlton, including a large plant for the manufacture of telephone cables capable of dealing with cables up to 1,000 pairs of small wires for local lines, and also "trunk" cables consisting of fewer but heavier wires.

One shop contained a large number of multiple-headed machines for covering the single wires with one or two layers of paper put on longitudinally or spirally, and forming a more or less loose tube of paper, also a number of special high-speed twinning machines which are used to twist two of the covered conductors together forming the "twin" which is wound on to a larger bobbin. These bobbins are taken to the "laying-up" machines—in another shop. Several of the "laying-up" machines are arranged for laying-up pair telephone cables of which large quantities are made.

Other larger machines consisting of three or four sections, each carrying different numbers of bobbins, are designed to "lay-up" the twinned conductors into cables, each layer of conductors being stranded in opposite directions. These machines will deal with cables up to 150 pairs. If the cable has to be made up with a larger number of pairs, it then goes to a still larger machine having four or five sections, the largest of which carries 70 standard bobbins, or, if necessary, 100 or more narrower bobbins.

The cable can be built up in this machine with several more layers of conductors put on in opposite directions, until it reaches a total of 800 to 1,000 pairs, according to requirements. The cable so made is coiled on to steel drums which are then placed in large steam-heated hermetically sealed chambers, to dry the paper covering, the moisture being carried off by means of an air pump which causes a more or less perfect vacuum in the chamber.

When the cable is thoroughly dried it is taken to the lead-covering press, and coated with lead. These presses consist of a lead container having a point or core and die through which the cable to be covered passes. Two hydraulic rams are arranged to work into

the lead container, and operated on the lead. Above the container is the lead-melting pot, the molten lead being run from the pot into the container where it is allowed a few minutes to "set" and then the hydraulic pressure is applied. The point or core through which the cable passes is cone-shaped, so that when the pressure is applied the lead moves forward off the core and through the die, this being the only exit, and the point of the core being close to the die a tube of lead is formed of such size as to cover the cable, take a grip of it, and pull it through the press as the pipe is formed.

The cable so covered is coiled on to drums and tested under water —with the ends of the pipe and cable projecting, to see that the pipe is quite sound and watertight.

These lead-covering presses can deal with cables of any practical length, without any joint in the lead pipe, because when a charge has as far as practicable been extruded, the hydraulic ram is withdrawn, and a further charge of molten lead is run into the container, and automatically burns itself on to the block of lead which is left in the chamber and around the cable.

In the same department there were a number of stranding machines of various sizes for dealing with copper strands composed of different sizes and numbers of wires as used for cables for power transmission and lighting, also a number of paper insulating machines for covering the strands with varying numbers of layers of paper according to the thickness of insulation required. These machines each have four or five heads, each head having three arms, and each arm adapted to carry three discs of paper, enabling the machines to put on 36 to 45 layers of paper at one operation. The heads of these machines have hollow mandrils through which the cable passes, while the head revolves laying the strips of paper on the cable spirally. From these machines the cable is coiled into steam-heated hermetically sealed pans, all moisture being evaporated and drawn off by means of an air pump. A resinous compound is admitted into the pan while it is still under vacuum, and the dry paper readily takes up the compound, and in a short time becomes thoroughly saturated. When this condition is reached, the vacuum is broken, the pan opened and the cable is passed through the lead-covering press as before described in connection with the telephone cables.

After lead covering, the power and lighting cables are usually armoured with steel wires or steel tapes, and protected with preservative tapes or jute yarns and compounds. The wire armouring machine is practically the same as the large stranding machine, arranged to carry a large number of bobbins: it sometimes being necessary to use as many as 100 or more wires.

The steel taping machine has a very massive head provided with

two worm adjusted quadrants, each of which carry a disc of steel tape. The head has a hollow mandril through which the cable passes, and the head revolving lays the tapes on the cable helically. Each tape is laid on in an "open" helix, the tapes being adjusted so that the outer one covers the space between the coils of the inner tape, so as to provide a perfect shield. Over the steel tapes it is usual to put one or two tapes or layers of jute and compound, and this is done at the same time as the armouring.

In the rubber cable department were seen wires and cables of various sizes being covered with pure and compounded rubbers, afterwards vulcanized and protected by tapes, braiding, etc. Especially interesting were the longitudinal rubber covering machines which are arranged to cover 12 conductors simultaneously with two, three or four layers of rubber. In these machines the wires are made to pass side by side through grooved rollers, while strips of rubber are fed in with the wires—one above, and one below—the rollers, crushing the rubber strip together between the wires, and practically forming a band of 12 covered wires, with a fine fin of rubber between them.

The crushing of the rubber has the effect of uniting the two strips of rubber at the side of each wire, and the fin is so thin that the band easily splits up, leaving 12 separate covered wires, which are coiled on to separate drums.

These rubber-covered conductors are then wound on to steel cylinders and placed in steam-heated pans in which they are submitted to a certain temperature for a certain period, according to the size of the wire or cable, and to the quality of the rubber being dealt with. After this operation the cable is protected with tapes or braiding and preservative compound according to specification.

For making the smaller strands Messrs. Johnson & Phillips, Ltd., have installed many of their latest high-speed stranding machines, which run at speeds of 1,250 to 1,000 revolutions per minute. These are comparatively long machines, with bobbin carriages arranged in a long cage; tandem to one another, and supported in ball bearings, in such a manner that they remain stationary while the cage revolves around them. The cages are splendidly balanced and they are supported at intervals in their length on special rollers which ensure very quiet running.

In addition to the stranding and covering machines, there were also various machines for cutting the rolls of rubber and cloth into strips to suit the various sizes of conductors.

The majority of the rubber-covered cables when completed are tested under water, and the visitors saw several large testing tanks and special testing rooms engaged upon this work.

Practically all the machines used by Messrs. Johnson & Phillips, Ltd., in their cable-making department are of their own manufacture, this work being a speciality of theirs. Owing to the short time at the disposal of the members, we were unable to go through various other shops engaged in the manufacture of transformers, switchboards, and switch gear: instruments, arc lamps, etc., but we spent a short time in the general engineering shop which is usually engaged in the manufacture of all kinds of cable-making machinery and of cable picking-up and paying-out gears and equipments for submarine cable steamers, but which this time was engaged on various munitions work.

REVIEW.

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).

(*Concluded*).

SIEGE OF TU-YEN-KWAN, *23rd November*, 1884, *to 3rd March*, 1885.

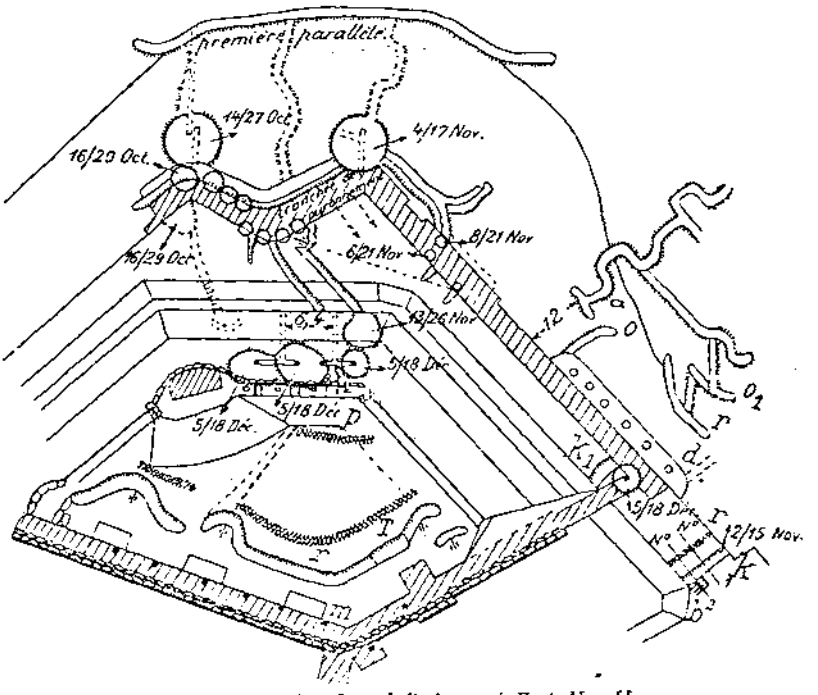
During the Tonkinese War 600 men held Tu-yen-kwan against a Chinese army. The latter fired 10,000 shells and 1,000,000 cartridges, opened 5 miles of trenches, excavated 10 galleries, and fired 7 mines. Improvements to the defences and countermine works were all directed by Serjt. Bobillot, of the Engineers, to whose zeal, intelligence and initiative the success of the defence was in a great measure due. The defenders had no powder for mines, all they could do was to try to penetrate the enemy's galleries, and if not successful in doing so, at any rate their countermine galleries might constitute a species of safety valves, and dissipate harmlessly to some extent the effect of the enemy's explosions. The little garrison held out long enough to enable a column to arrive to relieve them.

SIEGE OF PORT ARTHUR, *May*, 1904—*January*, 1905.

Omitting all general description of the country, fortifications, and strengths of the rival armies, the progress of the underground warfare only will be followed. The most important works were those undertaken against three of the detached forts, North Ki-kwan, East Erh-lung and Song-shu-shan. The Russians were driven within their main line of defence on the 28th of July, 1904. Between the 19th and 25th of August the Japanese Army, under General Nogi, attempted an *attaque brusquée*, and gained a little ground, but it was evident that regular siege works would have to be undertaken.

North Ki-kwan Fort is pentagonal in shape, its front facing north-east. The parapets of the face and flanks were 10½ ft. above the terreplein and 24½ ft. thick. The ditches were not revetted, and were about 13½ ft. deep and 25 ft. wide. The flank ditches were enfiladed from casemates built opposite the front face in the counterscarp, which was indented for that purpose. The walls and roofs of these casemates were of concrete 3 ft. thick. Communication with the interior of the fort was by a counterscarp gallery sloping downwards along the right flank as far as the gorge, and then by a passage under the ditch. At the time of the siege these galleries were incomplete. Double-storeyed barracks with ditches closed the gorge faces, and the gorge ditch to the left was

flanked by a caponier. Sandbag parapets were erected on the barrack roof. There was a bridge over the gorge ditch which was under fire from the Japanese position.



Works of Attack and Defence of Fort No. II.

At each flank of the casemates in the salient two arches had been left, from which countermine galleries were to have been driven, but these had not been commenced. By the middle of September the Japanese saps were not far from the fort, and it appeared that further progress was being made by mining. On the 14th countermining was begun by parties of 16 men with 8-hour reliefs; the Sappers were untrained in mining, most of the picks and shovels had been lost in the advanced positions (Nan-shan, etc.) and those bought locally were of very inferior quality. Later on a few tools of extreme lightness and strength were captured from the Japanese, indeed they were the object of several sorties. In the left-hand gallery work proceeded rapidly, in the right-hand gallery rock had to be removed with hammer and chisel.

As nothing definite was known of the Japanese mines, a sortie was organized on the 15th of October. The troops were armed with rifles, hand grenades and torpedoes of guncotton in tin cylinders, the last intended for blowing up the Japanese mine shafts. The sortie failed, and a similar attempt next day met with as little success, countermining proceeded therefore very much by guess work. On the 16th the left gallery was about 17 ft. long when the crater of a Japanese shell was broken into. As no plans of the fort were available, the gallery had

been driven too close to the surface of the glacis. The opening was closed and a shaft sunk a yard further back to 13-ft. depth, whence the gallery was continued towards the front. Part of the shaft was cased in, the remainder was not revetted. On the 17th accessory defences were prepared by fixing fraises on the berms, wire entanglements in the ditches, and fougasses and planks studded with nails on the glacis. Every fougasse to be fired electrically was abortive; the conductors had been laid on the ground, and were all sooner or later cut by shells.

On the 20th of October a fairly successful sortie took place, and it was ascertained that the Japanese had two galleries, one directed towards the centre of the front face, and another towards the left salient. This was, as a matter of fact, wrong, there was only one gallery; it would appear that the reports of soldiers were relied upon, and that no officer had been specially detailed to verify the information. On the 23rd from the left gallery the Japanese miners were heard, on the 24th the Japanese stopped work when the Russians did so, and *vice versâ*. It was evident that each knew of the other's presence. On 25th two more shafts were sunk in the floor of the casemates, whence fresh galleries could be driven if required. On the 26th it was estimated that the Japanese were only 5 ft. away, to the left of and slightly above the Russians. Lieut.-Colonel Rachevski, of the Engineers, calculated at 210 lbs. the charge for what was intended to be a camouflet, with L.L.R. of 21 ft., and coefficient for loamy soil, but Colonel Grigorenko, the Chief Engineer, using the higher coefficient for rock, decided to use 285 lbs. There was no powder nor means of ignition in the fort, and an officer of the *fougassiers* was sent for to bring the necessary materials. At 8 p.m. the Governor, Lieut.-General Smirnov, arrived, gave orders to charge the mine, and expressed a wish to fire it himself. Five detonators were placed in the charge, the conductors were 5-stranded and lead sheathed, and were taken from the mine in two groups in case of accident. A man watched a galvanometer during the charging and tamping to make sure of the electrical continuity of the circuit. A man was placed in the gallery to work with a pick, and deceive the Japanese as to what was really going on. Air spaces seem to have been left in the tamping. The mine was fired at mid-day on the 27th of October, and two officers standing in the casemates close to the entrance to the gallery heard no noise at all. Mr. David James, an English correspondent with the Japanese, relates that a squad of six of the Engineers of the guard worked till the last endeavouring to reach the Russian mine and remove the powder. Three were afterwards taken out badly wounded, the other three must have been killed. The explosion destroyed a large portion of the Japanese gallery, at the same time the ground was so disintegrated that the latter were able next day quickly to drive a sap up to the concrete wall of the casemates. Another report states that a corner of the building was actually exposed at the rear edge of the crater.

On the 28th the Japanese blew a large hole in the corner of the casemate, the explosion extinguishing the lights in the rooms. Miners' candles were distributed and lighted, rifles posted to prevent the Japanese entry, and attempts were made to block the hole with sandbags. A sandbag parapet was erected in the next room opposite the communi-

cating archway. The Japanese now blew up the sandbags in the hole they had made, and leaping in, drove the Russians behind their parapet, and placed a machine gun opposite it. Hand grenades were thrown, and the air became so vitiated that the candles were again extinguished. A Russian grenade set fire to some explosives brought by the Japanese, partially wrecking the casemates, and driving the Russians back to the further rooms. Colonel Rachewski now arrived, order was restored, and the Japanese driven out. After some time an officer of the Russian Engineers and a soldier managed to slide into the ditch, and blew in a loophole of the casemate on the left of the Japanese sap, entered the room, and secured themselves with sandbags. Grenades thrown through the hole, and a hot fire from the ramparts, checked all further approaches of the Japanese, on the other hand neither could the Russians break out.

The Russians now placed explosives in the walls separating the rooms of the casemates in their rear, for use in case they were driven back. They were arranged to be fired electrically from the counterscarp gallery. Meanwhile their right gallery had advanced about 35 ft., and a charge of 575 lbs. powder was placed in it. On the night of the 30th of October the Japanese breached the roofs of the remaining three rooms of the left half of the block of casemates, and drove the Russians into the right half. The Russians were thus no longer able to enfilade the ditch of the left flank of the fort. A party of Japanese tried to escalade the escarp, but were driven back.

On the 31st Japanese assaulted the right half of the casemates; the countermine prepared in the right gallery was fired and they retired. At 7 and 9 p.m. general assaults were made and repulsed.

On the 2nd of November the Japanese drove a sap round the back of their half of the casemates, and, entering the ditch by holes made in the front wall, managed to secure themselves on the exterior slope of the front face. In order to make sure of hitting them in this position the Russians had to tie grenades to cords, or their missiles rolled harmlessly into the ditch. The Japanese made wire screens to catch them, and could not be dislodged, indeed they had commenced a mine gallery in the exterior slope. The Russians placed a *cheval de frise* in front of the site of the expected explosion.

By the 9th of November the Russians had been driven out of three of the five rooms in the right half of the casemates, and the Japanese had pushed a mine gallery along the outside towards the right. On the 10th the Russians fired a second countermine from their right gallery. The tamping was insufficient, and smoke and flames were forced back into the casemate, but the Japanese gallery seems to have been damaged. On the 14th a third countermine was fired, of guncotton this time, as there was so little space for tamping. Some Japanese must have been cut off in their trenches by this explosion; they presently sent five carrier pigeons out to convey news of their predicament.

The Japanese were still heard at work outside the casemates, and on the 17th a fourth mine was fired from the right-hand gallery. It was at first intended to fire 70 lbs. guncotton, but this charge was doubled in the hope of securing a greater effect. The result was disastrous for the Russians. The back wall of the casemates was shattered, and the

opening into the countermine gallery was exposed. The Japanese then attacked, but were driven off. A traverse was built opposite the opening, and a sort of fougasse was prepared and fired, but its only effect was to knock down the traverse. The latter could not be restored, and the Russians withdrew from the last casemate into the counterscarp gallery. The fight for the casemate had lasted six weeks, and for the next month a desperate struggle underground was to follow for possession of the gallery.

On the 19th of November the Japanese placed a 3-in. gun in the casemates, and destroyed the gorge caponier, but this gun was shortly put out of action by fire from the Little Eagle's Nest Battery. Three other guns consecutively met with the same fate. The Japanese then tried pumping an irrespirable gas into the counterscarp gallery, but this was remedied by making another opening, and operating a diver's pump to increase the ventilation.

On the 21st of November the Japanese boldly entered the ditch and blew in the wall of the counterscarp gallery behind the Russians, and fired through the opening with a 2-in. gun which they had brought into action in the ditch, behind the parapet of the covered way they had built leading to their gallery under the escarp of the front face. The Russians retired behind the next breastwork which they had erected, and a third breastwork was constructed further in rear. The Japanese also sapped along the back of the gallery wall, and blew another hole opposite that made from the ditch. The arched roof was blown in, and more asphyxiating gas pumped in, probably obtained by burning guncotton or melinite. The hole in the roof could not be closed for fear of suffocation.

The Japanese now made a traversed approach from the Kouropatkin Redoubt, which they had captured in September, towards the middle of the gallery, where the wall had not yet been covered with earth. They were within 50 ft. when the Russians began a counter-approach from the back of the wall. Fortunately a Russian sortie from the Kouropatkin Lunette succeeded in partly destroying the Japanese trenches.

Work on the gallery under the parapet had been pushed on actively, and on the afternoon of the 26th of November, after a tremendous cannonade from the siege batteries, the Japanese exploded two mines on the front face near the right salient, and assaulted the fort. A hand-to-hand fight ensued, and the Japanese were ultimately repulsed. At 1 p.m. Colonel Aoki himself rushed on to the parapet with the flag of his regiment, but the attack he led was also repulsed with great loss. The Japanese, however, held on to the mine craters and were only driven from them after nightfall. This was part of a general assault on all the works, in which the Japanese lost 12,000 men.

A calm followed, and the opportunity was seized by the Russians to construct a retrenchment in the fort, opposite the expected breach, and place in it two guns and two machine guns. The Japanese also recommenced their work on the exterior slope in spite of the grenades thrown by the garrison. They also repaired their sap opposite the right flank. While collecting their wounded the Russians took note of two Japanese mine galleries under the parapet on a level with the berm

near the right salient, and another near the left. The retrenchment was strengthened with wire entanglement.

On the 4th of December the Russians unsuccessfully attempted to demolish, during a sortie, the Japanese approach on the right flank. They placed automatic fougasses in the hollow behind the wall of the counterscarp gallery, which besides causing loss to the enemy, would serve to warn the Little Eagle's Nest Battery that the fort was being attacked. Shots were still being exchanged daily in the counterscarp gallery.

On the 9th of December the Russians began to drive a gallery from the counterscarp gallery towards the Japanese saps on that flank. By the 13th the hourly expectation of explosions under the front parapet had reduced the garrison to an indescribable state of nervous tension. To counteract this two Boules' shafts were sunk in the terreplein for countermines, and a listening gallery in the parapet was loaded as a mine. On the 15th the Japanese threw some lighted arsenical compound into the counterscarp gallery to smoke out the Russians. Some hours later General Kondratenko and Colonel Rachevski were killed in the fort by the bursting of a 28-cm. shell. In the death of the latter the defence experienced a severe loss.

Up to the 17th of December there was great indecision about charging the Boules' shafts in the fort. Capt. Schwartz, of the Engineers, wished to charge them, his arguments being firstly, that a Russian explosion would cause no panic in the fort, and would forestall the enemy, and secondly, that if the latter overheard the Russians tamping they would promptly fire their mines, but the garrison would be prepared for such an event, and would not be caught unprepared. General Foch would give no decided answer, so von Schwartz referred to General Gorbatovski, who consulted the Chief Engineer. A council was convened and it was decided to charge the shafts on the 18th. This was too late.

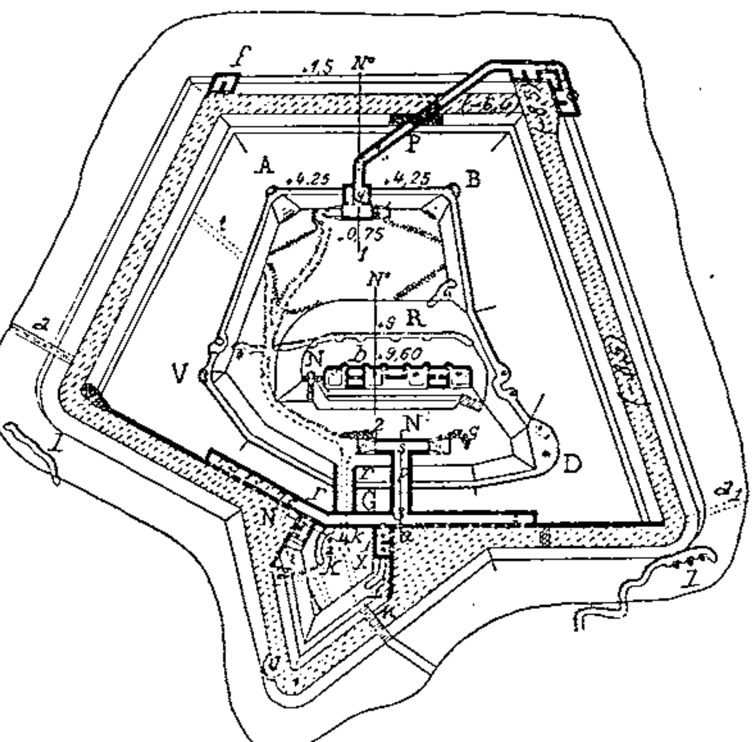
On the 18th at 10 a.m. the Japanese opened a heavy fire on the fort. At about 1.30 p.m. three successive explosions took place in the front face of the fort, and the intensity of the fire was increased. As soon as order was restored guns and machine guns were cleared of the earth which covered them. A Japanese assault after the first explosion had been repulsed, a second assault after the second explosion was overwhelmed by the third explosion, which appears to have been premature. At 3 p.m. Colonel Aoki's regiment held the forward edge of the craters. Only 20 Russians in the fort remained fit for duty, and a counter-attack delivered by them failed. Reinforcements arrived, but their efforts were in vain; the Japanese erected a breastwork of sandbags on the edge of the craters, and placed machine guns behind it. By evening all the guns in the fort had been dismounted, and at 11 p.m. the garrison evacuated the fort, bearing with them wounded, ammunition, breech blocks, machine guns and provisions. The guns had to be abandoned, as the gorge bridge had been broken down. When the tail of the column was 100 yards from the fort the barracks were blown up with the explosives already placed in readiness in the walls.

Numerous comments have already been made on the folly of building counterscarp galleries exposed to a mine attack without adequate countermine protection. From the point of view of fortification it is

interesting to note the efficient flanking defence afforded to the right flank of North Ki-kwan by the Little Eagle's Nest Battery. Doubtless the Great Eagle's Nest had as efficiently enfiladed the left flank, certainly the Japanese made no advance against that flank although they were in possession of the left end of the salient casemate at the end of October.

As regards the mine defence it seems evident that the Russians were unskilled in this nature of work. It was commenced too late, and the anxiety displayed over the arrangements for the first mine shows that it was considered no ordinary matter. Russian tenacity prevented the Japanese from immediately profiting by their capture of the left end of the casemates, but it is surprising that no attempt was made to countermine the Japanese advance under the front parapet. It cannot be argued that the enemy's fire prevented any work in the fort, since the Russians were able to build a retrenchment, and place obstacles there. In this particular instance borings would have been of immense service, but the Russians had no apparatus.

East Erh-lung Fort was situated on a spur of the Dragon Range. It and Fort Song-shu-shan mutually supported each other. The work consisted of a front and two flank faces with a curved gorge. At the outbreak of the war the ditches, cut in the rock, the concrete case-



Plan of Fort No. III.—Scale 1 : 2000.

mates at the forward angles of the counterscarp, and the concrete barracks closing the gorge, were just completed; the parapets had not been built and work was at once put in hand. Those of the front and flanks consisted of the natural rock with 2 to 3 ft. of earth over it. The gorge parapet was on the roof of the barracks, revetted with cement barrels and sandbags. Sandbag loopholes were made on all faces, the front face was also traversed. The left flank was exposed to view and reverse fire from Ta-ku-shan, and in August the banquette was widened, and a parados provided. The right flank was enfiladed from Wolf's Hill, and was given traverses and overhead cover of wooden beams covered with earth.

The terreplein was bare rock, and was covered with 1 ft. of earth. In the centre was a battery for four 6-in. guns, and an observatory tower. Officers' quarters, kitchens, magazines and latrines were all improvised. The front ditch was 21 ft. deep, and 28 ft. wide, the flank ditches sloped up to the gorge, the scarps were all vertical. In the right salient of the counterscarp was an L-shaped block of casemates for enfilade fire along the front and right flank ditches, a smaller casemate in the left salient flanked the left flank ditch. The former was reached by a passage under the ditch leading from the centre of the front face, the inner end of this passage was defended by a guard room. No gallery had yet been built to the casemate in the left salient, this casemate was therefore only approachable from the ditch and was consequently isolated. At the foot of the glacis was a wire entanglement.

It was only when the Russians found their counterscarp casemates threatened by the Japanese that they began to countermine. They first dug a trench in the glacis to defend the right casemate, and placed under it in shafts three mines of 70 lbs. of powder each. On the 26th of October when forced to abandon this trench they blew it up. Two openings were then made in the back wall of the right casemate whence it was intended to drive countermine galleries 30 ft. long, to join them by an envelope gallery, and excavate mine galleries from that. There were only seven sappers available, and hardly any tools for rock cutting, so that work was very slow. On the 28th a sortie was made to try to damage the saps constructed by the Japanese from the trench which had been abandoned and blown up, and which the Japanese had repaired and occupied. Another sortie was made next night, both were unsuccessful. On the 29th the Japanese were heard working behind the right casemate wall, and at 4.30 a.m. next day they blew a hole in it about 7 ft. in diameter and rushed in. The Russians retired by the passage leaving behind two 37-mm. guns and two machine guns. The passage was then blocked with sandbags and boxes of earth at a point under the parapet. The Japanese wrecked the casemate, and demolished part of the front wall. A general assault was made that day; the columns reached the crest of the glacis, and brought scaling ladders and light footbridges, but these were all too short for the deep and wide ditches. Fire from the fort and adjacent works dispersed the attack. The left casemate had been cut off all day, and that night its garrison fell back into the fort. No countermining had taken place on that side. Although the Japanese advance had been by sap only, yet in a

week's time they had won to the counterscarp; it had been very different at North Ki-kwan where the countermines, although commenced very late, delayed the attackers for three weeks.

The Russians now built two walls of stone in cement to block the passage under the front face; the first, close behind the barricade they had made, was solid except for a listening hole, the second, some yards further back had an opening at the top to throw grenades through, a shuttered loophole, and a manhole at the bottom.

By the 10th of November the Japanese had completed the works with which they crowned the glacis. On that day they blew up the casemate of the left salient, and made preparations to drive a mine gallery under the front ditch. They also attempted to bridge the ditch from the right casemate till a hot fire caused them to cease. On the 17th further attempts were made to demolish the right casemate, but the front wall was only cracked.

On the 18th more sappers were sent to the fort, and placed three charges each of 55 lbs. of melinite under the foundations of the passage guard room, so that it could be blown up if captured. Under the parapet of the left flank, and on the banquette, fougasses, each of 50 lbs. guncotton, were prepared, the electric conductors were buried 18 in. and the ends taken to the barrack. On the 19th, two countermine galleries were commenced, one from the right wall of the passage, between the two stone walls, the second from the banquette of the front face on the left of the passage. The reinforcement of sappers was now withdrawn, and those in the fort only continued the work half-heartedly.

On the 20th the Japanese blew down the counterscarp of the front face in three places, and threw a quantity of faggots into the ditch. Three companies tried an assault which failed. From the 22nd to the 25th several further attempts to cross the ditch were foiled, and the brushwood was occasionally set on fire by grenades, torpedoes, rags soaked in oil and tar, tar barrels, and other combustibles, but the fires were soon extinguished. The Japanese fired a small charge in the exterior slope of the parapet itself to facilitate escalading, and masked their approach from the right salient by a strong sandbag traverse. On the 26th another assault was checked by fire from the retrenchment, and a counter-attack with the bayonet drove the assailants back into the ditch.

On the 1st of December the Russians heard from the passage the sound of Japanese pickaxes, and there was no longer any doubt that the latter were mining under the parapet. Information was also received from Fort Song-shu-shan that the mouth of the gallery was visible, and might even be destroyed by a lucky shot. On the 8th of December owing to the rocky nature of the soil the Japanese had to blast in their gallery under the left salient, the explosions were distinctly audible, and the blows of picks were also heard under the centre of the front face. On the 18th of December a reinforcement of 12 sappers was sent from North Ki-kwan after it had been captured by the Japanese. The Russian countermine galleries were now only 13 and 10 ft. long respectively.

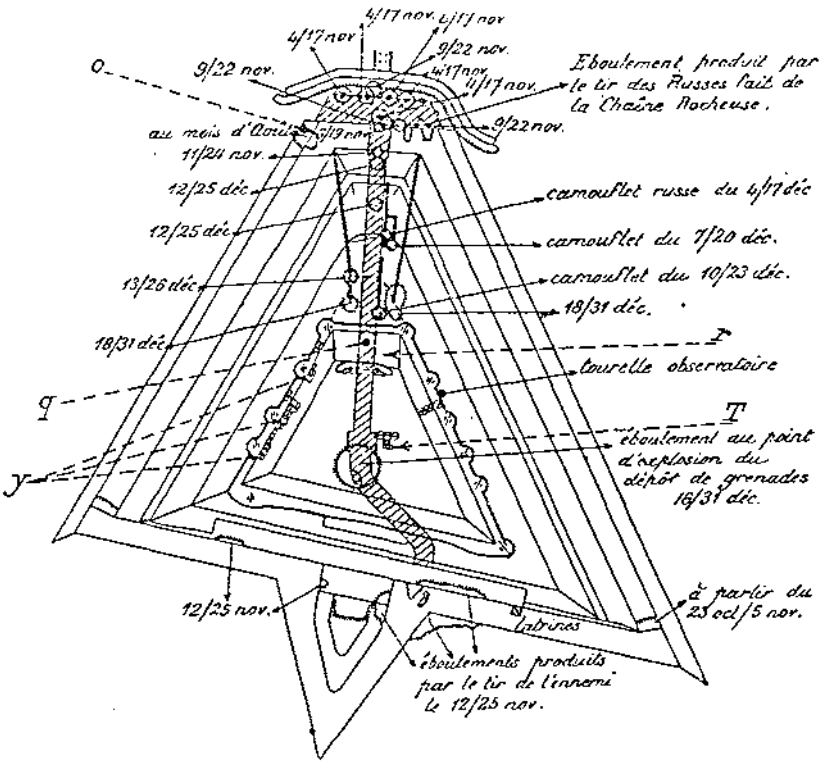
On the 21st of December General Gorbatovski issued an order, based on the lessons of North Ki-kwan, in regard to the dispositions to be made when the front face was blown up. The craters were to be occu-

pied at once, the troops taking filled sandbags with them. The cover would be better there than further in rear. The men were to be warned that there was nothing to fear from the explosions, and that the escalading would be carried out with some reluctance.

On the 27th the Japanese charged their mines, and, by keeping men at work with picks, completely deceived the Russians as to what was going on. The explosion was therefore quite unexpected. It occurred on the morning of the 28th, and was so violent that the walls of the barracks were shaken and the lights extinguished. Two large craters were formed, one on each side of the entrance to the passage under the ditch, and though formed in rock, the parapet was absolutely shorn off to the level of the terreplein. Large numbers of the assaulting troops were buried under the débris. The fort was shelled vigorously, even 11-in. guns being used. Ensign Poseda collected what troops he could find to defend the front face, but the Japanese held them at bay, and fifteen minutes after the explosions threw themselves on to the parapet. The Russian batteries and forts within range deluged the glacis and ditch with projectiles, but as they were themselves subjected to a heavy fire from the Japanese, their fire was not very effective. The Japanese succeeded in occupying and crowning the craters. Capt. Boulgakov, Commandant of the Fort, twice tried to lead parties from the barracks against the enemy, but the outlets were only wide enough for three men abreast, the Japanese machine guns mowed them down, and the counter-attacks failed. At 11 a.m. the fougasses prepared on the left flank were fired, and attempts were made to fire the charges placed under the foundations of the guard room, but they failed to explode. The central battery was by this time a ruin, but the Russians still held on to it. During the afternoon the Japanese crept slowly on, and at length captured the retrenchment. They now commanded the exits from the barracks, rapidly established flying saps, then a deeper trench in which they placed machine guns. Small parties tried to work round the flanks and turn the gorge, but still Capt. Boulgakov would not give in. At about 10 p.m. Lieut.-Colonel Gandourine, who was in command of that section of the defence, ordered the evacuation of the fort, and made arrangements for removing the wounded. The garrison retreated, taking with them their machine guns, ammunition, and provisions. The evacuation was completed by 2 a.m. on the 29th of December. The bedding in the barracks was saturated with kerosine, and set on fire, and the fuzes attached to some torpedoes stored near the gate were lighted. The bursting of these destroyed part of the passage, and the Japanese, for fear of further explosions, only entered the barracks next day. There remained in the fort three dismounted 6-in., seven 2-in., and a few other guns, which had all been rendered unserviceable before the evacuation.

Fort Song-shu-shan was of similar construction to the two forts above described, but was in trace triangular, with a blunted apex. The right flank was 82 yards long, the left 70 yards, and the gorge 83. The parapets had not been constructed, nor the ditch levelled. The flank ditches were enfiladed by casemates in the apex of the counterscarp, a caponier across the ditch joined these casemates to the fort, and provided flanking

fire for the short front face. To prevent an enemy from using the roof of the caponier as a bridge, it had been intended to fix an iron palisade across it, but this had not been made when the siege commenced. The concrete barrack closing the gorge was a low narrow corridor with barred windows. Opposite the centre and joined to the barrack was a caponier to flank the gorge ditch and containing officers' quarters, etc.



Work No. 3.—Scale 1 : 2000.

To the right of the gorge caponier, on a level with the ditch, was a door leading into the barracks. Opposite this was a passage leading up to the terreplein in the centre of the fort, where were openings to each side, covered by traverses. Beyond these openings the passage descended again to the caponier and casemates in the apex of the fort. Across the terreplein the passage was unroofed. On the outbreak of the war the parapets and revetment of the counterscarp were hurried on, and above the barracks, under the gorge parapet were placed blindages to serve as kitchens, stores, etc. The garrison was one company and a detachment of artillery. The glacis was surrounded by wire entanglement.

By the end of October, 1904, the fort had already successfully resisted several assaults, and the Japanese were established at the foot of the glacis. It had been proposed in September to countermine from the front casemates, but it was hardly expected that the Japanese could

mine in the rocky soil, workmen and special tools were wanting, and countermining was postponed till the 27th of October, by which date it was evident that the safety of the casemates was imperilled. Two galleries were then commenced from the back of the casemates. On the 30th the Japanese made another assault, but their scaling ladders were too short to reach the bottom of the ditch (28 ft. deep). Their saps had, however, nearly reached the crest of the glacis over the casemates, and from thence they sallied out and threw bags full of rags into the ditch, and returning again, repeated the operation. They then jumped into the ditch and climbed the exterior slope. Received by the fire of the garrison from the parapets and casemate, and by reverse fire from the neighbouring works, they were forced to retreat with loss. During this assault a shell burst in the passage across the fort, killed two officers, one of whom was Capt. Chemetillo, Commandant of the Fort, and exploded a magazine, which caused great damage to the exits from the passage on to the terreplein. Fortunately reinforcements arrived at that moment.

The Japanese now crowned the glacis with a sandbag parapet, and commenced sinking shafts to blow in the roof of the casemates. On the 31st the Japanese ladders left in the ditch were destroyed with torpedoes. On the 5th of November the Japanese were clearly heard working on the roof of the casemate. It was decided to close the openings into the countermines, which had only been driven for about 7 ft. each, and on the 7th the casemates were vacated, and the opening into the caponier was walled up. This work was completed by the 10th, and meanwhile the sinking of the Japanese shafts was interrupted as much as possible by grenades, torpedoes, etc. The Japanese fixed thick wire screens to protect themselves, and many of the missiles burst harmlessly.

Owing to the hardness of the rock the Japanese mines were only ready to fire on the 17th of November. There was one on the roof, and six in the back wall of the casemates. Two of the latter missed fire, but the back wall was pierced and the front wall shaken. On the 18th the Russians retired behind a breastwork which they had built in the passage where it opened into the caponier, and placed a pom-pom there. The Japanese made further attempts to wreck the casemates, and on the 22nd a charge was exploded against the caponier, but did little damage.

On the 26th another assault was repulsed; the Japanese began to mine under the parapet, and the Russians sank a shaft and placed 35 lbs. powder at the end of a short gallery driven through the right wall of the passage just behind their first breastwork. It was to be fired electrically when required, but the wires were broken, and the mine was never used. Meanwhile a duel took place between the Russian pom-pom and a machine gun fixed by the Japanese in the casemate at the outer end of the caponier. Grenades were also used, and the air in the passage could hardly be kept fresh by a diver's pump placed at the outlet into the fort. It was now found that the Japanese were mining outside the right wall of the passage, and on the 5th of December the first breastwork was forsaken for a second about 25 yards further back. Some days later the first breastwork was partly wrecked by the Japanese. Another mine gallery was driven out to the right from behind No. 2 breastwork,

and it and the passage were lighted by electric lamps. On the 6th the Japanese were heard at work in the caponier and in the parapet of the front face, and it was proposed to make a sortie to ascertain what they were doing, but the idea was abandoned. On the 11th various noises betrayed to listeners in the passage the gradual advance of the Japanese. The Russian gallery behind the second breastwork had been driven about 6 ft., and then turned to the front at right angles, parallel to the passage. On the 15th it was calculated that the head was about 5 ft. from the Japanese gallery. A mine chamber was excavated and loaded with 100 lbs. of powder, tamped with sandbags and wooden frames. To prevent damage to the wall of the passage sandbags were piled on the inside and strutted back from the opposite wall. Blows on the wall of the passage deceived the Japanese, who had no idea that a mine was being charged. At 2 a.m. on the 17th the countermine was fired and must have been effectual. Heartrending cries were heard, and numbers of Japanese rushed out of their gallery into the ditch.

From Japanese sources it has been ascertained since the war that the Japanese were working on the following plan. First, by Boules' shafts to demolish the caponier, and second, to make two covered ways in the parapet to enable them to reach the interior of the fort without being hammered by the neighbouring works. To this end they had driven two galleries, one on each side of the passage, from the extremities of the front face. Then perceiving that the fort possessed this passage they drove a third gallery outside its right wall. It was this gallery that was damaged by the Russians.

In spite of careful tamping the passage had been filled with fumes, and could not be entered for half an hour. Nine hours later sounds of mining were heard further to the rear, the countermine gallery was untamped, and a branch commenced at an angle of 135 degrees. Three days later it was about 11½ ft. long, and the Japanese were close enough to be reached by a second camouflet. 70 lbs. of powder was placed in position and fired. The effect on the enemy was insignificant, and owing to poor tamping the passage was filled with smoke. The Japanese were soon at work again, and it was decided to remove the tamping and prolong the gallery, and also to begin another gallery near a third breastwork which had been built across the passage just in front of a vertical through the superior crest of the front parapet. However the Japanese were heard at work outside between the second and third breastworks, and work was concentrated on the new gallery only. This was sufficiently far advanced by 23rd for 40 lbs. of powder to be placed in it and fired. The enemy's gallery was destroyed, and the tamping was so carefully carried out that no fumes entered the passage. On removing the tamping the end of the Japanese gallery was found to be exposed, and a hail of rifle bullets greeted the miners. 20 lbs. of powder was laid in the open and fired, driving back the Japanese. It was decided to bring up a small q.f. gun, and then enter the enemy's mine, but while arrangements were being made the Japanese fired a mine laid on the ground, killing and wounding eight Russians. Work was now suspended on both sides.

The detachment of sappers in the fort had been reinforced on the 20th of December, and fresh galleries were driven right and left from the

passage just behind the third breastwork. The Japanese were heard on the 23rd working on the roof between the first and second breastworks, the latter was therefore demolished in case it might be of use to them. The roof was blown in on the 25th, and grenades thrown into the passage, which produced such a suffocating smoke that the Russians had to retire behind their third breastwork, where a 1½-in. gun had been placed. On the 26th the Japanese fired a mine in the front parapet. Their tamping seems to have been insufficient, and little damage was done, the loopholes were unharmed, and the sentries remained at their posts. Grenades were thrown into the crater, but no assault was made by the Japanese, although they opened a heavy fire on the fort. On the 27th the Japanese tried to enter the passage, and threw in asphyxiating grenades, but the Russians kept them at bay.

By the 28th all the parapets were broken down, and through the earth banks covering the barracks the concrete walls showed in places. The outlet from the passage which was damaged on the 30th of October had been repaired, a sandbag parapet protected it on the right, and after the capture of East Erh-lung it was found necessary to protect the left flank by a parados. Preparations had also been made to blow up the barracks in case of necessity, 10 shafts had been sunk with chambers for 60 lbs. of guncotton each, and were ready by the 30th. On that date the work was violently bombarded. Charges had not been placed in the shafts in the barracks, but were stored under the beds, with detonators and Bickford's fuze ready fixed.

At 9 a.m. on the 31st two explosions sounded from the parapet caused by Japanese mines on either side of the passage. That on the left had little effect, on the right an oblong crater appeared, but still the crest was untouched. However the consequences were most disastrous; the garrison issued in a mass from the barracks, when a soldier struck with his foot a grenade placed in a magazine in the passage. The magazine blew up instantly, killing a large number of the defenders. Besides this, for some reason as yet unexplained, the charges of guncotton placed under the beds in the barracks were detonated and wrecked the whole building, 122 men out of the 250 then in the fort being killed. The Japanese rushed in over the ruins of the barracks and occupied the gorge, and the reinforcements hurried up by the Russians were forced to retire. General Gorbatovski telephoned an order for the garrison to surrender, seeing that it was impossible for more than a very few to save themselves by flight. 128 were made prisoners, of whom 65 were wounded. The subterranean war had lasted two months.

It may be deduced from the foregoing that as a general rule one mine gallery is insufficient. The opponent then has full liberty of action, and can avoid the danger. A system of galleries is required, especially in the case of defence by countermines.

One salient fact in all these operations was the capture, after a comparatively short period, of the casemates flanking the ditches of the three works. Shortly stated the events were as follows:—After the failure of their general assaults in August, the Japanese proceeded to construct regular siege works. In September and in October they again tried to carry the works by assault from a shorter distance but again

failed. At the end of October at Fort North Ki-kwan, after ten days of close approaches, they were in touch with the left end of the casemates, and on 30th they obtained possession of that end, but, hindered by the second Russian countermine, one branch of which protected the right half, it took them three weeks to completely capture the whole block. At Erh-lung East, where countermining was not commenced in time, the flanking work was taken on the 30th of October after a week only of close approaches. At Song-shu-shan, on the 5th of November, the Japanese threatened the walls of the casemates, there were no countermines, and the Russians being unable to make any defence had to abandon the flanking work. Comment is superfluous: the courage and stedfastness of the troops is unquestionable, it was only want of weapons, *i.e.*, of countermines, that led to the loss of the forts. A more stubborn defence of the glacis above ground could not have put a stop to the Japanese approaches. On an average, 2,000 grenades a day were used by the Russians besides other projectiles. Numerous sorties were made, which except for small local successes had no real effect on preventing the Japanese progress whether by sap or mine. The result would indisputably have been very different had a sound system of countermine galleries, prepared in peace time, been available from which to initiate a systematic underground defence.

A second fact which stands out clearly is the blowing up of the parapet as a prelude to the final assault. In all the three cases above described the processes were similar. After the capture of the works flanking the ditches successive assaults were attempted, preparations for which were made by constructing passages across the ditch, or by collecting scaling ladders and footbridges. Thanks to the mutual support afforded to each other by the forts, the more fragile implements were rapidly destroyed. The old methods were then resorted to, the counterscarp was demolished, forming several roads for columns into the ditch, and heavy masses were poured over the parapet. As a preliminary to the last, the parapet was razed to the ground and thrown into the ditch, and to effect this the Japanese attacked with the spade the dead angles in the ditch, and buried themselves in the parapet out of reach of grenades and other projectiles, their progress only being interrupted by a few hastily constructed countermines. The parapets which had valiantly withstood the heavy artillery were not proof against these methods. The explosions disheartened the garrison while the ardour of the attackers was enhanced, and rushing over the smoking ruins the latter were soon in possession of the conquered fort.

We may here be allowed to diverge slightly from subterranean warfare to emphasize the close connection which ought to exist, during the attack on a fortified position, between the sappers and the infantry. After a lapse of two centuries it is no longer the artillery that must be enabled to close round the work, but the infantry. There are obstacles to destroy, gaps to be made in wire entanglements or other accessory defences, ditches to be filled up, parapets to be blown down, and conquered localities to be made good. All this is the work of the sapper, who precedes the infantry and smooths his path. A thankless task very often; the general public has a tendency to ignore the fourth arm.

At Port Arthur, for the final assault on the works, a battalion of sappers always preceded the infantry, and there is no doubt that success was in a great measure due to the intimate association of the two arms. It is well to lay stress on this fact, viz., that strong bodies of sappers, carefully trained and disciplined to meet the difficulties and complexities of their comprehensive duties, are absolutely indispensable in the attack of fortified positions.

Among various surprises afforded by the Russo-Japanese War must be mentioned the use of mining in field warfare. During the winter of 1904-05 the belligerents were stationary for some months on the banks of the Sha-ho. The distance between the outposts was barely 100 yards. The *Revue du Genie*, 1907, Vol. XXXIV., p. 5, published details of this episode of the war. The Russians held the right bank, the Japanese the left, the latter also held the bridge of the Trans-Siberian Railway and had organized a bridgehead on the right bank of the river. To capture it the Russians constructed several retrenchments, and then advanced by sap and mine. To meet this move the Japanese drove two galleries, one along the railway embankment against one of the retrenchments, the other against the Russian mine. On the night of 27th February the Russians attacked the bridgehead, and a reconnoitring party of sappers entered the Japanese galleries, securing as trophies several objects left behind by the Japanese in their precipitate flight. The bridgehead was abandoned.

There was another war of mines at the village of Li-chia-pu, where the Russians occupied a fortified retrenchment about 300 yards from the village temple, which was held by the Japanese. In November, 1904, a Captain of Engineers proposed driving a gallery to blow up the temple, but his suggestion was not adopted till the middle of the following January. It then became clear that the Japanese had carried a quantity of earth out of their temple, and subterranean noises were heard. The General accordingly ordered a system of countermines to be prepared in front of the retrenchment, work was put in hand and proceeded at the rate of about 25 ft. a day. By the 24th of February the head of the gallery was rather more than half-way to the temple. Noises were still heard, and the Russians, becoming apprehensive, opened a branch gallery, and on the 27th a Japanese miner's pick pierced the floor of this gallery. Several mine chambers were then made and loaded; in all 2,000 lbs. of powder were used, and on the 28th the Japanese gallery was destroyed. There had been no means of ventilating the long gallery: the miners frequently collapsed, and had to be relieved.

The war in Manchuria inaugurated the era of long battles, and without drawing general conclusions from these episodes of the war, it may not be rash to predict that in certain circumstances mines may be used in the attack and defence of fieldworks. Certainly defended positions which form pivots of manœuvre might well be protected by fougasses with electric connections carried underground; the vulnerability of conductors laid on the surface is too well known. Fired at the right time these fougasses might check the impetus of an assault more surely than any other means.

The writer concludes his interesting work by a short discussion of

the probability of a European conflict being of sufficient duration to call for the employment of mining. It may be assumed that, in order to bring the war to a conclusion with the least possible delay, every legitimate means will be employed to defeat the adversary, and of these means mining is certainly not the least. The timely establishment of countermines will provide for the early extension of an active method of defence. In view of this possibility, however important may be the theoretical and historical study of the effects of mines, such study is not to be compared with practical experience. Mine warfare is, without doubt, an excellent way of training officers and men, it develops initiative and a sense of personality. The problems to be resolved are various and call for instant decision, the caprices of powder and the trickiness of soils demand constant study, the anxiety to guard against surprise stimulates listeners and observers, the deductions to be made in regard to the distances of sounds strengthen the judgment, and the old stager will form a correct opinion from one single fact where a beginner would fall into error. Attack and defence by mining should undoubtedly be practised constantly during peace, the lessons to be drawn from it are invaluable.

A.R.R.

NOTICES OF MAGAZINES.

REVUE MILITAIRE SUISSE.

No. 5.—May, 1916.

FIRE ACTION AGAINST AEROPLANES.

The article on the above subject commenced in the *Revue* for April, 1916 (*vide R.E. Journal* for July), is continued in the May number of the publication.

In this part of the article, the question of directing fire at targets at considerable altitudes above the earth is mathematically examined as a problem in elementary ballistics. If the trajectories of projectiles aimed at stationary targets at various altitudes above the earth, but at the *same distance from the spot whence the projectiles are assumed to be discharged*, be plotted a number of parabolic curves will be obtained. An examination of the curves thus obtained will at once show that where two targets are situated, one on the same horizontal plane as that from which projectiles are being fired, and the other at a considerable elevation above this horizontal plane, *e.g.*, so that the line of sight makes an angle of 40 degrees with the horizontal plane, then in taking aim the backsight must in the latter case be set for a shorter range than in the case of the former target.

If a number of trajectories for targets at various altitudes be plotted, it becomes possible to ascertain by inspection for what range the backsight must be set so as to hit an elevated target at any known distance from the point of discharge of the projectile aimed at it. Where the target is vertically above the firing point the range at which the backsight must be set to hit it is always a minimum for a given distance between a moving target and the firing point.

For a projectile to be effective against a given target it must possess sufficient energy ($E=\frac{1}{2}mv^2$), at the moment the target is struck, to do damage. The energy of a projectile in flight decreases very rapidly with the range, *e.g.*, in a particular case where the energy of a projectile is 2,700 ft.-lbs. at the muzzle of the gun, it falls to 270 ft.-lbs. at a range of 2,000 yards. As a rule, therefore, it is little use firing at aeroplanes in flight at ranges exceeding 2,000 yards.

Some of the expedients adopted by the machine-gun companies of the Swiss Army for utilizing their weapons against aircraft are referred to in the *Revue* article, and a number of photographs are reproduced showing detachments with machine guns ready for action against aircraft.

NOTES AND NEWS.

Switzerland.—A special contributor writes that the Federal Council and the General Staff have during the past few weeks been issuing a series of notes and orders on aerial defence and army boots. The Swiss soldier is said to have been hitherto very badly shod, but henceforth there will be little reason to complain in this respect.

A further violation of Swiss neutrality, more grave than that when German bombs were dropped on Porrentruy, is stated to have occurred; a German aeroplane has flown over and bombarded Delle. This time not only has the incident roused anger in French-Swiss circles alone, but also in other quarters. The Federal Council is said to have delivered an "energetic" remonstrance to the offending Power, and has received profuse apologies. The Swiss Government has decided that the incident shall now be regarded as closed.

Meanwhile, measures have been taken by the higher authorities to give "air pirates" a warm reception when next they come uninvited over Swiss territory; sentries and detachments are now permitted to open fire against foreign aircraft on the orders of an N.C.O. as well as of officers; formerly they could only do so on the order of an officer.

A reference is made to the arrival of the wounded and sick soldiers who are to be interned in Switzerland, and the hope is expressed that these victims of duty will derive benefit from their sojourn in the Swiss mountains.

The confidence shown by the belligerents in entrusting the care of their wounded soldiers to the Swiss is much appreciated by them: they expect not only that the soldier visitors will enable them to make good some of the loss arising out of the War but see in the arrival of their visitors also a guarantee that Swiss neutrality will be respected.

Portugal.—A special correspondent refers to the fact that Germany has at last declared war on Portugal. The doctrine of the German diplomats is that he who is not with Germany is against her. The Portuguese showed at the very beginning of the War to which side their sympathies inclined. Since then Portugal has done all she could to assist her historical ally, Great Britain. To the fact that Portugal has been thus loyal to an old friend has been attributed the invasion of Angola, on which occasion the Germans murdered the Portuguese Commandant of a frontier post. The torpedoing of Portuguese merchantmen was probably due to the same cause. Fortunately, the Portuguese Government was in a position to retaliate with effect, and promptly requisitioned the German ships which had taken shelter in her neutral waters. The action of the Portuguese Government in requisitioning the German shipping in Portugal was perfectly legal, since the doctrine of "Eminent Domain" has still the fullest force in that land; there was no violation either of the municipal law of the country, or of international law, or of treaty obligations. However, Germany sent a note declaring the action of Portugal to be a violation of international law and also of treaty obligations and in consequence broke off diplomatic relations.

The Portuguese are not in any way disturbed by the German thunder.

No. 6.—June, 1916.

PREVENTIVE MEASURES IN RELATION TO NERVOUS AND MENTAL DISEASES IN THE ARMY.

The article dealing with the above subject appearing in the number of the *Revue* under review is a reprint of a paper read before the "Société suisse de Neurologie" on the 14th May, 1916. The author of the paper points out that the world-wide war now raging has brought home to

every thinking person, in a more forcible manner than any other event in the history of mankind, how imperatively necessary it is that an army shall be composed wholly of men who are absolutely sound in mind and in body. Among the "undesirables" of an army none are a greater source of danger to it in the field than men liable to nervous or mental disorders. Such men may easily place an army in extreme peril at critical moments, and are at all times a dangerous and disturbing element; they should be got rid of as quickly as possible after the symptoms of their malady are first observed. Naturally it would be better still if "defectives" could be prevented from joining the colours altogether. The success of the preventive measures for dealing with nervous and mental disorders among soldiers depends on the thoroughness with which "undesirables" belonging to the mentally defective classes are kept out of the ranks of an army.

A very wide field would have to be covered in order to deal with the subject of the paper exhaustively; the intention of the author of the paper is not so ambitious, he confines himself to the treatment of preventive measures in connection with certain diseases under the three following heads:—

(i.). Recruiting for the army.
(ii.). Campaign against alcoholism.
(iii.). Prevention of venereal diseases.

In the introductory part of the paper extracts are given from statistical tables relating to the diseases under investigation as affecting the Swiss Army. It would appear that from the date of the mobilization of the Swiss Army on the 1st August, 1914, to 31st December, 1915, 28,050 men were invalided; out of this total 4,602 cases (*i.e.* about one-sixth) were due to alcoholism, and mental and nervous diseases.

Recruiting.—The question of the classification of men invalided from the Army is discussed under the heading "Recruiting." It is pointed out that the Swiss instructions for the classification of the men invalided out of the service are based on the *Prussian Instructions for Medical Officers*, issued in 1858 and revised in 1875. In accordance with these instructions men discharged on account of mental derangement are shown under two main groups, (*a*) congenital infirmities (*e.g.*, feeble-mindedness, lunacy, idiocy) and (*b*) mental diseases properly so-called. The question of the classification of invalided men under the various subheads of these two groups is next discussed and it is pointed out that the French expressions used for the subheads in the German classification are, at times, not strictly correct from a pathological point of view, as for instance in the translation of *geistige Beschränktheit* by *manque d'intelligence*. It is pointed out that this question possesses an importance greater than that of the mere choice of words; for recruiting purposes it is essential that precise information of the causes for which men were invalided should be on record and this necessarily involves the use of words which clearly define the entries found under them. For it must be borne in mind that serious mistakes made in relation to recruiting may have far-reaching effects on the finances of a State.

The number of men invalided from the Swiss Army between the 1st August, 1914, and the 31st December, 1915, for tuberculosis is next

dealt with. This number was 4,572, that is to say, nearly equal to the number invalided for alcoholism and mental and nervous diseases referred to above. Men suffering from this disease make bad soldiers.

The author of the paper is of opinion that it would be a mistake to discharge all epileptics from the army in accordance with the strict interpretation of the letter of the law. Many of those in this class of "undesirables" are capable of useful service in the non-combatant ranks, so long as they abstain from alcohol.

Those who desire further information on this branch of the subject are recommended to read *Les maladies mentales dans l'armée suisse* (*Le Caducée* of 5th June, 1909) by Dr. Haury, and *Les anormaux et les malades mentaux au régiment*, by the same author.

Campaign against Alcoholism.—As was the case in Germany and in France, so also in Switzerland as soon as mobilization was ordered a great wave of intemperance passed through the land. The measures adopted in various countries since the beginning of the War to fight the drink curse are touched upon in the paper. Control of the liquor traffic by the restriction of the sale of intoxicants to soldiers has proved most effective. In an article which appeared in the *Intransigeant* of the 9th April, 1915, the statement occurs: "In the army, alcoholism has been almost entirely stamped out. For many months past the men in the front line and in the trenches have not tasted alcohol; they have become accustomed to doing without it, they have ceased to have a longing for it, they do not even think about it."

In some "Notes" by a sub-prefect published in the *Revue de Paris* for 1st May, 1915, the statement occurs: "The modern young man contemns alcoholism and debauchery. . . . Out of about 2,400 conscripts of the 1915, 1916, and 1917 classes, I did not see a single one drunk, either before the Appeal Tribunal or in barracks. . . ."

Prevention of Venereal Diseases.—It is hardly necessary to draw attention to the part alcohol and syphilis play in the etiology of nervous and mental diseases. An examination into the personal or the hereditary antecedents of the majority of persons suffering from nervous or mental breakdown discloses either alcoholism or syphilis (or both these) as a contributory cause of the patient's condition.

Medical men have unfortunately divided themselves into two separate and opposing camps on the question of the methods to be adopted for combating these diseases; those who are for regulating prostitution and those who advocate its total abolition.

The author of the paper urges that medical men should deal with this question as one of hygiene and of therapeutics, and that they should not mix up with the medical aspects of the question considerations affecting police measures concerning public decency and offences against the moral law.

It is suggested that the two best methods of meeting the situation are (*a*) by giving lectures to the troops and familiarizing them with the dangers of alcoholism and of venereal diseases, and (*b*) by providing healthy recreation and amusements for soldiers during their leisure hours, in order to draw them away from drinking dens and loose company.

THE BELGIAN ARMY IN THE FIELD.

In the rapid survey of the operations of the Belgian Army which appears in the June number of the *Revue* two questions broadly are considered; first, what could one have reasonably expected from the Belgian Army at the period just prior to the War? And secondly, what has been the real influence of the part played by the Belgian Army in the great European struggle?

If, just prior to the 1st August, 1914, the question had been put, What do you *think* the Belgian Army will be able to do in the coming war? A large majority of people in Europe would unquestionably have replied: Not much. This was certainly the general opinion held in Germany, as events have proved. However, the course of the War has shown how erroneous were the opinions held even in quarters where a correct appreciation of the situation might have been expected.

A very large number of Belgians had as little confidence in the power of their army to defend the Fatherland as the Germans had respect for it. The vast majority of the Belgians were entirely opposed to an increase in military power on the part of their country, and a large number of deputies had successfully sought election to the popular Chamber on a clearly antimilitarist ticket. The formula adopted by an important group of the Government party was: No one need be a soldier against his wish (Niemand gedwongen Soldaat).

The Roman Catholic Press lulled the public to sleep by teachings of which the following is a brief summary: "The great Powers of Europe have guaranteed by their signature our neutrality and our independence. We cannot take up the attitude that we have no confidence in their pledges. Why then should we maintain a powerful army? Against whom can we use it? All we want is a small army of sufficient strength to do police duties as a frontier guard as was the case in 1870."

The Belgians now know what faith to put in treaties and guarantees.

In spite of the ridicule heaped by many Belgian politicians on their army, there were clear-sighted patriots in the land who worked assiduously with the object of seeing that their country was provided with an army capable of meeting her needs as well in relation to her geographical position as in relation to her wealth and economic power. No one worked more devotedly in the interests of the little kingdom in this matter than the late king, Leopold II., and he was ably assisted by Baron de Broqueville, the present Belgian War Minister.

The Belgian Army prior to the War.—Some little time before the present war the Belgian Army was in a deplorable condition and was deteriorating more and more as each day passed.

Officially, the Active Army had a strength of 100,000 men and was organized into four Divisions and two Cavalry Divisions.

The four Divisions each consisted of 12 battalions of 1,000 rifles each, a battalion of carabiniers, two regiments of artillery (72 guns), an engineer group and military police.

The two Cavalry Divisions consisted each of four regiments and two batteries of artillery.

The peace establishment was 42,500 men (about $\frac{1}{180}$ of the population). The annual drafts of recruits amounted to 18,000 men. Colour service

only lasted 15 months in the infantry. The effective peace strength was much below the peace establishment. For financial and other reasons many men were always compulsorily absent on leave. Thus ordinarily not more than the equivalent of half the numbers of the peace establishment were present with the colours. The Belgian Army was indeed a phantom army. Companies were only from 15 to 20 strong, so that companies and battalions from many different regiments had to be brought together from the several garrison towns in order to form units of suitable strength for training purposes.

In considering the value of Belgians as soldiers it is said that they are on the whole an intelligent, willing and tenacious people, but their independence and capacity for fault-finding renders them somewhat insubordinate.

The natural characteristics of the recruit, as stated above, and the general conditions which existed in the Belgian Army had, as might be expected, an unfortunate influence on the training of the soldier. Discipline was very lax, and the perpetual interference on the part of civil and religious authorities, when punishments were awarded to offending soldiers, tended to accentuate this unfortunate state of affairs. It is not surprising then that even the keenest officers became dispirited in time.

The officers of the Belgian Army are on the whole a well educated and intelligent body of men, who have received a very thorough education in military subjects. Wasters there certainly were in the Officer Corps when war broke out, but as soon as hostilities began they were given short shrift.

The Belgian Army took the field well armed and equipped, except that it was without heavy artillery. It started the War with 324 field pieces (the " 75 " gun) and 120 machine guns (these were of the Hotchkiss and Maxim types).

A detailed examination into the causes which led to the fall of Antwerp, Liège and Namur would be interesting, but the consideration of this question is reserved for a future occasion. As is well known the fortifications of Antwerp were being remodelled when war broke out, and the detached works provided for the defence of this important place were still without their new armament.

The uniform of the Belgian Army in the pre-war days was perhaps the most unpractical and anti-hygienic of any worn in Europe. Attempts to introduce reforms had failed owing to the intense conservatism of the older school of officers.

Briefly then, prior to the outbreak of the War, the Belgian Army was weak in numbers, ill-disciplined and poorly trained; the Belgian Nation reposed too great confidence in treaty stipulations, moreover it was unwilling to bear the cost of defensive measures. The general situation in the little kingdom was not calculated to raise the spirits of its well-wishers.

Nevertheless the part played by the Belgian Army in the present war has been considerable.

The fight put up by Belgian troops at the beginning of the War, very probably settled the final issue of the Great Conflict now raging. The stand of the Belgian Army on the banks of the Meuse, of the Gette,

of the Nether and lastly on the Yser undoubtedly upset the strategic plans of the Great General Staff in Berlin. The crushing German blow intended to be delivered at France miscarried in consequence. The intervention of the Belgian Army was the sand which threw the German machinery out of gear. By the time the last of the forts at Namur had surrendered, the mobilization of the French Army was completed. During the first three weeks of the Campaign Germany, it is said, found it necessary to detach half a million men from her invading army to deal with the Belgians. In the western theatre, Germany set in motion 12 Army Corps at the beginning of the War; these Corps were preceded and flanked by 12 cavalry regiments and accompanied by 2,000 guns, heavy and light. During these three weeks, the Germans are said to have suffered losses amounting to 10 per cent. of their effectives. The Belgians had, at this time, little more than 100,000 men in the field.

During the next phase of the operations—end of August to October 1914—the remnants of the Belgian Army contributed valuable assistance to the Anglo-French troops in Belgium. For many long days, the Belgians held up several German Army Corps which were urgently required by von Kluck and for the German outflanking manœuvre in the north of France.

During the decisive days of the fighting on the Marne, the sorties of the Belgian Divisions in Antwerp caused serious inconvenience to the Germany Army; troops on the way to reinforce the Germans opposing General Manoury had to be diverted to Antwerp.

The fortress of Antwerp had little influence, *per se*, on the operations; it stood no chance against the long-range heavy artillery brought against it.

The last phase in the field operations in which the Army of King Albert played a part was at the First Battle on the Yser, and here again, it accomplished great things. The German advance on Dunkirk and Calais was barred by Belgian soldiers, and the German attempt to outflank the Allied Armies in Flanders and northern France was thus completely foiled. The German hope of a rapid and complete victory faded away here. Since those days what remains of the Belgian Army has been engaged on the left of the long line which extends from the North Sea to the Alps, adding to the renown of the great deeds it accomplished in the autumn of 1914.

The *Revue* article is illustrated with photographic reproductions relating to the Belgian Army.—(*To be continued*).

THE PSYCHOLOGY OF DRILL.

There are some who argue that drill is of value as an educative factor in forming and strengthening will power and that this can be shown to be true on psychological grounds. Advocates of the use of drill as a means for developing will power hold the view that the rational method of training will power consists, in the earliest stages, in the rapid and accurate execution of certain simple muscular movements which are repeated until the stage of perfection is reached.

Such persons desire to strengthen the will power of a soldier in the same way that a man develops his muscles by repeated relaxations and

contractions of the same; the object aimed at by them is to inculcate the most implicit obedience in a soldier.

The writer of the *Revue* article admits that drill can be usefully utilized for training will power, but too much drill, he says, only causes a man to lose interest in soldiering, and bores him; too much drill destroys the spirit of troops, gives rise to discontent and hence weakens the *morale* of the soldier. The greater the value that a man puts on his individuality the greater is the destructive effect of too much drill; this is so more particularly in a highly democratic country and in the case of an army composed of citizen-soldiers.

The principles contained in *Scouting for Boys*, by General Sir Robert Baden-Powell, are, in the opinion of the writer of the *Revue* article, better adapted for training soldiers for defensive warfare than drill. These principles are psychological; they tend not only to raise the *morale* of the man, but at the same time to improve his technical knowledge.

Notes and News.

Switzerland.—In a reference to the arrival of wounded British soldiers in Switzerland surprise is expressed at the hostile attitude shown by a part of the Swiss Press towards Great Britain. It is pointed out that Switzerland has less reason for anticipating difficulties in her relations with Great Britain than in the case of her powerful neighbours, particularly in view of the principles of liberalism and tolerance with which the British public are imbued.

Attention is called to the article by Monsieur André de Bavier entitled *L'Angleterre Chevaleresque* published in the *Revue des Jeunes* for 10th April, 1916, in which are discussed the policy of Great Britain and the moral principles on which the character of the British people are founded. In the article in question it is shown that British statesmen have at all times held out for the rights of other nations, even when Great Britain's interests have been adversely affected thereby. The Chinese War of 1856 is cited as an example; in this case many Englishmen openly stated that their own country was in the wrong and China in the right. On this occasion a Vote of Censure was moved against the Government, which at that time enjoyed the popular favour and could have met the situation by dissolving Parliament. Nevertheless the Vote of Censure was passed; 263 members voting for and 247 against the motion. Another example quoted is the moral support given by the British Press to Switzerland in 1861, when the Swiss Confederation came into collision with the Government of Napoleon III. in relation to the claim of the latter to the Vallée des Dappes in the Canton of Vaud.

Great Britain had already done Switzerland a signal service in 1847, when Austria and Prussia were about to interfere in Swiss affairs at the time of the Sonderbund. Lord Palmerston set his face against the interference of foreign Powers in this matter and thus enabled the Federal Diet to deal with the situation promptly and effectively. General Dufour soon put an end to the Sonderbund and the pretext for foreign intervention immediately disappeared.

Canada.—A special correspondent contributes an article in which attention is drawn to the part Canada has been playing in the world

war. Canada has set herself the task of providing a contingent of half a million men out of her population of 8,000,000. Up to the 1st January, 1916, she had raised 225,000 men, of whom 120,000 have crossed the Atlantic. The enrolment of the balance of 275,000 men is being prosecuted with vigour.

Canada's contribution to the Expeditionary Force consists mainly of infantry; artillery is difficult to raise and train in a colony such as Canada and there has been no very great demand for cavalry since resort was had to trench warfare.

The Militia is being retained in Canada as a sedentary reserve to meet unforeseen eventualities, but the officers are allowed to transfer to "Overseas" battalions. Officers who have returned from the front are in many cases attached to the "Overseas" battalions now in training in Canada; in spite of climatic difficulties the new levies are being rapidly trained for service in Europe.

Special schools have been formed for the training of officers. At the McGill University, Montreal, a special Canadian Officers' Training Corps has been formed. The University has already furnished 200 officers and 2,000 N.C.O.'s and men to the Army.

The cost of the Canadian Contingent is being entirely borne by the Colony. The Dominion has also organized workshops for the manufacture of munitions, and 454 workshops, employing some 225,000 persons, are at the present time busily engaged in turning out shells, etc.

The question of finding employment, on the declaration of peace, for those who are now fighting the Empire's battles is receiving attention. A proposal has been put forward by a Canadian M.P. that a certain number of positions in the public services should be reserved for men who have served at the front. The President of the Canadian Pacific Railway, Lord Shaughnessy, is interesting himself in a movement having for its object the settlement of soldiers on the land as agriculturists.

This number of the *Revue* concludes with a Bibliography.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

April, 1916.

GERMANY.

Incendiary Bombs and Explosive Bombs thrown from Airships.—The bombs thrown from the Zeppelin which made an incursion over Paris on the night of the 30th January belong to two types; incendiary bombs and explosive bombs. The first have been described in this review. The others according to the *Génie Civil*, *No.* 8, are of spherical form constructed of steel or of castings of relatively small thickness—from 15 to 25 mm.—and of two sizes; one with a diameter of 320 mm. and a weight of 60 kg. and the other having a diameter of 380 mm. and a weight of 100 kg. The internal charges are respectively 20 kg. and 30 kg. and of trinitrotoluene. A percussion fuze is used with a small retarding end or tail which lasts for a considerable time so that

the bomb when it strikes a building does not burst until after it has penetrated deeply, thus causing grave damage.

From calculations it is inferred that one of these bombs falling from a height of 3,000 m. would assume in a vacuum a velocity of over 240 m. per second; actually on account of the resistance of the air the velocity would probably be less than 200 m. per second. A bomb weighing 60 kg. fell on a tunnel not far from a station where the vaulted arch is less than 2 m. in thickness; the bomb produced a crater of 5 by 6 m. dimension, but the railway lines were not damaged and the traffic was soon restored. A building of 5 stories with brick walls of 33 cm. was entirely demolished by the explosion of another bomb.

One of the enemy's dirigibles threw 18 explosive bombs of 60 kg. and 100 kg.; it was estimated that the charge of these was about 1,400 kg.

Another airship threw 19 incendiary bombs and 27 explosive bombs, the charges of these being over 2 tons.

Twenty-six persons were killed and 27 wounded.

United States.

Increase to the Defences of the Panama Canal.—The Panama Government is showing itself disposed to assign to the United States the land required for the construction of new batteries of heavy calibre at the mouths of the canal according to the project prepared by General Goethals for improving their defences. These lands will comprise the city of Chagres at the mouth of the river of the same name, and several other small towns and suburbs. The treaty between the State Department and the Ministry of Panama is proceeding on good terms, says the *Army and Navy Journal* of New York.

Coast Defences.—At the military meeting of Congress General E. M. Weaver, Commandant of Coast Artillery, speaking of the reorganization of the Army said that it would not be impossible for a fleet effectively to bombard New York and San Francisco previous to a disembarkation; he declared that the conditions of these two towns are such as to need all possible attention, since the guns posted for their defence have not sufficient range to keep at a distance ships armed with the latest powerful weapons. He added that measures should be taken to remedy provisionally this situation, installing 40 cannon of 305 mm., that were now at Sandy Hook, on carriages permitting of great elevation, and long ranges, while there are under construction cannon of 406 mm. for sea defences with ranges equal to those of the most powerful guns carried by modern ships. It should not be forgotten, adds General Weaver, that for probability of striking the target and exactness of fire, the coast guns are to those installed on board ships as 8 to 1.

France.

Consumption and Production of Munitions.—When in France Albert Thomas was nominated Under-Secretary for Munitions the problem presented to him was to produce with the greatest possible care, an enormous quantity of war material according to the requirements of the supreme command of the army. But there were no factories in working order, material was wanting and 50 per cent. of the workmen had been mobilized.

Four of the French departments occupied by the Germans (Nord, Pas de Calais, Ardennes, Meurthe and Moselle) represented alone 77 per cent. of the French metallurgical industry (6,723,000,000 tons on a total production of 8,714,000,000 tons). The Germans had occupied in the north of France, the fossil carbon mines, which previous to the War gave 68 per cent. of the entire production of fossil carbon of France; they have now in their hands 68 per cent. of the French production of coke, 76 per cent. of steel.

It is calculated that at the commencement of hostilities France disposed of resources of 3,235,000 h.p. of which 1,173,000 or 34 per cent. were in the above-named departments. All this horse power was lost by the French and utilized by the Germans. Of useful machines now working, 81,675 belong to the four departments of which more than 16 per cent., 12,887, are now for the most part working for the German war industry. Under such circumstances it was no light duty for M. Thomas to create an industry to double the production and to provide the skilled workmen for want of whom a great number of offices were closed.

Some time ago the French Minister of Public Works ordered an inquiry on the condition of 26,610 establishments that in peace times employed 1,097,670 employees; the result being that while in August, 1914, 42 per cent. of those employed were absent—for the most part at the Front- in the following October there were at work 68 per cent. of the normal number.

Since it was evident that the issue of the War depended upon munitions, a great number of workmen were recalled by a decree from the Front and were sent to work in the munition factories.

The quantity of material and of munitions required for the War seems almost incredible. In the War of 1870-71 the German Artillery did not in any battle fire more than 200 shots per piece; during the Russian-Japanese War the consumption of munitions was doubled; in the Battle of Tachicaio one Russian battery fired an average of 522 shots per piece.

Altogether 817,000 cannon shots were fired during the Franco-German War of which 479,000 were against fortifications and the rest in field battles; during the Russian-Japanese War there were 954,000 cannon shots; at the commencement of the first campaign the most intense artillery fire took place at the Battle of St. Privat when 39,000 shots were fired.

With these lists it is interesting to confront the following from the present war; in one day, over a front of only 8 km., the German artillery fired about 100,000 projectiles; the consumption was even more during the battles in Galicia; a French communication of the 17th June, 1915, relates that to the north of Arras, in the course of 24 hours, the trenches and the German reinforcements were struck by 300,000 projectiles, as many as were fired by the German Artillery in the whole of the campaign of 1870–71.

The weight of these 300,000 projectiles was about 4,500 tons, and for their transport 300 large railway wagons and 4,000 munition cars were necessary. These 24 hours of fire cost France 9,375,000 francs.

E. T. THACKERAY.