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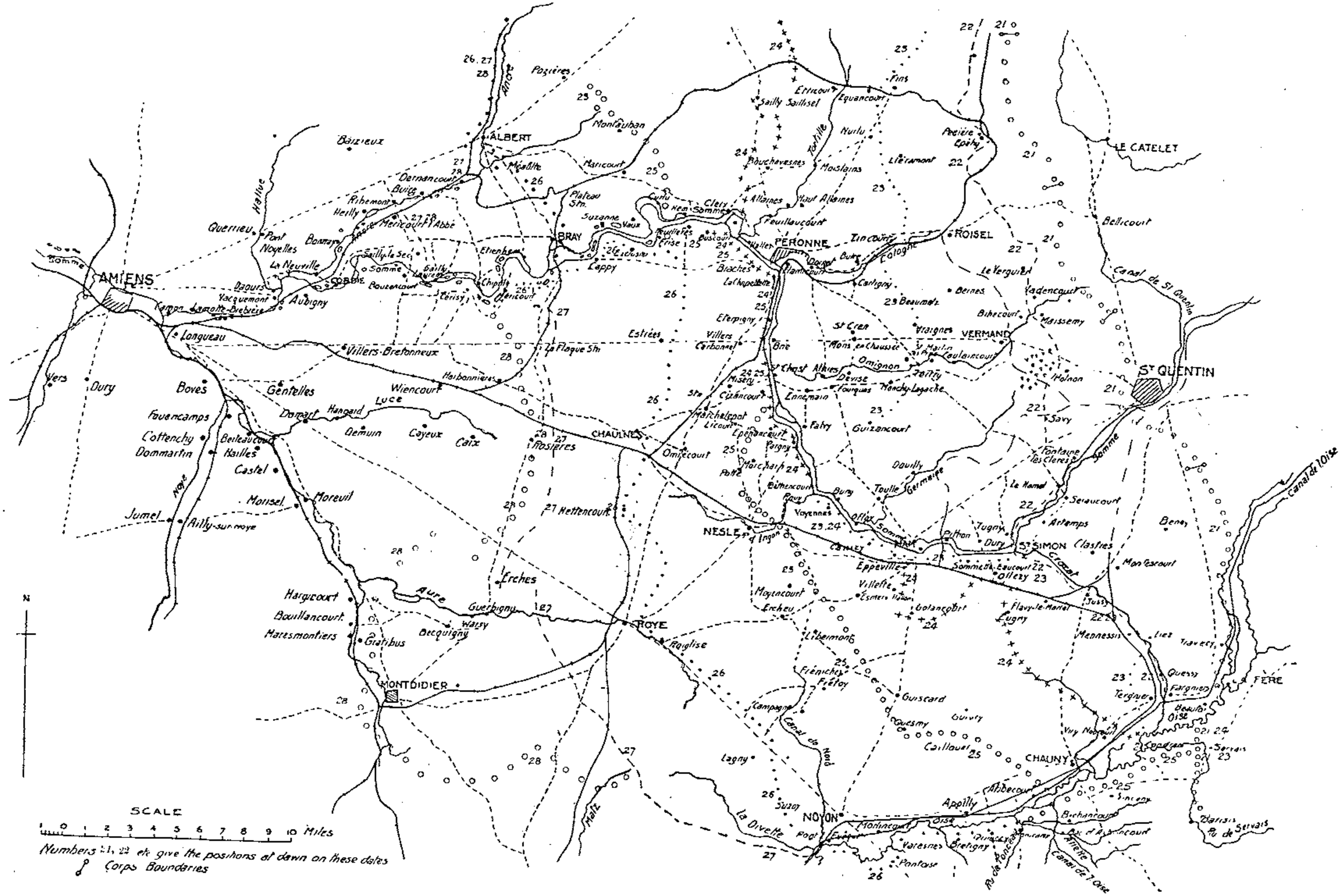
DEMOLITIONS, FIFTH ARMY, 1918.



From the figures given by the III. Corps it looks as if bridges prepared by them and handed over to the French must have been included as " not destroyed."

I must conclude by thanking my 85 correspondents for the help they have so kindly given. I am especially indebted to Brig.-General Sir James Edmonds and the whole of his staff at Audit House, where diaries of staffs and units, boxes of reports and correspondence, and copies of the daily position maps, prepared for the Official History now being written, were always produced at a moment's notice. I have also to thank Colonel E. E. B. Mackintosh, A.A.G., R.E., and his staff, for tracing the addresses of many of the temporary R.E. officers with whom I wished to communicate.

ADDENDUM.

With reference to the road bridge at Trilport destroyed by Lieut. Perkins on 3rd September, 1914, and to the footnote on page 235 of *The R.E. Journal*, June, 1932 :—

Major Gordon Dill, then a subaltern in the 5th Lancers, tells me that he saw a German car which had fallen into the river here, owing, apparently, to the driver (travelling west) not having seen the gap in the bridge. It was lying in shallow water, not very badly damaged, and the occupants had escaped, but in it was a letter written by a German Staff Officer to his wife. A French picture postcard, sent me by Major V. P. Smith, shows a car lying in the gap.

It is curious that a car was trapped both here and at Isles les Villenoy.

"HOW SOON CAN YOU GUARANTEE TO COMPLETE A MEDIUM BRIDGE?"

By CAPTAIN E. V. DALDY, R.E.

INTRODUCTION.

IN modern warfare, with mechanized forces, the medium bridge has increased in importance, as it is an undoubted fact that a force, faced by a river-crossing, may be able to get infantry and light vehicles over by means of assault bridges and folding boats, but it will not be able to advance far beyond the river without calling on its heavier vehicles for fresh supplies.

A commander who wishes to carry out an assault across a river and take any position more than about two miles beyond it, will naturally ask his C.R.E. to give an estimate of the time by which a medium bridge can be completed. The timings of the various stages of the attack will be governed to a great extent by the answer given, and so accuracy is very important.

Mechanization has affected the whole problem considerably, and as very few officers have the chance of working in a mechanized unit, the advantages and disadvantages are not generally known. This article has been written in the hope that it will draw attention to some points, often overlooked, and help officers to arrive at a correct solution to the problem. Throughout I have only dealt with what I call the "Primary Medium Bridge," a temporary bridge which is only intended to get a certain number of vehicles across a river, beyond which their own cross-country capabilities will get them to their forward formations. It should not be confused with the medium bridges which would be required for the normal traffic of the Division, and which would not be available for general traffic until some time later, owing to road work which is normally needed.

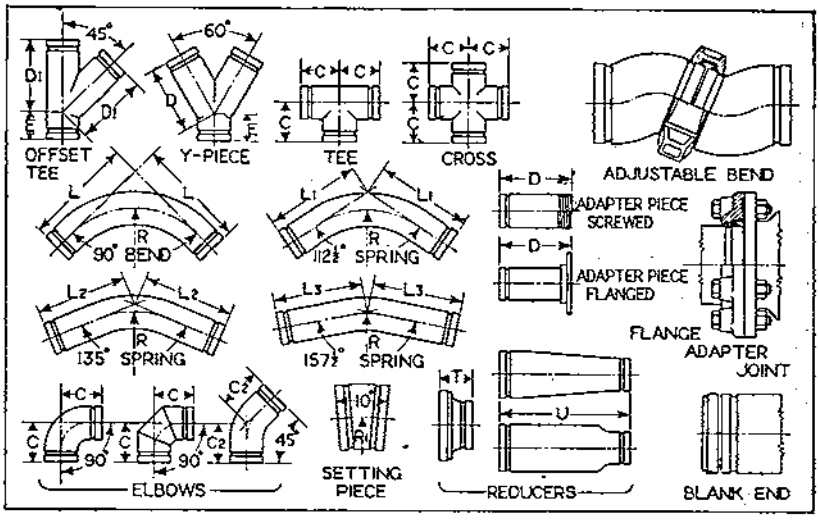
GENERAL.

The points particularly affected by mechanization are:—

(1) Initial action by forward R.E. units.
(2) Action by C.R.E., on receipt of reconnaissance reports.
(3) Action by O.C. unit detailed to make the bridge.
(4) Actual bridging operations.

and these are dealt with in the above order.

VICTAULIC



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3	3 1/2	3 1/2	3 1/4	6	8 3/4	3	11 1/2	10 1/4	9 1/2	9 3/8	9 1/4	10 1/2	3	12
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5	5 1/2	5 1/2	4 3/4	9	12	4 1/2	18	16	15 1/2	14 7/8	15	19	3	15
6	6 1/2	6 1/2	5 1/2	10	13 1/2	5 1/2	22	19 1/2	18 1/2	18 1/4	18	20 1/2	3	18

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2,200—1.9.33.

A sapper, J. R. T. Aldous, had accompanied one of the Club's expeditions to Spitzbergen as surveyor. His work had been so successful that the organizers of the 1931 expedition applied again for the services of a sapper in the same capacity. I was lucky enough to get leave for the summer, and accepted the chance. A long absence from plane-tables and theodolites caused me some misgivings. It was reassuring, though, though, to learn that the survey work would

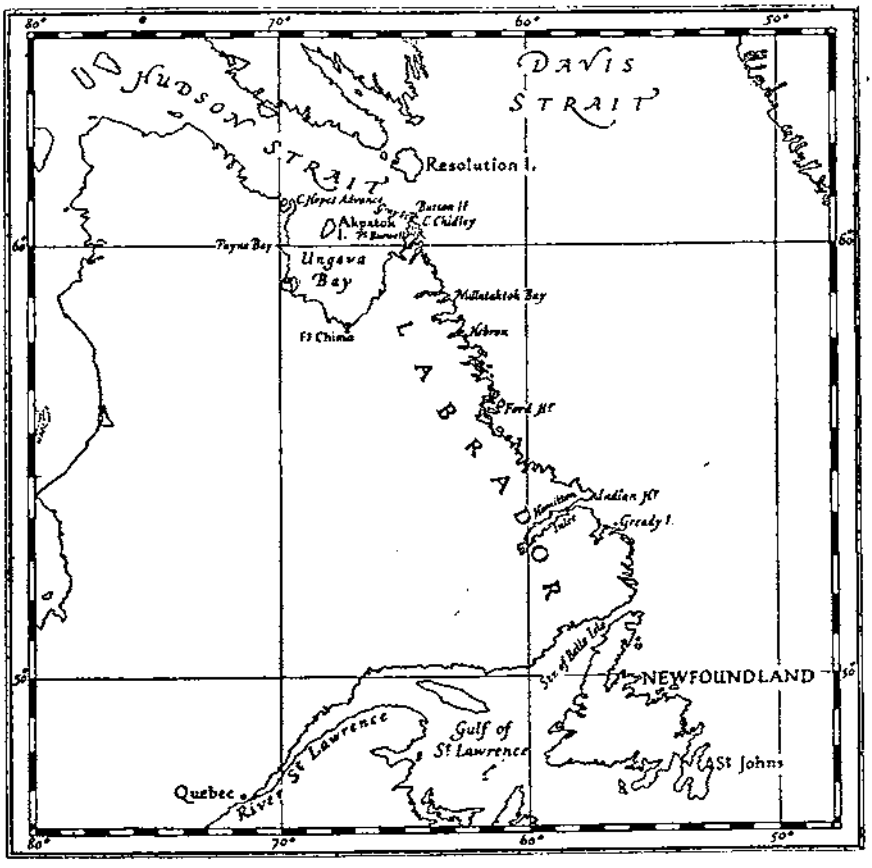

FIG. 1.—Coast of Labrador.

necessarily be of a rough and rapid variety, and that my map would have to join up with nothing but itself.

By August 3rd the members of the expedition had assembled at St. John's, Newfoundland. We were ten in number. A meteorologist, botanist, ornithologist, biologist, geologist, entomologist and photographer represented a comprehensive collection of the sciences. Hugh Clutterbuck, our leader, the organizing secretary, and I completed the party.

For the voyage north we had chartered a 100-ton two-masted

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THE OXFORD HUDSON STRAIT EXPEDITION, 1931.

By CAPTAIN C. M. SINGER, R.E.

IN the summer of 1931 the Oxford Exploration Club organized an expedition to the Hudson Strait, to continue the scientific work in sub-arctic regions begun by the Club's previous expeditions to Spitzbergen and Greenland. This work had been mainly ornithological and botanical, but on this occasion the survey and meteorological work possessed added interest, owing to the growing importance of the Hudson Strait since the opening of the new grain route to Port Churchill.

The choice of objective was governed largely by the time available. The expedition could not leave England before the middle of July, and it would be necessary to be clear of the Hudson Strait again by the end of September, to avoid the risk of getting ice-bound and having to winter in the North. Allowing one month for the voyage there *via* Newfoundland and the Labrador coast, only some five or six weeks would be available at the far end. Rather than land on Baffin Land, or any other of the vast islands that lie to the north of Canada, it was decided to choose a smaller island which could be thoroughly investigated in the short time available. A suitable objective seemed to be Akpatok Island, lying in Ungava Bay at the eastern end of the Hudson Strait. This island was sighted by Henry Hudson in 1610, but so far as could be ascertained had only once been actually visited by a white man. This was in 1885, when Dr. R. Bell, a Canadian Government geologist, landed there for a few hours. Very little seemed to be known of the island, and its position and size as shown on the Admiralty charts were doubtful; how doubtful can be gathered from the sketch in Fig. 2.

General Robert Morse

schooner, with the curious name of the *Young Harp*. She was fitted with an auxiliary semi-Diesel engine of 120 h.p., which proved to be the only blot on an otherwise excellent ship. Usually engaged in sealing, she required a few alterations to accomodate us. The fore part of the main hold was fitted with bunks, and an additional galley and storeroom were partitioned off between this and the forecastle. We were very comfortable on

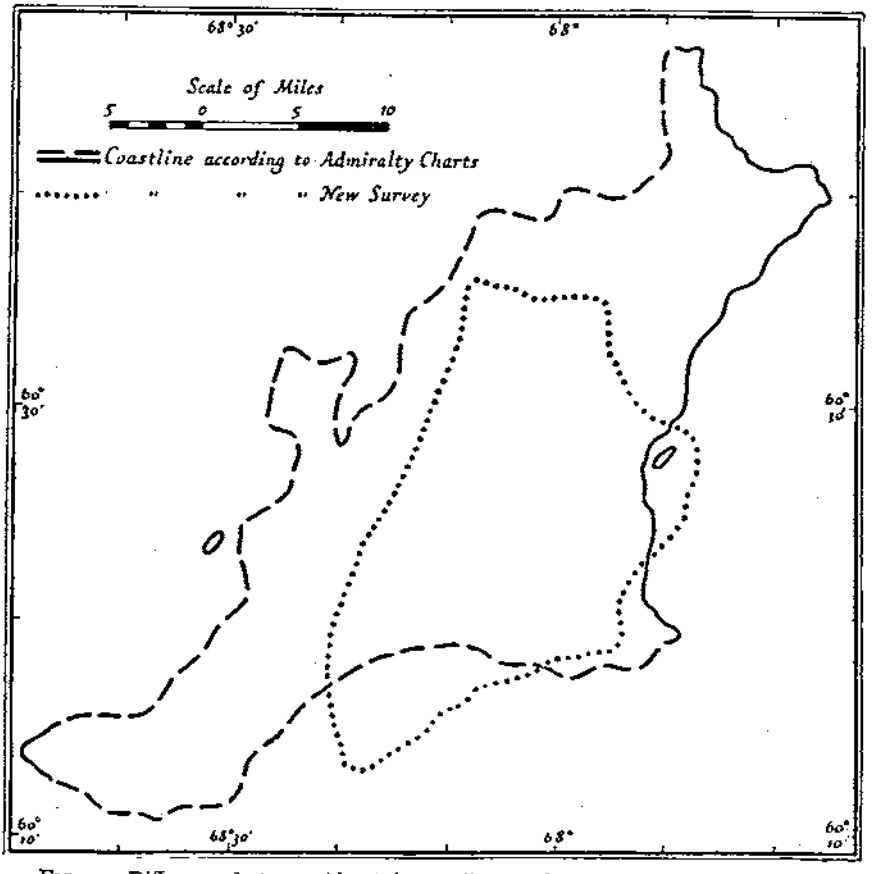


FIG. 2.—Difference between Akpatok coastline as shown by Admiralty Charts and by New Survey.

board, except when rough weather necessitated closing down the hatches and the lingering odour of seal permeated our quarters. The ship was manned by a Newfoundland skipper and crew of four, in whom we were exceptionally fortunate.

We had hoped to round Cape Chidley, the northernmost point of Labrador, a week after leaving St. John's. But we had put too much faith in the engine. Right at the beginning, while we were negotiating the very narrow entrance to St. John's harbour in a

fitful breeze, the engine failed: a bearing had run. A sudden puff of wind brought us round almost on to the rocks, and we were forced to let go the anchor hurriedly to avoid running aground—a manœuvre which was to be repeated twice more during the voyage. A few blasts on our portable fog-horn brought a harbour tug to our rescue, and an hour later we were ignominiously back at the point from which we had started.

This inauspicious beginning was the forerunner of a long series of misfortunes with the engine. When the lubricating arrangements were working satisfactorily, a jet was blocked; and *vice versa*. There was little or no wind, and for ten days we sailed slowly northwards under a cloudless sky. Every day we met two or three schooners, southward bound, laden with cod. In August, as a rule, there are at least a dozen icebergs always in sight off Northern Labrador, but this summer the Hudson Strait and Labrador Coast were unusually free of ice, and we rarely saw more than two or three bergs at a time. We were also lucky in meeting with no fog, which, combined with the proximity of ice, frequently forms a serious obstacle to navigation in these waters.

During the voyage advantage was taken of the fine weather to make a series of sextant observations on abnormal refraction. The combination of a low water temperature, about 35°F., with a relatively high air temperature, resulted in the horizon being miraged to a greater or less extent. The false horizon (the only one visible) was well defined, and appeared to lie on the average about 5 minutes of arc above the horizontal. If no allowance is made for this, the ship's calculated position will be 5 miles out.

On the morning of the 15th we sighted Cape Chidley, and turning westwards approached Gray Strait, which passes between the Button Islands and the mainland. Here the mirage was most striking; the islands, though only some five miles away, at one moment seemed to be lifted well out of the water, and the next moment to disappear altogether.

The currents and tide rips in Gray Strait are as bad as those in the similarly placed Pentland Firth. In the former, the tide is said to reach a maximum of 7 knots, a figure with which we found no reason to disagree. Fortunately, we reached the Strait at a favourable tide, and were spared the necessity of making the longer passage round the north of the Button Islands.

A few miles south of the western end of Gray Strait, in Ungava Bay, lies Port Burwell, the most northerly of the Hudson Bay Company's posts in Labrador. Here we anchored for 24 hours, and tried to gather some local information about Akpatok. The Hudson Bay Company's staff and two Royal Canadian Mounted policemen, who form the white population, were extremely hospitable and took great interest in the expedition, but were unable to give us any

useful information. Nor did the Eskimos living round Port Burwell know much more. They estimated the distance of Akpatok from the mainland variously at 100 or 200 miles, whereas our chart showed it to be 80 miles. A superstitious people, they assured us that it was inhabited by spirits who lived in holes in the cliffs, and that it had been known to move bodily. They regard the island with great fear and dislike. This is probably due partly to the fact that some years ago two Eskimo families wintered there, and all perished through lack of food; and partly, also, to the entirely different nature of the island from the country to which they are accustomed. As can be seen from the photos reproduced here, the northern Labrador coast is mountainous and intersected with long, narrow inlets, very similar to the coast of Norway, while Akpatok is gently undulating, with a regular coast-line of high, almost unbroken, cliffs.

On August 16th we left Port Burwell and sailed westward. Our first difficulty was to find Akpatok, and the second would be to find a landing-place. The uncertainty of the chart led us to set a course straight for the centre of the island as marked. As it could not be much more than 80 or 100 miles distant, we had reasonable hopes of sighting something before long, despite the unknown effect of the considerable tides in Ungava Bay. Again we had a calm day, though cloudy, and again the engine failed. This time the skipper, affected perhaps by Eskimo superstitions, decided that there must be a devil on board. Disappearing into his cabin, he returned with his gun, accompanied by the mate with a piece of wood on which was painted a large blue heart. This was the devil's heart, ready to be blown into the sea, and it was duly pierced with a silver ten-cent piece discharged from the gun at five yards' range.

After 24 hours' sailing, or rather drifting, Akpatok was sighted to the south. We realized later that we had hit off one of the most northerly points of the island, in about latitude 60° 35′. It will be seen from Fig. 2 that we had not drifted far off our course, but that the island is in reality very different from that on the chart. At first sight, nothing could be seen but an unbroken line of high cliffs, awe-inspiring but depressing, as nowhere could we see a break in the cliffs or a likely path up them. Along the foot a ledge of rock, some 50 yards wide, uncovered at low tide, made landing out of the question. Some ten miles down the coast, however, a gap in the cliffs 100 yards wide appeared, and the ledge of rock gave way to a sloping shingle beach. Here we anchored for the night, sending a party ashore to investigate. Two deep ravines wound inland, and at their mouth a reasonably sheltered camping ground was found. There was no lack of fresh running water in the ravines, and access to the interior of the island looked easy. Some bleached skulls of bear and walrus showed that Eskimo had camped here many years

before. Unfortunately the anchorage for the ship was exposed, and safe only in a westerly wind.

We were anxious to sail right round the island if possible before leaving the ship. We could then get some idea of its true shape and size, and choose the best site for our base camp. This would necessarily be close to a sloping beach, such as we had already found, on which our stores could be landed in small rowing boats. It was important, too, that the beach should be as sheltered as possible, especially as we should probably have bad weather for our re-embarkation at the end of September. Since once on shore our only form of transport would be ourselves, the more central the base camp could be the better.

The following day we were lucky. A fresh breeze sprang up, visibility was excellent, and our engine worked perfectly. To our great surprise, we completed the circuit of the island in under ten hours. It soon became apparent that the chart was very wrong, and the island much smaller than we had been led by it to expect. A rough traverse was plotted from the ship's courses and log readings —a procedure known to hydrographers as making a "running survey." The closing error of this traverse proved to be about one mile. This was unexpectedly small, since the proper allowance to be made for the tidal current was quite unknown, and at least once the log was fouled by floating seaweed.

Our day's voyage had shown us that the formidable cliffs we had first sighted continued practically unbroken right round the island, without a sheltered anchorage anywhere. The gap off which we had anchored was, in fact, the only good camp site, though a smaller shingle beach was noticed a few miles farther south. Moreover, this gap proved to be approximately in the middle of the island, so we decided to make it our base. The exposed nature of the anchorage, however, meant that the ship would have to return to Port Burwell after we had disembarked, and come and fetch us off again when weather permitted, towards the end of September. Disembarkation began early in the morning. Unfortunately it was low tide, and a spring tide, too; the wind and sea were rising, and the skipper was anxious to be off. Our stores were soon landed, but we were faced with the manhandling of five tons of packing cases up 100 yards of loose shingle in a race with the tide. The tide rose 35 feet, but by mid-day everything was above high-water level. The *Young Harp* sailed off, leaving us with a slightly uncomfortable marooned feeling.

Our camp consisted of one large mess tent, and five smaller sleeping tents. In addition, we had three small light tents weighing about 25 lb. each for subsidiary camps. The sleeping tents were constructed with floors sewn into the sides, and only a small circular opening, about two feet in diameter, as a door. They were ideal for the conditions we experienced. There was a strong wind practically

throughout our stay on Akpatok; the temperature was reasonably high in August, about 48°F., but fell in September to an average of 35°F.; the humidity was about that of London in winter so long as the fog kept off. Fog in these regions takes the form of a thick mist, in which the atmosphere is completely saturated, and is generally accompanied by a wind which makes life most uncomfortable while it lasts.

Owing to the absence on the island of driftwood or vegetation of any kind except moss, fuel was precious and had to be carefully preserved. Our cooking arrangements consisted of two large Primus stoves burning paraffin, and food came mainly out of tins. We were not bothered at all by the plagues of mosquitoes and black flies which are so common in the summer in this part of the world.

Polar bears were the only animals seen, though tracks of silver fox were noticed in places. The bears were numerous, with many cubs. As a general rule, we regarded each other with mutual respect, pursuing a policy of live and let live, though a few days after our arrival we had to shoot one that was found prowling round the camp, evidently with designs on our larder. The seal and walrus had moved northwards with the receding ice, and none was seen.

Bird life, on the other hand, was abundant. Coveys of ptarmigan were found all over the island, and provided us with many excellent meals. Quite unused to human beings, they were very tame and would often stand still enough to be caught in one's hat. "Hatting the ptarmigan" became a most popular sport. Guillemots swarmed on the cliffs—*Akpat* is Eskimo for guillemot—and in September many gulls and snow-bunting passed on their southward migration.

The most striking physical features of the island were the imposing cliffs, 400 or 500 feet high, that bounded it on all sides. Inland, there was little but a desolate waste of broken stone and coarse moss, forming an undulating limestone plateau devoid of any marked features. Small lakes were dotted here and there in broad shallow valleys radiating from high ground in the centre of the island. Near the coast these valleys became deeply-cut ravines with precipitous sides. It was at the mouth of the largest of these that our base camp was pitched. Except in the interior, cross-country journeys were difficult. Nearly every ravine involved a detour of half a mile or more before a possible crossing-place could be found.

The running survey from the ship had given us a good idea of the island's general shape and size, and it was decided to map it to a 1/120,000 scale. It was clear that visibility would be limited by the nature of the ground to two or three miles from the tops of the ridges. Time was very limited, and the transport of camping gear and instruments was a serious problem. The quickest and easiest procedure under the circumstances seemed to be to fix points at two- to three-mile intervals all over the island, by triangulation and intersection with a very light 3-in. vernier theodolite we had with us.

With fixed points so close together, it was sufficient for the purposes of the expedition to fill in what little detail existed by eye, helped out by compass traverses taken by various members of the expedition when travelling from point to point. This saved the considerable extra labour involved in carrying a plane-table about. The coast-line was dealt with rather more fully than the interior; points along it were intersected by theodolite whenever possible, and information obtained during the running survey was incorporated. The triangulation sprang from a half-mile base-line measured just north of the main camp. The fixed points were marked on the ground by stone cairns five feet or six feet high, in the building of which we all soon became expert. The heights of the fixed points were determined by vertical theodolite angles and of intermediate points by aneroid. In this way it was hoped to cover the whole island from the base camp, with a short stay only at two subsidiary camps.

Our position on the earth's surface and the azimuth of one line in the triangulation were found astronomically, using a Zeiss theodolite which had been very kindly lent us by another Sapper, K. M. Papworth. All our other instruments were lent by the Royal Geographical Society.

Up till the end of August the weather treated us kindly: we had evidently been fortunate in striking an exceptionally fine summer. There was much sun, and little fog. The work of the expedition in all its branches went forward well. The wind was our chief enemy, at times being so strong that the theodolite had to be erected with its legs as short as possible for stability, the observer lying full length on the ground. In order to take full advantage of the daylight, without appearing to get up unduly early, we continued to keep Newfoundland Summer Time, to which our watches had been set in St. John's. At Akpatok this actually resulted in our being two hours ahead of the sun.

We had expected that our proximity to the magnetic North Pole would render our compasses valueless. But we found that the only effect of the weak horizontal magnetic field was to prolong the time taken for the needle to settle down. One or two of the cheaper prismatic compasses were inclined to stick, but the others (especially those mounted in oil) ultimately pointed truly, if the observer had sufficient patience. There was, of course, a large magnetic variation (43° W.), but this was easily determined.

By September 10th work on the southern half of the island was complete. A subsidiary camp had been established some ten miles W.S.W. of the base camp, and brought in when done with. The weather was now showing signs of breaking. Fog was becoming more frequent, and we had had some rain and sleet. The ship was expected back about the 22nd, and it only remained to establish a small camp to the north, and to complete our work from there. This camp was duly pitched on the 14th, near Point 815 (see Fig. 3),

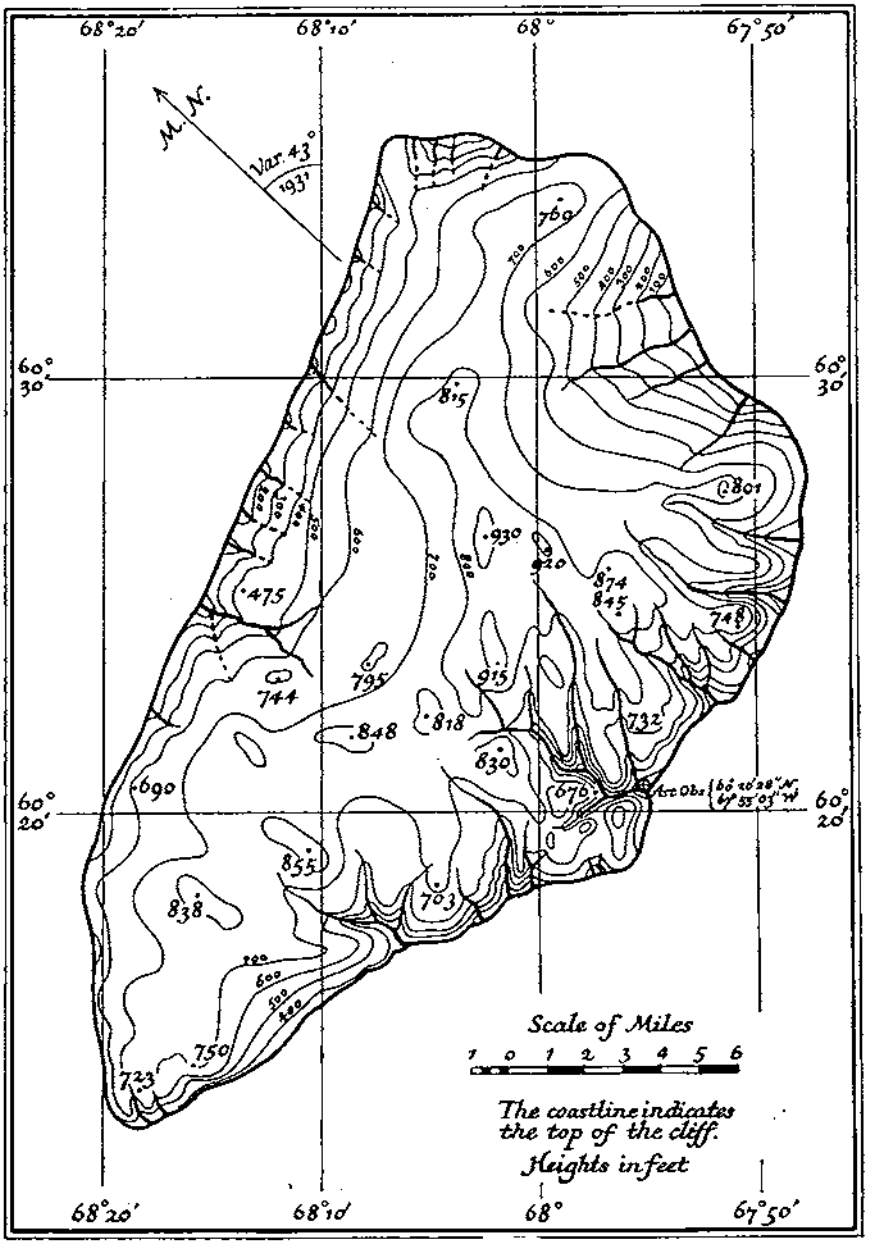


FIG. 3.—Akpatok Island.

and two of our number moved out to it, intending to stay for three days. After this they would be relieved by two others. That night a strong N.W. wind blew up, the temperature fell, and our first blizzard set in. The next morning as we were beginning breakfast at the base, one of the two suddenly appeared in the mess tent, dazed and exhausted, his boots in ribbons. The only coherent statement he could make was that his companion, D'Aeth, was in a ravine two miles away. A search party set out immediately, and found him after an hour's search. He was alive, but delirious and completely exhausted. The snow and wind continued unabated, and all efforts to restore circulation failed. He soon became unconscious, and died before camp was reached. Christopher D'Aeth had been the organizing secretary of the expedition; extremely energetic and hardworking, he set no limit to his own powers of endurance. It was sheer bad luck that the evening before, he and his companion had been overtaken by fog while returning to their camp and had failed to locate their tent in the strange surroundings. Accordingly they decided to make their way back to the base camp by compass. Unfortunately, the fog turned into blizzard and, to crown all, D'Aeth slipped at the edge of a ravine, and lost the compass in his fall. Steering by the wind as best they could, they struggled on through the night, wandering far off their course, until D'Aeth was exhausted. When daylight came, his companion recognized his surroundings and had just strength enough to make his way into camp for assistance.

From this time onwards we had continual bad weather. Little work could be done. The northern camp was brought in, but much of the detail of that part of the island had to be left unmapped. It was evident that in such weather getting off the island would be a more difficult matter than landing had been. By the 18th all stores had been packed up and marked in order of their importance. Early on the 19th the *Young Harp* arrived, taking advantage of a slight easing of the weather. She anchored in a choppy sea, with a stiff westerly offshore breeze. Embarkation was begun without delay, but the wind soon increased and veered round to the north. By 5 p.m. all but some reserve food was on board. It was now blowing a full gale, so we dropped a second anchor and rode out the night. The next day we sailed for Port Burwell. A high sea was running, but the schooner made light of it and shipped very little water. In the evening land was sighted. Recently fallen snow had made landmarks difficult to recognize, and at one time we seemed likely to spend the night in the unpleasantly rough waters of Ungava Bay—a gloomy prospect for the indifferent sailors among us. However, at dusk we picked up the entrance to the harbour and were soon inside.

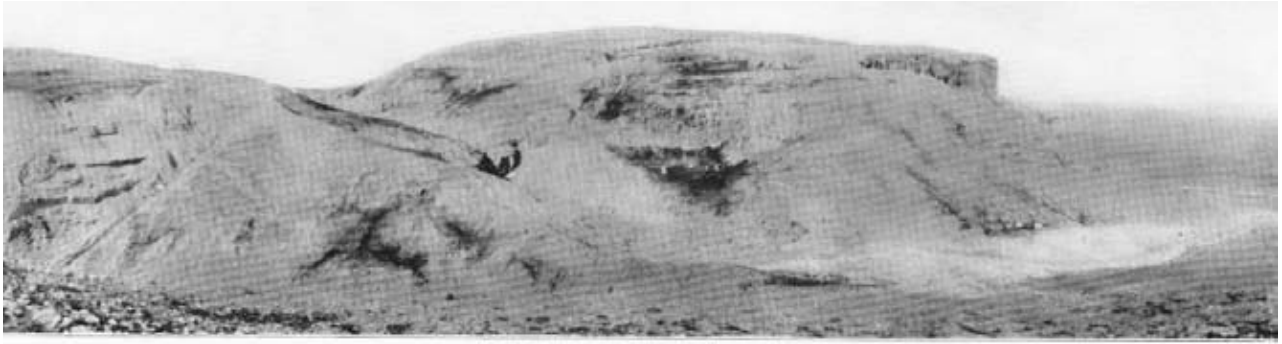
On the evening of the 22nd we left Port Burwell and with the

Young Harp in Port Burwell.

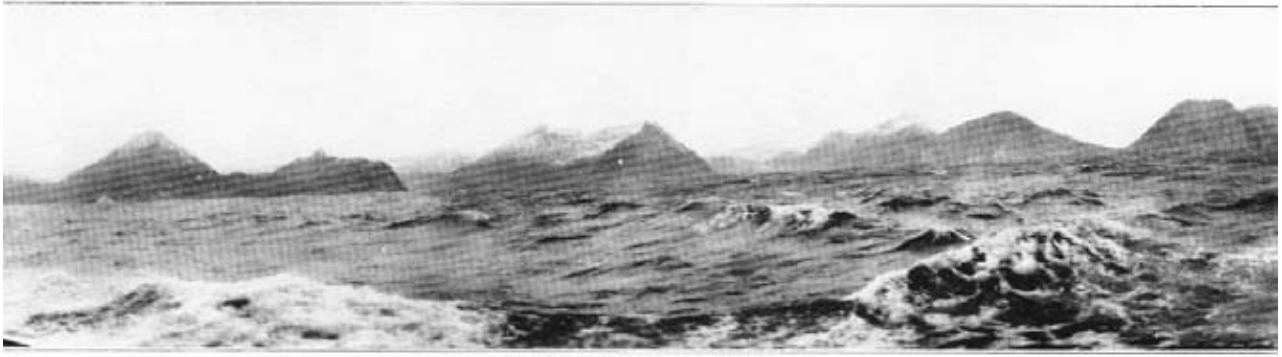
Typical Akpatok cliff.

Akpatok. Dry inland river-bed.

The Oxford Hudson Strait expedition 1-3



Base camp from ridge to the south.



Labrador coast near C. Chidley.

The Oxford Hudson Strait expedition 4-5.

tide in our favour were through Gray Strait and round Cape Chidley by midnight. During the next week the wind was generally strong, but rarely favourable, and progress southward was made in a series of bounds. On the voyage north we had kept well out to sea to take advantage of what wind there was. But this time we kept for the most part within the line of small islands that fringe this coast, and sheltered at night and in unfavourable winds in one of the numerous fiords or "tickles" that abound there. A "tickle" is the Labrador for a narrow passage between two islands. They are known by fascinating names: "Cut Throat Tickle," "Smoky Tickle," "Run-by-guess Tickle," being fair samples. The engine, doubtless realizing that we were now heading the right way, behaved excellently, and with its help we reached St. John's on October 3rd. A calm 24 hours before reaching harbour gave us the chance of a much-needed shave. Few of us had been Spartan enough to attempt this since leaving St. John's two months earlier.

The scientific results of the expedition have been described in the *Geographical Journal* of September, 1932. It is interesting to note that Akpatok was found to bear little resemblance to the island outlined in the previously existing charts. No islands exist in its immediate neighbourhood, and it possesses no harbours or safe anchorages such as the chart would seem to suggest. It is permissible, perhaps, to doubt the accuracy of these charts with regard to the positions and sizes of other islands in the vicinity of the Hudson Strait, such as the Mill Islands, Salisbury I., Nottingham I., and Charles I. These islands all lie on or near the new grain route from Port Churchill, and would therefore appear to merit close attention.

Expeditions such as this are organized from time to time both at Oxford and Cambridge, and have frequently been accompanied by members of the Corps. This year (1933) expeditions have gone from both Universities, and I understand that there is a sapper with each: H. R. Greenwood with the Oxford Expedition to Greenland, and H. Carrington Smith with the Cambridge Expedition to Spitzbergen. I would sincerely recommend anyone to do likewise if he has the opportunity. He will have a most enjoyable holiday, combined with much useful experience, and if the expedition is not too ambitious the cost should be very reasonable.

TEMPORARY ROADS DEPARTMENT.—I.

By "ROADSURVEY."

DURING the six years between 1925 and 1931 the names of certain officers of the Corps appeared in *The R.E. Quarterly List* under the heading "Specially Employed—Gold Coast Survey—Temporary Roads Department." This department, usually referred to as the T.R.D., was entirely a Sapper show, and for this reason it is considered that some account of the work done, with a description of some of the methods of survey and construction employed, may be of interest to the members of the Corps.

The condition of the roads on the Gold Coast prior to 1924 may be best summarized by quoting the following doggerel, which appeared in the T.R.D. 1930 Christmas card :—

"Before the Sapper reached Oda
Or out of Tarkwa strode,
The wily Fanti Bushmen
Made the rolling Gold Coast Road.
A rolling road, a reeling road,
Quite free from grades and curves;
A soggy road, a boggy road,
Distressing to the nerves.
With topo pole and lufkins band
The T.R.D. essayed
To straighten out this reeling road
The Fanti Bushmen made."

The six years following the war were a period of great prosperity on the Gold Coast. Cocoa boomed, trade expanded and the revenue went up by leaps and bounds.

At this time the Governor of the Gold Coast was a Sapper, the late Sir Gordon Guggisberg, who, with ample funds at his disposal, now found himself confronted with the problem of how to improve the communications of the Colony to keep pace with this rapid expansion in trade.

The roads then existing may be said to have been developed in three stages. They originally consisted of mere hunter's trails and bush paths cut through the bush by the natives to establish communication between the various villages. The first stage in their development was their improvement from bush paths to hammock roads, to enable the District Commissioners (D.C.'s) to be carried from village to village in a hammock. This was certainly an improvement—from the D.C.'s point of view.

The second stage was due to the mechanization of the D.C. who,

marching abreast of the times, bought a motor-bicycle. This necessitated the construction of bridges and culverts, and the reduction of all gradients to a minimum of about 1 in 4. This work was done by the chiefs, who constructed the bridges with timber and circumvented the worst gradients (those of more than 1 in 1 !) by the use of numerous right-angled corners.

The third and last stage was due to the mechanization of the local chief and all his family. In order that they might be able to take the cocoa and themselves from the villages to the nearest railway station (gin store !), the Public Works Department (P.W.D.) widened the hammock roads, substituted concrete bridges and culverts and did something to ease the right-angle corners and the worst gradients. Funds were usually insufficient for more extensive work.

It can, therefore, be seen that the original locator of most of the P.W.D. roads was the native himself, who ranks very low in the profession. It is hardly surprising that Sir Gordon Guggisberg was considerably shattered, both in mind and body, when reviewing the road communications in the Colony. It was quite obvious to him that an efficient method of road survey must be introduced before further money could be spent on road construction. He therefore consulted the Surveyor-General, and instructed him to detail two officers for the special work of evolving this survey.

The two officers selected were Capt. R. L. Brown, R.E., and Lieut. G. C. Rogerson, R.A., and the T.R.D. may be said to have originated when these two officers commenced this special work in June, 1924, although the Department was not actually known as the T.R.D. until a year later.

In order to grasp the difficulties of the problem confronting these two officers, it is necessary to give a brief description of the Gold Coast, its climate and its people.

Broadly speaking, the Gold Coast can be divided into three belts :—

(*a*) *The Bush or Forest Country.* This belt extends for 200 miles inland from the coast (see map) and includes the whole of the Colony and the southern half of Ashanti. The trees are from 80 ft. to 200 ft. high, and rendered impassable without the use of a cutlass or *machete* by an impenetrable undergrowth of small trees and tough creeper called *ti-ti*. Throughout the whole of this belt visibility is limited to about 15 feet, except in the occasional cocoa or banana farms. It has a uniformly high temperature and the atmosphere of a greenhouse. The heavy rains fall between late May and November, and although there are frequent tornadoes, fine weather predominates for the remainder of the year.

(*b*) *The Orchard Bush Country* extends northwards for another 100 miles. As its name indicates, this strip is covered with small trees and scrub, and during the rainy season visibility is reduced to *nil* by thick elephant grass, which grows to a height of 10 ft. to 12 ft. This is burnt in December and visibility then becomes fairly good. The climate here is similar to that of the bush country south of it, except that its dry season is drier.

(*c*) *The Northern Territories* extend for another 200 miles farther north and consist of normal open country with very few trees. Here again elephant grass springs up in the rainy season and is burnt in December, after which visibility is excellent. The seasons correspond with those of the other two belts. The rains, during which the fall is torrential, last from May to October. Between October and May there is no rain whatever, but the heat is intense and dust storms take the place of tornadoes.

The inhabitants can be divided into two classes—the Coast native who inhabits the Colony and Ashanti, and the Northern Territory native. The first class, owing to the fact that they have been longer in contact with Europeans than their Northern Territory neighbours, supply the bulk of the educated class, who are employed as clerks, engine-drivers, lorry-drivers, chainmen, etc.

The second class is much more primitive, but at the same time a much more sturdy crowd of people. They will carry a 60- to 80-lb. headload 20 miles a day for days on end. It is from them that all carriers and labourers are recruited.

So much for the Gold Coast and its people. We now return to Brown and Rogerson.

Their first move will commend itself to all as extremely sound. They promptly proceeded to England on leave to collect instruments and stores and to make discreet enquiries as to how roads were surveyed.

Interviews with county surveyors and the chief engineers of road construction firms produced little result for, as far as they could gather, roads just " happened " and were not surveyed at all. They therefore tried the S.M.E., Chatham, and went to Wales with a batch on a survey tour. They rejected the methods taught as unsuitable and their leave ended without either of them having much idea as to how to do a road survey in the bush.

On their return to the Gold Coast they started work separately in the Central Province, under the title of " Roadsurvey Party," on what was called a " Stab Location " method. This depended largely on the excellence of the preliminary reconnaissance, the idea being to cut a location straight on the ground after an intensive

reconnaissance and blazing a trail. The results were moderately good, but it was obvious to both that this was largely a "hit or miss" method, and that in difficult country in thick bush the probability would be more "miss" than "hit." Furthermore, they could not be certain that, even when their location line proved to be good, it was actually the best possible one.

About January, 1925, Rogerson received a series of letters from Brown purporting to be a correspondence course on a new method of survey. Rogerson, who was not versed in the subtleties of correspondence courses, decided that the best way out of the maze was to go and see Brown in Oda.

In Oda he learnt that Brown had, in the course of his work, met Major Silcox, a highly-experienced railway engineer, who was at that time in charge of a party locating the Central Province Railway. Major Silcox was using methods largely evolved by himself, which Brown realized at once were exactly what were required for a road survey. Minor modifications were, of course, necessary to allow for the wider limits of grade and curvature permissible in road location. These methods, subject to slight alterations and improvements, were used by the T.R.D. until it closed down in 1931, and are described in some detail in a later article.

The results obtained by these methods in the Oda district so impressed Sir Gordon Guggisberg, that in June, 1925, he sanctioned the formation of a special T.R.D. under the charge of Brown, for the survey and construction of roads. The department was to be run by officers and N.C.O's from the Corps and was put directly under the Secretariat.

1925–26.

Brown went on leave to England and returned in September with his staff, which consisted of Rogerson, Serjeants Giles, Black and Emery, Lce.-Serjt. Benlow and Corporal Haskell.

Work was commenced in earnest with H.Q. still at Oda. It was intended that the survey work should be done by four parties, each under an African surveyor, with a Sapper N.C.O. superintending two parties. Unfortunately, by November, it was realized that this was unworkable, as African surveyors were quite unable to produce the necessary results without daily supervision by an N.C.O. Serjeants Giles, Emery, Benlow and Corporal Haskell were, therefore, each given charge of a survey party, and Serjeant Black remained as a foreman on the construction of the lines surveyed earlier by Brown and Rogerson. Rogerson left the Department soon after returning from leave, in September, 1925, to start the Sierra Leone Survey, and Lieut. H. C. Bogle, R.E., arrived in October.

As the survey was now in full swing, Brown and Bogle undertook

the design of the standard culverts and bridges to be used in construction and were assisted in this by Lieut. R. P. Wheeler, who arrived in May, 1926.

Just as the Department had got well into its stride, a terrible misfortune overtook it in the shape of a serious accident to Brown, which resulted in the loss of his arm. This accident might well have proved fatal but for the stout work done by Serjeant Emery who, at the time of the accident, happened to be working six miles away from Brown. As soon as the news reached him, he hurried to Brown's assistance, and after rendering first aid, succeeded in getting Brown to Cape Coast Hospital, a distance of 15 miles by bush path and 60 miles by road, within 12 hours. A very fine achievement.

It was now necessary to reorganize the Department. Bogle became acting officer-in-charge, Wheeler took over construction, and the supervision of the survey fell largely on to Serjeant Emery's shoulders.

The survey output between September, 1925, and April, 1926, was 118 miles.

APRIL, 1926—April, 1927.

During this year most of the work was confined to the Central and Eastern Provinces, but a start was made in the Western Province, with the survey of the Insu–Enchi road, one of the three great west roads from the Sekondi–Kumasi railway to the Ivory Coast frontier.

It was soon obvious that work in the Western Province would provide an acid test of our survey methods, as the country was extremely broken and the bush very dense. As a matter of fact, two previous attempts by other departments to survey the Insu–Enchi line had failed dismally.

The survey mileage this year was 108.

The largest construction work during this period was the Prahsu–Brofoyedru road, on the line surveyed by Brown and Rogerson. This road was the continuation of one from Cape Coast to Prahsu, built by Sappers in the First Ashanti War, when Sir Garnet Wolseley advanced to the relief of Kumasi. Sir James Willcocks also used this road when advancing to the relief of Kumasi in the Ashanti Expedition of 1900. In his book, *The Romance of Soldiering and Sport*, he says :—

> " Prahsu, which temporarily became our base, was 75 miles from Kumasi and was an abominable place. It was an insanitary post, surrounded by dense forest and jungle and the home of every sort of insect life and tropical disease."

We are inclined to agree with him !

Considerable trouble was experienced with the foundations of the double 20-ft. span bridge over the Jimi River on this road. It was ultimately decided in the interests of economy to use a shallow foundation in poor soil, but not to deck this bridge until the abutments had been under observation for one year. In 1927 a horizontal crack appeared in one abutment, and the P.W.D. engineer, under whose charge the bridge had been left, reported that the abutment had sunk 0·75 inches. At the same time, he submitted level readings in confirmation, which showed that the abutment had *risen*. Wheeler proceeded to the site to re-level the abutment, and found that it had sunk 0·36 inches. The concrete above the crack was removed and replaced, and the decking completed. We had no further trouble with this bridge.

There were a number of alterations in the personnel during this year. Brown recovered from his accident and took over again as officer-in-charge. Serjeant Benlow and Corporal Haskell returned to the Corps in June, and were relieved by Serjeant Morgan R.E., (surveyor), and Mr. B. J. Pritchard, a civilian, as office assistant. The latter appointment was equivalent to the loss of one survey N.C.O., but was absolutely necessary to cope with the rapidly-increasing amount of correspondence and routine office work.

April, 1927—April, 1928.

In addition to our work in the Central, Eastern and Western Provinces, a start was now made in the Northern Territories on the Tamale–Bole survey. The work here was very much easier than that in the other districts, but was difficult to supervise as it was 450 miles from the headquarters in Oda.

The survey work in the Western Province was also getting farther and farther away from headquarters and so a District Headquarters was formed at Insu under Wheeler in December.

The amount of survey completed in this year was 116 miles.

The construction of the Prahsu–Brofoyedru road was completed, together with those in the neighbourhood of Oda, and a start was made with the construction of the Insu–Enchi road. The construction output during this period was 71 miles.

Brown went on leave in May, and on medical advice, though much against his will, reverted to the Corps. His relief was Lieut. W. H. Stratton, who arrived in November, and Bogle now became officer-in-charge. Serjeants Emery and Giles reverted to the Corps in June, and were relieved by Serjeants Bedford, Brown and Woram. Before retiring, Serjeant Emery attained an average speed of six miles a month on survey in bush country, a record that was never equalled by any other N.C.O.

This year did not pass without a mishap to the personnel. Serjeant Brown went down with a bad attack of cerebral malaria at Dentebaso. Captain Guthrie-Hall, the D.C. at Enchi (distant 15 miles), received information of this and trekked by night along a very rough bush path. He was joined in the course of the next day by Serjeant Bedford, who had trekked 44 miles in a day and a half, and by Captain Braddick of the Frontier Customs Police, who had covered 30 miles, both having heard rumours of "white man sick in bush." The nearest doctor was 60 miles away and a messenger sent to fetch him covered the distance in less than 24 hours! Brown was eventually moved to the railway and on to Kumasi Hospital, where he made a complete recovery. This was undoubtedly due to the very prompt assistance rendered by the above-named officials and the African doctor, to all of whom the T.R.D. will always be indebted.

APRIL, 1928—APRIL, 1929.

Practically all the work during this period was confined to the Western Province, and in May headquarters were moved from Oda to Tarkwa.

The survey of the Insu–Enchi road was completed and that of the second Great West road, from Wiawso to Krokosua, was commenced. In the Northern Territories the survey of the Tamale–Bole line was continued from Daboya to Grupe.

In this year, also, the Department was for the first time asked to re-align certain of the existing roads. This was unpleasant work, and the results were never so satisfactory as those obtained in virgin country. The cry was always "Use as much of the old road as possible," as it was a popular fallacy that to re-align involved merely easing the grades and curves. However, the majority of the roads were so badly located that it was more economical to choose a completely new line.

The total mileage surveyed this year was 198, a record for the Department.

The construction programme included the completion of the Nyenasi–Assamang road and the continuation of the Insu–Enchi road.

The former was held up by the misbehaviour of the River Minto, which during the dry season appeared to be only a small stream, and which, judging from the map, had a negligible catchment area. It was, therefore, crossed by a double 5 ft. 6 in. culvert. When the rains started in May, this culvert, weighing some 80 tons, was torn bodily out of its foundations and flung clear of the road. A 100 feet of 6-ft. banking followed, or preceded it. This culvert could not be replaced

by a bridge until near the end of the rainy season, with the result that the construction ahead came almost to a standstill.

The construction mileage this year was 53.

Bogle proceeded on leave at the end of April and Wheeler took over as officer-in-charge. Stratton took over the District Headquarters at Insu, which was closed down in August, as it was now possible to superintend the work in the Western Province from the new Headquarters at Tarkwa.

Lieut. H. A. Macdonald arrived in the Colony in July, complete with bagpipes. The latter introduced a new and fearsome element to the natives, resigned as they were to " mad dogs and Englishmen." Centuries of experiment by Ju-Ju men had failed to produce any sound which could compete with bagpipes, whose use was quickly assumed to be some new form of " god-palaver." On Bogle's return from leave in September, Wheeler went home and reverted to the Corps. Unfortunately, soon after going to York as S.O.R.E., he went down with blackwater fever, the result of almost continuous bouts of malaria on the Coast.

In October, Stratton went sick in bush near Enchi, and was collected by Captain Guthrie-Hall, who once again came to the rescue of the Department. After three weeks at Enchi, Stratton was brought back to the railway by canoe and hammock, being accompanied by Captain Gildea of the Police, who happened to be trekking through the district. After a short stay in Kumasi Hospital he went on leave and was operated on in England.

In March this year, the Department was visited by Brigadier H. St. J. L. Winterbotham, then carrying out his survey tour of the Dominions and Colonies. He appeared to be impressed by our survey methods and suggested that a lot of the preliminary reconnaissance work might be cut out by the use of aerial survey. This is probably quite true, but unfortunately there was no one then serving with the Department who had tasted the joys of the "dot game." Moreover, page 71 of *Stereoscopic Examination of Aerial Photographs* lays down that " alcohol has an adverse effect on stereoscopic observation, and, in extreme cases, may result in the breakdown of fusion." The idea had, therefore, to be abandoned.

April, 1929—April, 1930.

The work in this year was in practically the same areas as the previous year.

In survey the Wiawso–Krokosua line was continued, and the third Great West road, this time along the Coast from Axim–Half Assinie, was commenced. In the Northern Territories the Tamale–Bole line was completed, and the main north road, from Tamale to

Navrongo on the border of the French Haute Volta, was also surveyed.

In construction the progress for this year was a record and reached the high figure of 99 miles. Included in this was the completion, with the exception of the three bridges mentioned below, of the first Great West road (Insu–Enchi), and the start of the second west road, Wiawso–Krokosua. Construction with direct labour was also undertaken for the first time. This work was carried out in the Northern Territories and consisted of the construction of the line surveyed previously through the Sambruno and Tankwiddi Swamps. The re-alignment of the main north road between Savelugu and Naboggo was completed by contract.

The Department were also asked to prepare a detailed road scheme for the development of the eastern half of the Northern Territories, with an estimate of its cost. To supervise these works from Tarkwa was quite impracticable, so a sub-headquarters was established at Tamale, under Stratton, in November.

We were also called upon to assist the Political officers in the reconstruction of the old German road through Togoland, which had been started in order to link up Accra with Tamale *via* Keta–Krachi and Yendi.

The three bridges, just mentioned as not completed on the Insu–Enchi road, were as follows :—

(i) 100-ft. clear span steel girder bridge over the River Mansi at Bopo.
(ii) 75-ft. clear span steel girder bridge over the River Disue at Achimfu.
(iii) Treble 30-ft. concrete span over the River Disue at Enchi.

The 100-ft. and 75-ft. bridges were the Crown Agents' Standard design and were sent out to the Coast in pieces. Unfortunately it was impossible for an officer to supervise the unloading at Insu station, with the result that the parts of both bridges were thrown indiscriminately into one pile. The manufacturers had sent out some plans, but had failed to mark the various parts. The office assistant, who was the only man available, had to go and sort out the mess. No one knows how he did it ; his expression and language were so appalling when we gathered around to hear his story that the subject was never mentioned again.

Although the bridges themselves were already designed, there were no plans, or even suggestions, for the abutments. Worse still, the money available was distinctly limited.

Military Engineering—Bridging dismisses the subject of abutments for permanent bridges with commendable brevity, so we had to search elsewhere for enlightenment. It was not very difficult to

find out how to do the necessary calculations for the abutments themselves, but it was a very different matter to find a design cheap enough. As the abutments in each case were some 30 ft. to 40 ft. in height, the calculations for each design covered about 20 pages of foolscap. At least six designs were tried, and the only slide-rule available was so warped that the cursor would not curse. We did!

The next difficulty was the wing-walls. Search as we might, no one could find out exactly how these were calculated. It is said that "necessity is the mother of invention," but no member of the T.R.D. was, at that time, particularly keen on being acclaimed a "father." However, the job was done with, we think, all reasonable economy and certainly with success, for the bridges are still standing!

When the final design had been approved (by ourselves), and the drawings made, some worthless specimen suggested that a reinforced-concrete abutment, instead of a solid concrete one, might be much cheaper, the saving in cement being considerable. Anyone who has ever tried to design a reinforced-concrete abutment will sympathize with us. We had never attempted this, and we hope that we will never have to do so again! Nevertheless, the floor of the office and the bungalow was once more covered with a mass of discarded calculations and "necessity" brought forth another child. Fortunately it did not live long! The saving in cement would have been considerable, but the bars were so numerous and so difficult to place accurately that it was decided that no available contractor would be able to compete, and that in any case the tenders submitted would not be any less than those submitted for the plain concrete structure.

No special launching gear was supplied with the bridges and there was none available on the Coast. The firm who made the bridges wanted nearly £200 to supply some, so we asked the contractor, whose tender had been accepted for the abutments and the erection of the bridge, what he could do about it. He said there would be no trouble. There wasn't! He erected scaffolding in the river-bed in both cases, and built the bridges in a very short time, using only unskilled native labour, a few crowbars, one 3-in. snatch block and a length of 3-in. cordage. At least, that is the only material we ever saw. These Italian contractors certainly take a lot of beating at getting a job done under adverse conditions. Furthermore, they never appear to make any calculations. Presumably they do it all by instinct.

The designers of the treble 30-ft. span reinforced concrete bridge at Enchi certainly wished that they could have trusted entirely to instinct! The largest span previously used by the Department was 25 ft., but as three 30-ft. spans were almost certain to be much cheaper than four 25-ft., owing to the saving of the large amount of labour and material required for the extra pier, a new

design was put in hand. For the first time, reinforced T-beams were used. To the mathematically-minded, the calculations involved (see *S.M.E. Reinforced Concrete* book) may be quite simple, but we did not find them so. However, the thing was finally completed, and as far as we know, nobody has yet put his foot through it.

This bridge certainly cost much less than five spans of 20 ft. and the appearance is quite pleasing. The bottoms of the piers, however, do look too wide, probably some saving could have been safely obtained by reducing them. Someone may feel the urge to check them? We will willingly supply all the necessary data, but to be quite fair to the original designers, we must insist that he does his calculations in a greenhouse with the heat full on!

The construction of these bridges was left until the next year.

As usual, there were again many changes in personnel. Bogle reverted to the Corps in June, and Stratton took over as acting-officer-in-charge. Serjeants Bedford and Morgan reverted to the Corps in July and were replaced by Corporal Moran and Lce.-Corporals Hardwick, Landon and Newell.

Lieut. A. R. Logan arrived in the Colony in July to fill the vacancy left by Wheeler, and C.S.M. Black reverted to the Corps in August, retired, and later returned to the Gold Coast as a foreman in the P.W.D. His retirement left the Department without a foreman of works, so Lce.-Corporal Hardwick filled the post temporarily before commencing survey duties.

Captain F. K. Stranack, the new officer-in-charge, arrived in the Colony and took up his duties in September.

In July the Governor, Sir Ransford Slater, carried out a tour of inspection of the Western Province and travelled along the Insu-Enchi road, roadhead at this time having reached the Tano river. His opinion of the quality of the work turned out by the T.R.D. is best gauged by the fact that on his return to Accra, the Department received authority to spend an additional £48,000 on construction this year, and were warned that a further £35,000 might be allotted in January. This latter sum was never voted, because before the end of the year the first icy blasts of the world financial crisis had reached the Gold Coast.

APRIL, 1930—APRIL, 1931.

This was the final period of the Department. All the factors that had led to its formation had been reversed. Cocoa prices fell in company with other world commodities, and an ill-advised attempt at a boycott by native cocoa farmers turned this fall in prices into a landslide. Something closely resembling a panic set in, as trade

came practically to a standstill. An enormous hole appeared in the revenue, and through this hole the T.R.D. disappeared with a bump, to the cry of " economy and retrenchment."

The work, therefore, was limited to the completion of the items already authorized.

The survey programme included the completion of the two great west roads Wiawso–Krokosua and Axim–Half Assinie.

By July all the N.C.O's had left the Colony, and so an officer was placed in charge of the survey parties, and relieved of all construction work. Previously, an officer was normally responsible for construction spread over a large area, as well as for at least two survey parties under N.C.O's.

By way of experiment the size of the party under this officer was increased to almost twice the size of a normal survey party and the result was rather interesting. Previously the average progress of an N.C.O. was four miles of completed location a month. This party, however, reached a maximum of 20 miles a month, and at the end of three and a half months the average output was 15 miles per month. After making due allowance for the increased size of party, and for the fact that the district was well supplied with paths and hunters' trails, this striking increase in output can be attributed to two items : (1) experience (this officer was now in his third tour), (2) knowledge of construction and its difficulties. These items undoubtedly enable a surveyor to assess much more clearly the value of a line by reconnaissance only, and reduce to a minimum the number of traverses and branch traverses to be cut afterwards. Reconnaissance work is infinitely quicker than cutting traverses all over the countryside.

The re-alignment of the Swedru–Asantemang road was completed. Many Sappers will doubtless remember this road with its 190 curves (so called) in 22 miles. The re-alignment consisted in scrapping the whole of the old line and adopting a completely new location with 37 curves.

The last survey to be undertaken was the Fomena–Brofoyedru line, and it was probably the most difficult. The object was to link up the road system round Kumasi with the Prahsu–Brofoyedru line, over the intervening high range of hills. All idea of tangents and curves had to be thrown away and a survey for a mountain road carried out. The party spent a happy time clinging on, for most of the time, with their teeth and eyebrows to a 1 in 1 slope of rock.

In construction the roads through the Sambruno and Tankwiddi swamps in the Northern Territories were completed by the construction of masonry bridges. The *magnum opus* of the T.R.D., the Insu–Enchi road commenced in 1927, was brought to an end with the completion of the three large bridges already referred to.

The second great west road, Wiawso–Krokosua, was unfortunately never completed owing to lack of funds. Construction ceased at a

point three miles beyond Asafo, and here we erected a concrete tombstone with the following inscription :—

"HERE DIED THE T.R.D."
"BORN 1925 DIED 1931."
"R.I.P."

The personnel were gradually reduced in numbers. In May, Macdonald relieved Stratton in the Northern Territories, and in July he sailed for England for the last time, complete with bagpipes. In July, also, Corporal Moran, Lance-Corporals Hardwick, Landon and Newell all reverted to the Corps and were not replaced.

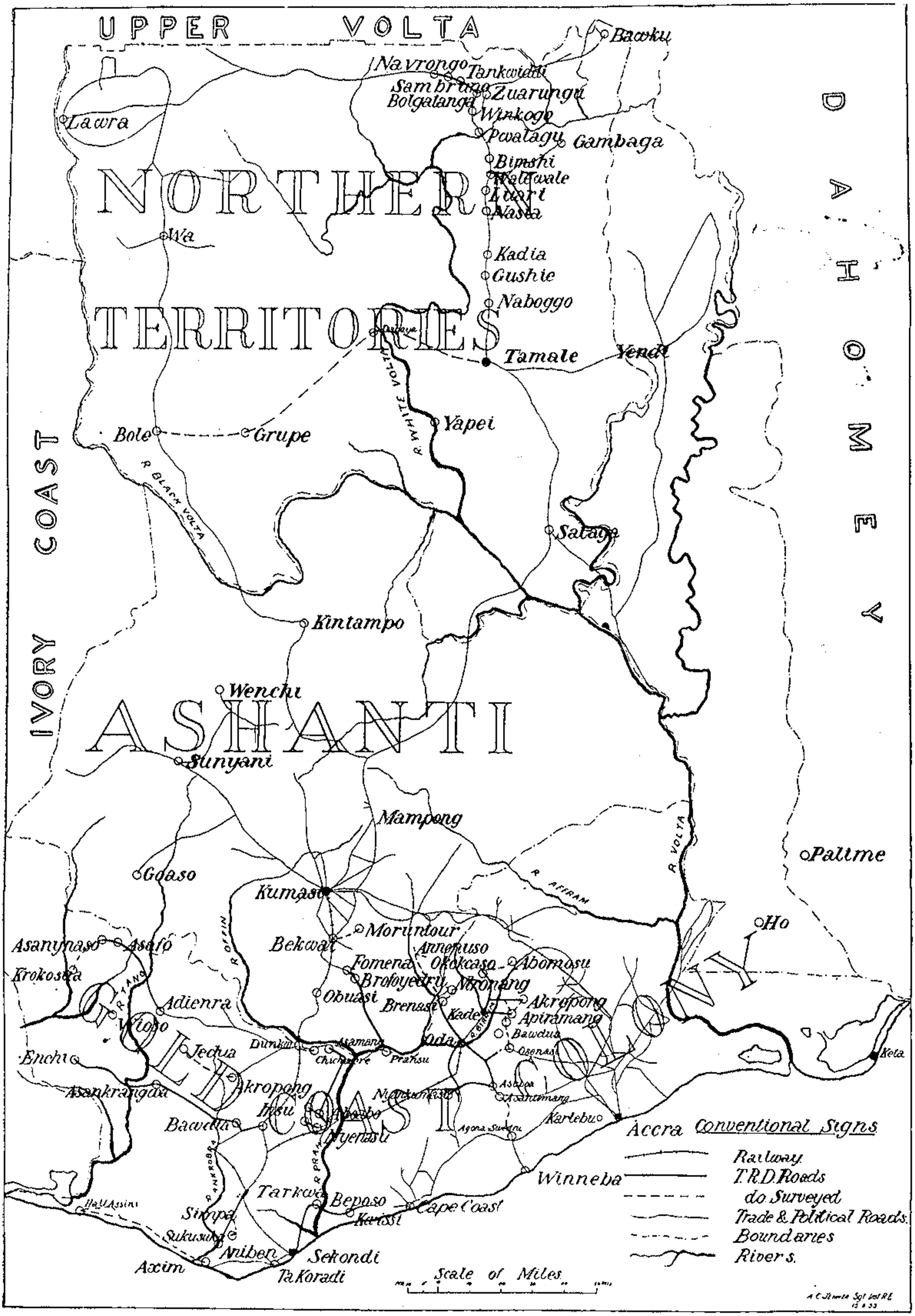
This left a rear party consisting of Stranack, Logan and Stratton to complete the work and wind up the Department. The Governor also called for a detailed report of the methods used by the T.R.D. so that they could be adopted by other departments.

The preparation of this grisly report (running to over 100,000 words) gave rise to the idea that the T.R.D. would one day perpetrate an outrage in the *Pickaxe*.

The last members of the T.R.D. left the Colony in May, 1931.

It is a matter of great regret that, owing to the world crisis, there are no further opportunities for members of the Corps to be seconded to the Colonial Office for this work. When brighter times arrive, however, it is reasonable to hope that the opportunity may recur, because the Corps has undoubtedly left its mark behind. In his speech to the Legislative Council in February, 1931, the Governor said : " It is with very much regret that the decision has been taken to advance the date for the closure of the Temporary Roads Department. During the years of its activities in the Gold Coast an immense contribution has been made by its staff, not only in road location and construction, though the value of these in terms of permanent development are inestimable, but also in the records that they leave with us. I have just spoken of certain improvements in design which we owe to them. These are only instances of many valuable investigations which the Department has made into local survey and structural work in the Gold Coast. The fruits of their labours and experience will remain with us to our permanent profit. We may say of them, ' *Si monumentum requiris circumspice.*' "

(*To be continued.*)


UPPER VOLTA
IVORY COAST
DAHOMEY
NORTHERN TERRITORIES
ASHANTI
GOLD COAST COLONY
Bawku
Navrongo
Tankwidi
Sambruno
Zuarungu
Bolgatanga
Winkogo
Pwalagu
Gambaga
Bimshi
Walewale
Luari
Nasia
Kadia
Gushie
Naboggo
Tamale
Yendi
Lawra
Wa
Bole
Grupe
Yapei
Salaga
Kintampo
Wenchi
Sunyani
Mampong
Goaso
Kumasi
Pallme
Ho
Keta
Asanynaso
Asafo
Krokosua
Bekwai
Morontour
Annemuso
Fomena
Okokcaso
Abomosu
Brofoyedru
Nkronang
Obuasi
Brenasi
Kade
Akropong
Apiramang
Adienra
Wioso
Enchi
Jedua
Dunkwa
Chichiwere
Prahsu
Oda
Bawdua
Osenasi
Asankrangua
Akropong
Insu
Nyenasu
Asanmang
Agona Swedru
Karlebu
Accra
Bawdia
Tarkwa
Beposo
Cape Coast
Winneba
Half Assini
Simpa
Sukusuku
Axim
Aniben
Sekondi
Takoradi
R. BLACK VOLTA
R. WHITE VOLTA
R. VOLTA
R. AFFRAM
R. OFFIN
R. TANO
R. PRAH
R. ANKROBRA
R. BIRIM
Conventional Signs
Railway
T.R.D. Roads
do Surveyed
Trade & Political Roads
Boundaries
Rivers.
Scale of Miles

APPENDIX I.

Members of the Department.

(In order of their arrival in the Gold Coast.)

Capt.	R. L. Brown	1924–1927.
Lieut.	G. C. Rogerson	1924–1925.
,,	H. C. Bogle	1925–1929.
,,	R. P. Wheeler	1926–1928.
,,	W. H. Stratton	1927–1931.
,,	H. A. Macdonald...	1928–1930.
,,	A. R. Logan	1929–1931.
Capt.	F. K. Stranack	1929–1931.

Serjeant	Black	1925–1929.
,,	Emery	1925–1927.
,,	Giles	1925–1926.
Lce.-Serjt.	Benlow	1925–1926.
Corporal	Haskell	1925–1927.
Serjeant	Morgan	1926–1929.
,,	Brown	1927–1928.
,,	Bedford	1927–1929.
,,	Woram	1927–1929.
Corporal	Moran	1929–1930.
Lce.-Corpl.	Newell	1929–1930.
,,	Hardwick	1929–1930.
,,	Landon	1929–1930.

B. J. Pritchard	Civilian office	1927–1929.
C. Stevens	assistants ...	1929–1930.

Summary of Work.

	Survey.	*Construction.*
1925–26	118·1 miles	6·3 miles.
1926–27	108·2 ,, ...	94·4 ,,
1927–28	116·2 ,, ...	70·9 ,,
1928–29	192·6 ,, ...	52·7 ,,
1929–30	159·2 ,, ...	98·9 ,,
1930–31	83·1 ,, ...	34·7 ,,
Total ...	777·4 ,, ...	357·9 ,,

THE CROSSING OF THE PIAVE BY THE AUSTRIAN 24TH CORPS, JUNE, 1918.

By CAPTAIN E. G. PEMBERTON, NORTHUMBERLAND FUSILIERS.

INTRODUCTORY.

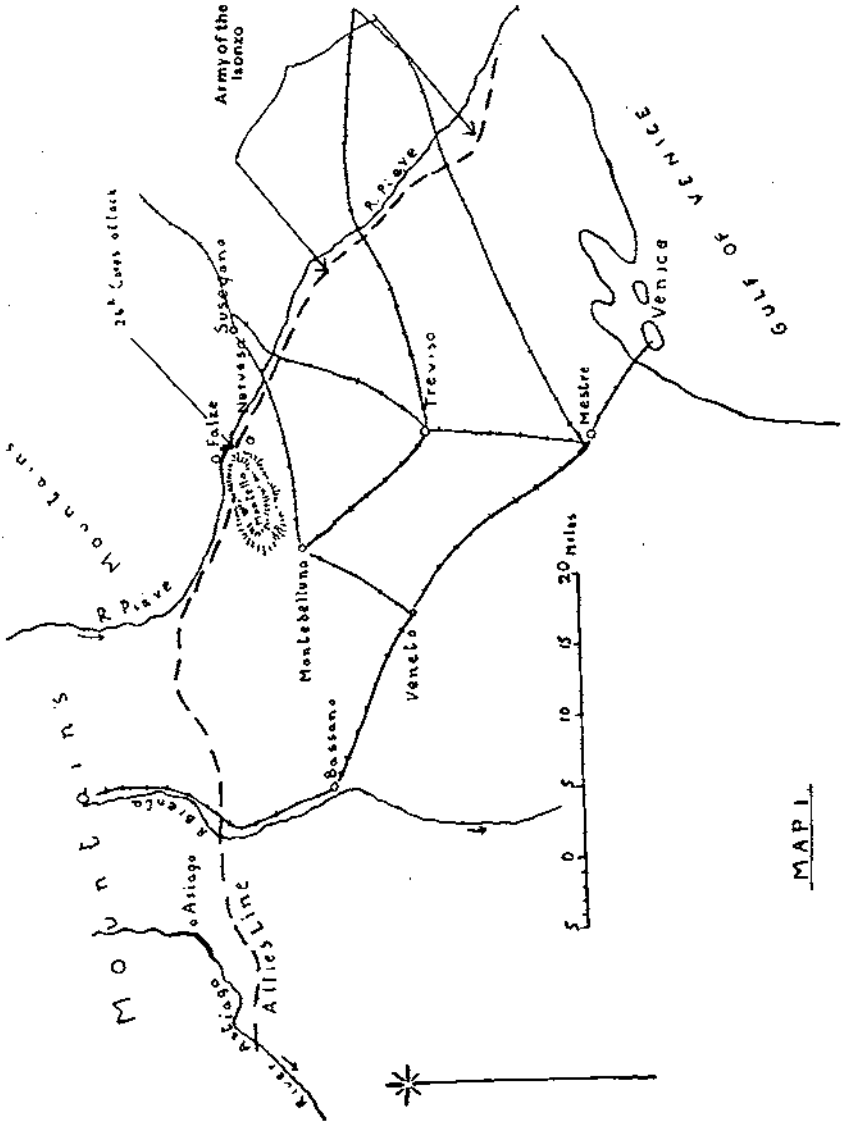
IT was suggested to the writer that an account of this crossing, which he recently had occasion to study in detail, would be of particular interest to readers of *The R.E. Journal*. In no river-crossing during the late war were the sappers, of any nation, faced with a tougher proposition, either in preparation or in execution, nor on such a large scale. That it met initially with partial success and did not finally end in disaster was largely due to the sustained and heroic efforts of the Austrian Sappers. As far as the writer knows, no account of this crossing has yet been published in English.

It is, perhaps, unusual to embark upon such an account without either having had access to official records or, alternatively, having taken part in the operation. The account which follows is not based directly on either of these sources of information. An Austrian, Major Lothar Rendulie, wrote his version of the battle in *Militärwissenschaftlische und Technische Mitteilungen* in 1927 (*R.E.J.*, March, 1928, p. 175), and an article by a French Colonel Baills, based upon the Austrian account, was published in the *Revue Militaire* of 1928 (*R.E.J.*, March, 1929, p. 178). The present writer is considerably indebted to the French article. The story which follows is, therefore, to a certain extent, third hand. Since, however, the Austrian writer quotes at length from the orders of various formations concerned, and gives a day-to-day account of certain phases of the battle, a measure of authenticity, however indirect, may be claimed for the third-hand product.

GENERAL SITUATION.

In June, 1918, the Austrian and Italian armies lay facing one another on the line of the Piave. The operation under review was part of the last large-scale offensive by the Austrians on the Italian front. (See Map 1.) The Austrians were to attack in two zones, on the Montello and on the lower Piave. This narrative is concerned only with the attack on the Montello by the Austrian 24th Corps. Its task was to cross the Piave, capture the Montello, and reach as soon as possible the line of the railway from Montebelluna to Treviso.

The object of this operation was to support the right flank of the Army of the Isonzo, which was attacking on the lower Piave. Between the Army of the Isonzo and the 24th Corps was a gap in the



attacking front of some seven kilometres. The 24th Corps was ordered, in addition to capturing the Montello, to make a feint in the northern part of this gap with a view to (*a*) fixing the attention of the Italians in that sector, and (*b*) facilitating the advance of its own left, and of the right of the Army of the Isonzo.

TOPOGRAPHY.

In order to appreciate some of the causes of success and failure in this operation, it is necessary to examine the battle area in some detail.

The Piave itself was a formidable obstacle. The portion which the 24th Corps was to cross flows between the Montello on the west and the Colfosco to the east. (Map 2.) Here the river-bed varies in width from 1,000 to 2,000 yards. In it are scattered shingle banks and islands, some of the larger ones being covered with scrub. Between these, the numerous channels of the river, some shallow, some deep, but all fairly rapid, wind their way. Some of the larger channels are approximately a hundred yards wide, with a depth of six to nine feet and, according to Colonel Bailis, a current reaching six to seven miles an hour. These were not the only complications. The Piave also has the unenviable characteristic common to mountain rivers, of being quick to rise in flood as rain falls in the mountains and quick to fall again. The result is that the position of islands, banks and channels frequently changes after a flood, and, when a flood is actually in progress, they may disappear and water be continuous from bank to bank.

As regards the left bank, approaches to the river west of Falze are comparatively easy, and the launching of bridging material presented no great difficulty. South of Falze, however, there were various difficulties. In the Colfosco numerous deep and narrow ravines lead towards the river, and the ground is covered with scrub often right up to the river-bank. Near Mina the Austrians had to cross a retaining wall some ten to thirteen feet high, on to a narrow spit of sand. This meant using ramps for pontoons and ladders for troops, conditions which were bound to slow up the passage of the first assault troops. Only two roads give access to the river on this side, namely, the road Piave di Soligo—Falze—Villa Matta, and the road from Susegana to Mina. These two were connected by another one parallel to, and at a short distance from, the river. All were badly metalled, overlooked by the Italians, and lit up at night by searchlights.

On the right bank was the 24th Corps objective, the Montello, a long, isolated hill some eight miles long and three wide, varying from four to eight hundred feet above the surrounding plain. It was undoubtedly the key to the Italian positions in this area, and an enemy in possession of it could overlook and enfilade defences stretching south along the line of the river. This somewhat peculiar feature, protected as it already was by the river, was also very adaptable to defence in other respects. Numerous roads ran across it, though these were unmetalled and apt to break up in wet weather. The hillsides were pitted with deep cup-like depressions which

afforded good cover for troops, guns, and material. Furthermore, during the winter of 1917-18 British troops, then in occupation of the sector, had added to its natural strength by the construction of well-made defences. Numerous trench lines were dug, wire obstacles were erected, some of them stretching out into the bed of the river, and concealed machine-gun emplacements were tunnelled out of the hillside in such a way as to enfilade the line of the river.* The Austrian account refers to four defensive lines, and also mentions a strong defensive system at Nervesa.

Altogether, therefore, the operation of crossing the Piave and capturing the Montello seems to have bristled with tactical and technical difficulties of many kinds.

Preliminary Preparations.

As will be seen from Map 2, the Austrians intended to cross on a three-division front, and it is hardly necessary to point out that the simultaneous crossing by three divisions, of a river like the Piave, requires the concentration of a vast amount of material. There were many obstacles for the Austrians to negotiate in this concentration. In addition to the difficulties caused by lack of roads, and the rather broken ground, all movement had to be restricted to night time. Even then it was considerably interfered with by enemy harassing fire and searchlights. Under such conditions a surprise crossing seems almost impossible. Nevertheless, by taking infinite pains, the Austrians did achieve a measure of initial surprise. Seventeen nights were devoted to the collection of bridging material, which was carefully hidden in camouflaged dumps near to the river. The dumping of gun ammunition occupied a month. In addition, the river was reconnoitred night after night by enterprising patrols, until every channel and shoal was known, and the minimum bridging requirements for each site could be accurately estimated.

Troops and Material Available.

Austrian.

The three divisions taking part in the crossing were the 31st, 13th and 17th. Artillery support consisted of 616 pieces. Of these two-thirds were howitzers of various calibre. There were also 126 mortars or small howitzers, making in all an average of about 120 guns or howitzers per kilometre. 2,000 to 3,000 tons of artillery ammunition were available for each division. There were also three anti-aircraft batteries on the Corps front.

As regards air resources each division had a squadron corresponding roughly in functions to an Army Co-operation Squadron, and there were three fighter squadrons under Corps.

* This sector was handed over by the British to the Italians in Spring, 1918.

Engineers and Engineer Material.

No attempt has been made in this article to compare the engineer resources available with British establishments. In a detailed statement the French writer reduces the Austrian units to terms of French Bridging Parks, 1901 type, but the comparison is only approximate, and any attempt at further conversion would probably only lead to false conclusions. Some interesting facts do, however, emerge from the details of resources given.

In the first place a total of some 220 pontoons and 308 boats were collected, concentrated, and hidden for the crossing—a considerable undertaking in itself. Fifteen companies of sappers were available, of whom, according to the French account, 60% were really old pioneer companies, and far from being fully trained. None of the companies had had much experience in watermanship, but steps were taken to remedy this weakness by giving them special preliminary training on the Tagliamento and the Livenza.

The distribution of resources in material and personnel calls for special comment. Here it is convenient to use some of the French figures. The total material available came to the equivalent of 21½ French Bridging Parks. The allotment made was: 31st Division, 6 units; 13th Division, 6½ units; 17th Division, 8 units; Corps reserve, one incomplete unit, having only four pontoons in it.* Of the fifteen sapper companies less than one was kept in reserve, the remainder being more or less evenly divided between the three divisions.

The retention by the Austrians of such an infinitesimal reserve for an operation which, in many respects, was otherwise carefully planned, seems almost incomprehensible. As regards material, Colonel Baills explains that as Austrian bridging units had an equal number of trestles and pontoons this in itself may have constituted a local reserve of sorts in each division, as in some places it was possible to replace pontoons by trestles. If all estimates of material required were based solely on the use of pontoon equipment in the first instance, there may be some foundation for this suggestion. On the other hand the account only mentions one instance in which this was successfully done. There seems to be no reasonable explanation of the feeble reserve of personnel. The French writer puts it down to the Austrians' "excessive contempt" of their opponents, and attributes to the same cause the lack of any reserve division in the attack. The Italian collapse at Caporetto was probably still fresh in the memory of the Austrians, and so there may be some grounds for the suggestion. It does not, however, explain an apparently similar attitude towards the numerous mischances which may attend an operation of this kind, especially when the river to be crossed is

* There was also a dump of material near Falze, but this was only intended for extemporised and later bridging after the attack had gone through.

one possessing the characteristics of the Piave. It will be seen later how the Austrians were to suffer from lack of reserve engineer personnel.

Italian Troops.

The account is not clear as to the exact strength in which the sector was held by the Italians, but orders of one division, the 17th, report elements of the Italian 58th division on its front on the Montello, and a brigade of the 48th division below Nervesa. Later orders of the same division refer to one brigade of the 58th and two brigades of the 48th, so it appears that the position was fairly strongly held. In addition, it is common knowledge that at this time and in this theatre of war, the Allies were uniformly superior in the air.

24TH CORPS PLAN.

Before the outline plan of the 24th Corps is considered, there is one important factor relating to it which must be emphasized. It will be seen from Map 2 that the sector in which the 24th Corps was to attack consisted of two arms of the river almost at right angles. Unless adequate steps were taken to protect them, both flanks of the attack were likely to be enfiladed from up- or down-stream. What measures did the Austrians take to prevent this? On the right flank the 11th Corps was to demonstrate and keep the enemy under artillery fire. But the total amount of artillery available to this corps for all its tasks was only 134 pieces, all of light artillery, less than the artillery of two British divisions on present war establishments. On the left flank, it will be remembered, there was to be a demonstration by the 24th Corps. This demonstration was entrusted to a diminutive force of one battalion with a cavalry squadron and a few machine-guns and mortars. It will be seen later that the inadequacy of these arrangements for protection of the flanks of the attack was one of the greatest weaknesses of the Austrian plan.

The outline plan may be summarized as follows :—

Z day.	June 15th.
0300 hrs.	Gas and H.E. bombardment of enemy position to begin.
0530 hrs.	Leading troops of divisions to cross by boat and assemble for assault.
0730 hrs.	Attack on enemy front line. After capture of this position, bridging operations were to begin, the remainder of the infantry were to advance and artillery was to begin moving up to the Piave. The second and third enemy lines were then to be

attacked, after which the bulk of the artillery was to cross the river, to support the attack on the fourth line.

The minimum objective on the first day was to be five roads junction 1½ kilometres S.E. of Rivasecca, thence approximately line B on map.

Amongst other things, the order visualized the establishment of :—

(*a*) A footbridge or ferry in each regimental sector as early as possible.

(*b*) A pontoon bridge on each divisional front by 1200 hrs. During the construction of bridges, ferrying was to be continued with all available resources.

A portion of the orders of one division, the 17th, is given in the French account in considerable detail, but as it runs into four pages it is too long for reproduction in full.

The main points of interest in it are :—

(i) There were to be two embarkation points for the leading parties, and bridges were later to be constructed at or near these points.

(ii) A limited amount of light artillery was to be moved across by ferry as early as possible after the leading infantry.

(iii) Bridging operations were to begin at 0740 hours, *i.e.*, at the same time as the leading troops delivered their first assault.

It seems that the only possible justification for beginning to bridge at such an early hour could be that the enemy artillery should be dominated, or deprived of observation, and this is far from being what happened.

THE CROSSING.

Operations began on June 15th and lasted until the morning of the 23rd. During that time the Austrians advanced as far as line D, on Map 2, after which their advance came to a standstill. Withdrawal was ordered on the 20th, and at dawn on the 23rd they were back on the left bank. The course of the battle will now be traced in greater detail.

By midnight on the night 14th-15th June all Austrian troops had got into position without a hitch. At 0300 hrs. on the 15th the artillery bombardment began. The enemy made no reply until 0500 hrs., but he then opened a vigorous fire with artillery, mortars and machine-guns. The early morning was, however, misty, and this, together with the smoke of bursting shells, filled the valley of the Piave with a dense cloud, which helped to screen the attackers from

hostile artillery observation. These conditions prevailed until 0600 hrs., at which time it became just possible to see the far bank. Austrian ferrying operations had started well, and the first troops were soon across. Harassed during their assembly by enemy activity on almost the whole front, they assaulted before the time ordered. The Italian front line was soon over-run, and the attack, well supported by low-flying aircraft, made rapid progress.

According to the Austrian account many of the Italians were found in their dugouts. Whether they were caught unawares or were sheltering from the Austrian artillery fire is not clear, but it certainly seems that full use cannot have been made of the sheltered machine-gun emplacements sited to enfilade the river.

Towards 1000 hrs. the Austrian attack had reached line A on the map, an advance of about two kilometres, but attempts to capture Nervesa had failed. At about mid-day Italian resistance stiffened. Meanwhile their artillery and aircraft had begun to engage all the crossing-places, and were interfering considerably with bridging and with movement by ferry. The two Austrian flank divisions in particular were having a very bad time, and all divisions were finding it almost impossible to get their close-support artillery across.

At 1440 hrs. the 13th division was the only one which had been able to get all its infantry across and the only artillery accompanying it was three mountain batteries. Although special arrangements had been made to get signallers across with the leading troops, communications broke down almost completely, and the only methods which worked at all were by aircraft and carrier pigeon. The result of all these shortcomings was that an attack by the whole Corps, designed to start at 1500 hrs. to capture line B on the map, could not take place because there were not yet enough troops across.

The situation on the flanks of 24th Corps was no better. Only a feeble demonstration had been made by the Corps on the right, and their artillery fire afforded little or no protection to the crossing of the 31st Division.

On the left, the whole of the ferrying resources of the nearest division had been rapidly destroyed by shell fire.

The Army Commander now ordered a division to cross in support on either flank, and join in with 24th Corps to capture line B. After the capture of line B they were to push on to line C; but it was too late. Only a few troops of these divisions were able to cross, and once more the projected attack on line B never started.

On the 16th the Italians made numerous counter-attacks, but these were delivered in small packets and came to nothing. A fresh Austrian attack against Nervesa failed at first, but later the Italians evacuated it. The Austrians then pushed on as far as the railway line just east of the village of Bavaria.

The night of the 16th-17th was employed by the Austrians in efforts to improve their communications on the Italian side of the river, but on the 17th the weather came to the assistance of the Italians, rain fell in torrents, roads were broken up, the river began to rise, and communications became more and more precarious. In spite of this the Austrians progressed during the 17th as far as the high ground north of Giavera, and reached the outposts of the enemy's second line.

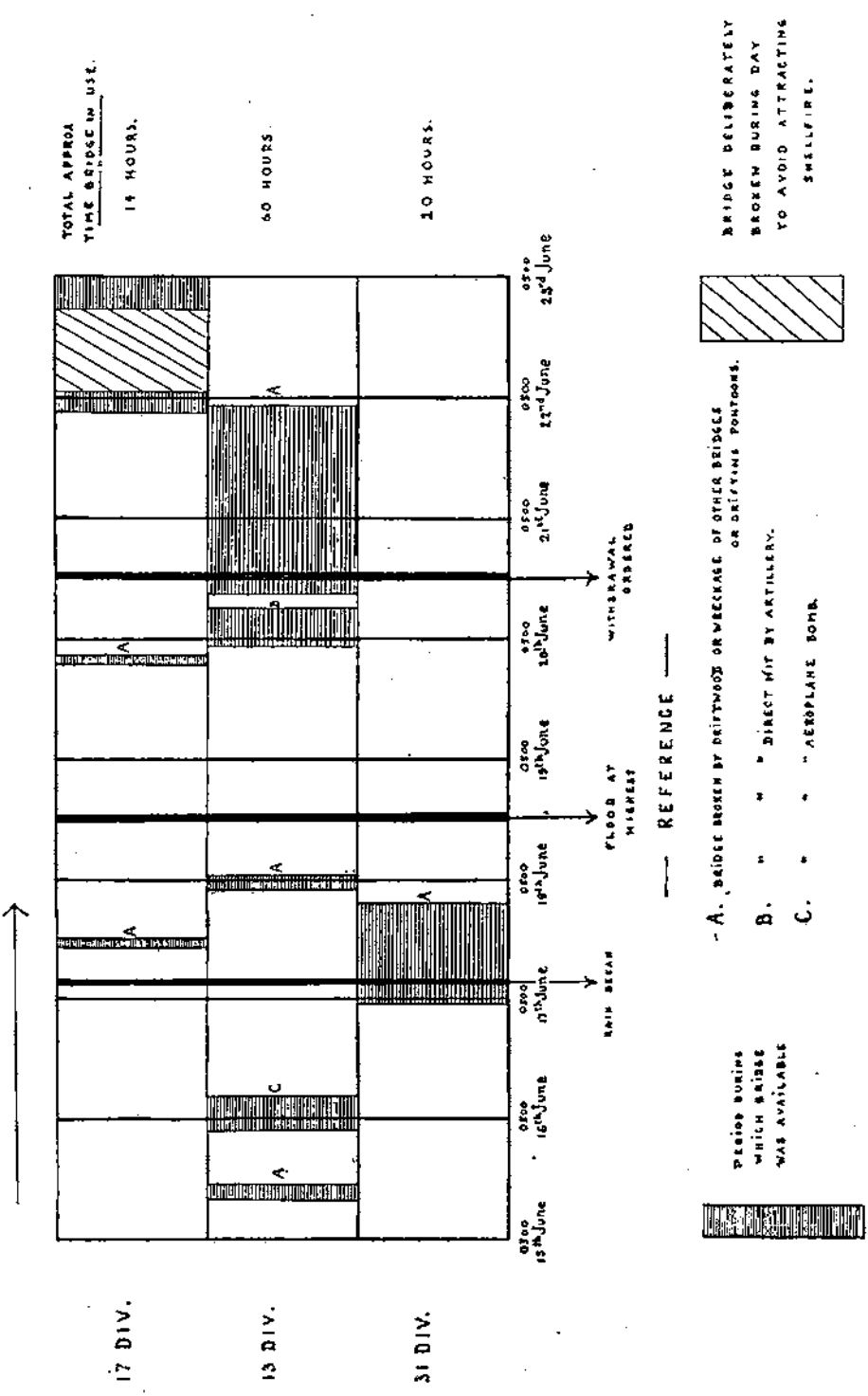
After this their advance came to a standstill on the line marked D. The Italians counter-attacked on the 18th, 19th and 20th, but were met by a stout resistance and made no ground at all.

By the 20th the Austrian maintenance services had dwindled almost to nothing, and the troops were short of supplies and stores of every kind. The choice lay between (*a*) consolidating the ground won, in the hopes of renewing the offensive later, and (*b*) withdrawing. On the 20th the Austrian higher command decided to withdraw.

THE WITHDRAWAL.

Withdrawal was carried out during the nights of the 20th, 22nd and 23rd, without any interference by the Italians. By dawn on June 23rd the right bank was clear of Austrian troops, and bridging and ferrying material had been moved to the left bank. On the morning of this day, the Austrians now being all safely across, there was a heavy Italian bombardment of the position they had evacuated on the Montello. It was not until 1000 hrs. that small Italian patrols ventured beyond the railway south-west of Nervesa and advanced slowly towards the Montello. A little later, larger bodies of troops, supported by heavy machine-gun fire, delivered an assault against a position which did not contain a single Austrian soldier. It was not until 1845 hrs. on the 23rd that the first Italian patrols were observed on the right bank of the Piave. So ended the remarkable battle of the Montello.

But the picture is not complete without some account of the trials and tribulations of the Austrian sappers. Ferrying and bridging were constantly interrupted from an early hour by enemy artillery and low-flying aircraft. Their casualties were heavy. One case is mentioned of a sapper company suffering 70% casualties by 1130 hrs. on the first day. The last straw came when the river rose in flood. The bare results of their efforts are shown in the diagram, but the full tale cannot be told in this way. The diagram only shows the actual periods during which bridges were in use, and the causes of their destruction. It does not show those on which they toiled for hours only to have them broken at the last minute, nor does it show the Austrian sappers scrambling in the flood to salve the wreckage in hopes of starting all over again. It cannot tell the story


TOTAL APPROX TIME BRIDGE IN USE.
14 HOURS.
60 HOURS.
10 HOURS.
17 DIV.
13 DIV.
31 DIV.
0500 15th June
0500 16th June
0500 17th June
0500 18th June
0500 19th June
0500 20th June
0500 21st June
0500 22nd June
0500 23rd June
RAIN BEGAN
FLOOD AT HIGHEST
WITHDRAWAL ORDERED
— REFERENCE —
A. BRIDGE BROKEN BY DRIFTWOOD OR WRECKAGE OF OTHER BRIDGES OR DRIFTING PONTOONS.
B. " " " DIRECT HIT BY ARTILLERY.
C. " " " AEROPLANE BOMB.
PERIOD DURING WHICH BRIDGE WAS AVAILABLE
BRIDGE DELIBERATELY BROKEN DURING DAY TO AVOID ATTRACTING SHELLFIRE.

of their laborious ferrying to and fro, day and night without relief, across the swollen river, at a time when it was said to be flowing at ten miles an hour, and each crossing there and back took as long as three hours. Lastly, it cannot show the periods when, through sheer exhaustion owing to lack of relief, they were hardly capable of any work at all. Only a brief summary of the operations on each divisional front can be given.

31ST DIVISION.

This division had two embarkation points, approximate positions marked P and Q on Map 2. On the 15th of June ferrying at point P had to be stopped at 0930 hrs. owing to enemy artillery fire. No bridging could take place at either point. During the day some troops crossed by ferry at point Q and some by a bridge which the 13th Division had succeeded in building. No bridging took place until the night of 16th-17th, but during this night a trestle bridge 190 yards long was built across the existing channels. On the 17th only four regiments were able to cross, some by ferry and some by the bridge, a testimony to the harassing effect of Italian artillery and aircraft. On the night of the 17th-18th some of the bridge had to be taken down owing to the rising flood, and on the following night a portion was washed away and the material lost.

Bridging was resumed at nightfall on the 19th. The bridge was nearly completed by 0600 hrs. on the 20th, but was broken by drifting pontoons from farther upstream.

During the subsequent withdrawal the sappers, exhausted and reduced to a few survivors, could only maintain traffic by ferrying. It is interesting to note that three mountain batteries were ferried, their horses swimming behind the boats.

13TH DIVISION.

By 1245 hrs. on the 15th this division had a bridge across (about point M on map), and by 1440 hrs. all the infantry and three mountain batteries were across. After 1400 hrs. the Italian fire became more effective, and nine batteries of artillery which were waiting to cross had to be held back. In the end they never got across. At 1630 hrs. the bridge was broken by a drifting ramp, but it was repaired again during the night of 15th-16th. At 1000 hrs. on the 16th, as will be seen from the diagram, it was again broken, this time by an aeroplane bomb. On the 17th sapper reinforcements from the 11th Corps (on right of 24th Corps) arrived. The remainder of this division's operations can easily be followed on the diagram.

17TH DIVISION.

This division had two crossing-places, approximate positions marked X and Y on Map 2. On the 15th ferrying had to be discontinued at point Y at 1130 hrs., owing to enemy flanking fire. Bridging was out of the question. Ferrying was working under great difficulties at point X, but bridging failed here also. During the 15th this division had transported five battalions across by 0800 hrs., but between that hour and nightfall only one additional battalion had been able to cross. During the night of 15th-16th a bridge was nearly completed, but was then broken by a drifting pontoon. By the 16th the sappers, who had suffered heavy casualties, were exhausted. All attempts at bridging were abandoned, and only a little ferrying was done. During the night 16th-17th bridging was resumed, but as the bridge could not be completed before daylight, work was stopped. A company of fresh sappers, again from 11th Corps, arrived and during the 17th a bridge was completed by the afternoon. Its life was short, portions of it being swept away by masses of driftwood and wreckage of other bridges farther upstream. The result of this division's subsequent operations up to the night 21st-22nd can be seen from the diagram. On this night a bridge was built by another fresh company of sappers, and completed by 0230 hrs. It was used until daylight, when, in order not to attract artillery fire a break was made in it. At nightfall the break was repaired and the division used the bridge to complete its withdrawal.

COMMENTS.

(1) The battle of the Montello illustrates the outstanding difficulty of constructing and maintaining bridges when fighting against an enemy who has local air superiority and whose artillery is neither subdued nor even deprived of observation. Counter battery work by the Austrian artillery seems to have been either neglected or misdirected. They paid heavily for the weakness of their measures for flank protection. It was particularly flanking fire from the guns of neighbouring Italian divisions which interfered with the earlier stages of their crossing. A glance at the diagram shows that whilst the centre division was able to use a bridge for altogether 60 hours, the two flank divisions could only do so for 20 and 14 hours respectively.

It is easy to be wise after the event, but it certainly seems that if the Austrians were to attempt to cross with three divisions on such a narrow front as eight kilometres, the necessity for strong flank protection should have been obvious to them. This, after all, is a vital part of the plan for any attack on a narrow front, but when the

attack involves, in addition, a river crossing in the face of the enemy, its importance seems to loom larger than ever.

(2) The question arises as to how soon, after the initial crossing, bridging may begin. It is impossible to be in any way arbitrary over coming to a decision. The only answer seems to be the commonsense one, *i.e.*, when it is appreciated that the enemy cannot bring effective artillery fire or air bombing to bear on the selected site. This depends on a variety of conditions such as the depth of advance necessary before the site is defiladed, the prospects and means available of depriving the enemy of air and ground observation, resources in A.A. defence and so on. There is no evidence, in the accounts read, of the extent to which these considerations were weighed by the Austrians. The only evidence is to be found in the plan itself. In it they all seem to have been disregarded almost completely.

(3) Closely related to the last question is another one. If bridging has to be deferred for any length of time, how is artillery to be got across the river in support of the leading troops? This question argues the need for a stout raft, self-propelled or capable of being towed. The present-day collapsible boat raft, perhaps towed by a motor-boat, may be one answer.

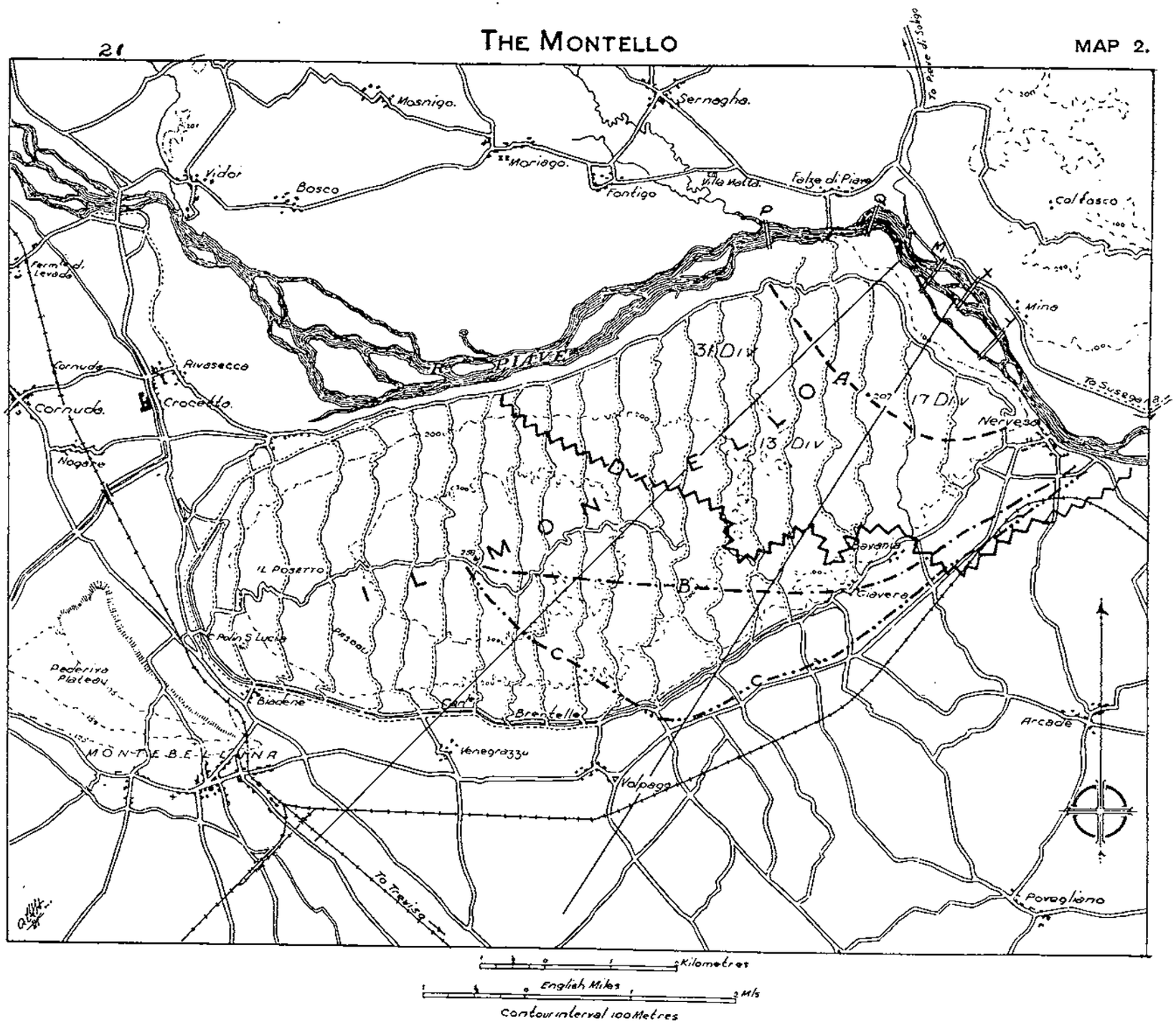
(4) As regards air defence, the story of the crossing contains numerous instances of bridging and movement being stopped by aircraft flying low and using machine-guns. There is also one case of a bridge being broken by an aeroplane bomb. There seems to be little doubt that in future operations of this kind, the whole plan, however complete in other respects, may be doomed to failure unless adequate protection against hostile air action can be assured.

(5) So far attention has been directed mainly to the Austrians' side of the battle. What of the Italian defence? The strength of their position has already been shown. It has also been seen that in spite of its strength, and in spite of the Italian machine-guns in sheltered emplacements, sited to sweep the river, large numbers of Austrians were still able to cross. The mist may have been in the Austrians' favour during the first half-hour, but by 0600 hrs. it was possible to see from bank to bank. Nevertheless by the early afternoon the centre division had all its infantry across. After this the Austrians were allowed to maintain a precarious foothold on the Montello for five days, and finally to withdraw unmolested.

If the Austrians had been in any way pressed by the Italians in their withdrawal, their failure might easily have been turned into utter rout. A glance at the bridging diagram shows, on the other hand, that in the cases of the 13th and 17th Divisions, bridging during the withdrawal presented less difficulties than at any other time, whilst the 31st Division, who by this time had neither the strength nor the

THE MONTELLO

MAP 2.



resources to build a bridge, was still able to effect its withdrawal by ferrying alone.

The lessons to be learnt from the Italian side are not new ones. Very briefly, the causes of their weakness seem to have been :—

Either (*a*) The defensive fire plan was incomplete, the Italians relying too much on the river to defend them, and having no plan to deal with conditions of fog or darkness.

or (*b*) The fire plan was not ready to operate at once. (It will be remembered that the Austrian bombardment began at 0300 hrs., but that no reply, not even in the nature of counter battery work, was made until approximately two hours had elapsed.)

or (*c*) The will to defend was lacking. Their failure to maintain contact during the Austrian withdrawal seems to indicate at least a lack of enterprise.

or (*d*) Any combination of the above.

In short, it is difficult to escape the conviction that the Austrian plan would have broken down at the very outset, if the Italian defence had been thoroughly organized and the troops alert and determined. The subsequent failure to maintain contact with the Austrians must take a prominent place in historical examples of this kind.

(6) Last but not least we come to the Austrian sappers. Their heroic efforts under desperate conditions, and their utter exhaustion, have been illustrated. Although some of the units were inexperienced it cannot be said that the failure of the crossing was due to their shortcomings. It may be urged that the Chief Engineer 24th Corps should have protested to the " G " Staff that his resources and reserves were insufficient. There is nothing in the account to show whether he did or not. Possibly the boot was on the other leg, and the Staff did not appreciate the magnitude of the sapper problem. The last words of Colonel Baills on the subject may find an echo in the minds of sapper readers. He concludes his article as follows :—

" Let us therefore aspire, in our peace-time exercises, to closer liaison and increased mutual confidence between engineers and the higher command, remembering the frequent lack of these desirable conditions during the late war."

A SOLDIER FAMILY.

By J. W. LYDEKKER, ESQ.

THE family of Durnford during a period of nearly two hundred years has had an unbroken succession of service in the army. Of this, no less than five successive generations have served in the Royal Engineers. Probably this constitutes a record in army service, and the following biographical sketch of this soldier family may not be without interest.

The first member of the family to be connected with the army was Elias Durnford. He was born at Ringwood on 14th March, 1720, and was the eldest son of Thomas Durnford, of Christchurch, Hants. After serving some years in the Ordnance Department he was appointed Deputy Treasurer of H.M. Ordnance.

On 15th April, 1738, he married Martha Gannaway, and, in due course, four sons were born: Elias on 13th June, 1739, Thomas on 26th January, 1742, Andrew on 24th April, 1744, and Clark on 24th July, 1748.

The eldest son, Elias Durnford, joined the Royal Engineers and was gazetted a Practitioner Engineer with rank of Ensign on 17th March, 1759, and promoted Sub-Engineer and Lieutenant on 28th January, 1762. In the same year he was present at the siege and capture of Belleisle, in an expedition commanded by General Hodgson. The next year an expedition was sent to cripple the Spaniards in their West Indian colonies. The Earl of Albermarle was given the command. Six Engineer officers accompanied the expedition, among whom was Elias Durnford. The force landed at Havana and attacked a fort called El Moro. This fort was strongly defended by a gigantic ditch and scarp, which could only be overcome by mining. The Engineers dug two mines, which were sprung. A breach was made and the fort surrendered, after being besieged for forty-two days. Shortly afterwards the whole island capitulated. A letter, which to our modern modesty reads somewhat fulsomely, was written many years afterwards by Elias Durnford when he was seeking promotion. In this letter he thus recapitulated his experiences at Havana:—

> "I afterwards embarked for the siege of Havanna without a single recommendation to any General Officer in the Army, trusting to my inclination and zeal for my King and Country's service as

the surest and best path to their notice. On this expedition I was Lieutenant of Engineers, and during that siege my conduct and activity so much attracted the notice of the Earl of Albermarle, Lord Heathfield, and other officers of the Army, that the Commander-in-Chief sent to me as soon as the place was taken, and in the most flattering manner offered me the appointment of Aide-de-camp, assuring me of further proofs of his esteem whenever it lay in his power, saying that he was happy to show his Army the good opinion he entertained of my conduct during the siege, and I was continued in that station until the Staff was landed in England."

The next year (1764) Elias Durnford was appointed Commanding Engineer and Surveyor-General of West Florida, and in 1769 he was made Lieutenant-Governor of that Province. On 4th September, 1770, he was promoted Engineer-Extraordinary and Captain-Lieutenant, and Engineer in Ordinary and Captain on 26th March, 1779. In 1780, Elias Durnford, who was then in command at Mobile, was besieged and forced to surrender the place to the Spaniards under Don Bernard de Galvez. In a letter to his son, he wrote :—

"I was taken prisoner by him (Don Galvez) in his siege of Mobile. I call it a siege because he was obliged, in consequence of the measures and precautions I used in the defence of this paltry fort, to open trenches and enter into all the formalities of a siege. It took him upwards of a month to reduce it, nor was it reduced until two practicable breaches were made in the front attacked, and all my shot expended.

"The garrison, including regulars, inhabitants, a few servants, and slaves employed as workmen, were about 300 persons, and his force consisted of twenty times my number of people.

"I marched out with the honours of war, and Don Galvez treated me and my garrison in an honourable manner. I had no hope of succour from Pensacola, but by the defence made by me at this post the attack against Pensacola was delayed one year."

He returned to England a prisoner of war under condition that he did not serve again either in Florida or Louisiana. He remonstrated with Don Galvez at this condition, who replied, "I know you too well, and if my Sovereign sends me an order to exchange you whilst I command here, I will disobey it."

In 1784, Elias Durnford was Commanding Engineer at Newcastle, and at the same time his brother Andrew was Chief Engineer at Chatham, with rank of Captain-Lieutenant.

Elias Durnford was later appointed Chief Engineer at Plymouth.

At the beginning of 1794 an expedition was sent to attack the French West Indian colonies. General Sir Charles Grey was placed

in command and Elias Durnford (now a Colonel) was appointed to command the Royal Engineers who accompanied the force. It is interesting that his eldest son, Elias Walker Durnford, a young Ensign in the Royal Engineers, was also with the expedition and served directly under his father.

The islands of Martinique, St. Lucia and Guadeloupe were captured, the last, however, being retaken by the French shortly afterwards. H.R.H. the Duke of Kent, the father of Queen Victoria, served throughout the expedition.

A few weeks after the capture by the English of Guadeloupe, Elias Durnford died of yellow fever at Tobago, on 21st June, 1794, after serving in the Royal Engineers for thirty-five years.

Elias Durnford was married on 25th August, 1769, to Rebecca Walker. He had four sons, Elias Walker born in 1774 (of whom hereafter), Philip born in 1780, Thomas William born in 1784, and George born in 1788. He also had four daughters. Both Philip and George entered the army and became respectively a Lieutenant-Colonel and a Lieutenant-General in the Royal Artillery.

Elias Walker Durnford joined his father's Corps, receiving his commission on 17th October, 1793, and accompanied his father in the expedition of 1794. In 1801 he was taken prisoner at the surrender of camp Berville with 66 other officers, and was exchanged 17 months later.

He was Chief Engineer at Newfoundland from 1809 to 1815, Commanding Engineer in Canada from 1815 to 1830, and at Portsmouth from 1830 to 1837, when he was promoted Major-General. He subsequently became a Lieutenant-General. He died on 8th October, 1849.

On 30th October, 1798, he married Jane Sophia Mann. He had ten children, six sons and four daughters. Two of his sons were gazetted to the Royal Engineers.

The branch of the family with whom we are interested descends from Andrew Durnford, brother of Colonel Elias Durnford.

Andrew Durnford was born on 24th April, 1744, at the "Hundred-Windowed House," Fordingham, Hants.

He obtained a commission in the Royal Engineers on 28th July, 1769, and next year he was appointed Assistant Commissary to superintend the demolition of the fortifications and canal of Dunkirk, according to the terms of the Treaty of 1763. He owed his selection for this work to his well-known talents as a draughtsman.

On leaving Dunkirk in 1774 he was next engaged for two years on the defences at Plymouth, and in 1776 he sailed for America, where he served throughout the War of Independence, being appointed Deputy Assistant Quartermaster-General in Georgia and West Florida, from 1780 to 1783. He returned from America at the close of the war, and from 1784 to 1787 he was Chief Engineer at Chatham, with rank

of Captain-Lieutenant. In 1788 the island of Bermuda was ordered to be fortified, and Andrew Durnford was selected for this work. He was promoted to the rank of Captain and sailed on 18th July of that year to Bermuda. He was subsequently promoted Major. He remained at Bermuda till his death in 1798.

Andrew Durnford married Jemina Margaret, daughter of Anthony Isaacson, Esq., on 8th July, 1772. He had two sons, Andrew Montague Isaacson, born 24th June, 1773, and Anthony William, born 24th January, 1775.

Andrew Montague Isaacson Durnford entered the army and became a Lieutenant-Colonel of the 3rd Foot Guards. He married Barbara, daughter of Sir Patrick Blake. He had five children, two sons and three daughters. His eldest son Andrew Montague Isaacson served in the 60th Foot (now the King's Royal Rifle Corps) and in the 31st Regiment. He retired as a Lieutenant.

Anthony William Durnford (younger son of Andrew Durnford) became an Ensign in the 1st Foot Guards (now the Grenadier Guards) in February, 1794. He was promoted Lieutenant and Captain in September, 1796, Adjutant of the 1st Battalion on 1st January, 1797, and Brigade-Major in August, 1805. He embarked with General Wynyard's Brigade of Guards for Sicily in June, 1806, during the Napoleonic War, and served there until October, 1807, when the Brigade embarked as part of the force under General Sir John Moore, destined for Lisbon. Owing to adverse circumstances the expedition proceeded to England, arriving there in December.

Major Durnford was promoted Lieutenant-Colonel in November, 1807. He again embarked in June, 1811, with the 3rd Battalion for Cadiz, where they were blockaded by the French. He returned to England later in that year, and then retired from the army. He married Barbara, daughter of the Hon. William Brabazon, of Tara House, Co. Heath. Five children were born to him, three sons and two daughters.

His second son, George Anthony, was born on 18th September, 1804. He entered the army and became a Brevet Lieutenant-Colonel of the 27th Regiment. He died unmarried in 1856.

The eldest son, Edward William Durnford, was born on 22nd October, 1803. In April, 1825, he was nominated a "Candidate for the Corps of Royal Engineers," and joined the Ordnance Survey at Cardiff. In August, 1826, he was posted to Chatham, and was gazetted 2nd-Lieutenant on 22nd September of the same year. On the application of the Colonel-Superintendent of the Ordnance Survey of Ireland, Lieutenant Durnford joined the Ordnance Survey of that country in June, 1827, and served there until 1842, when he transferred to the English Survey, in which he served until 1844. He had been promoted 2nd-Captain in November, 1841. At the completion of the Survey of which he was in charge, the gentry of

Craven, Yorks, wrote to the Master-General of the Ordnance as follows :—

". . . We take opportunity of alluding more particularly to the efficient manner in which the Ordnance Sufvey has been conducted by Captain Durnford, and the very satisfactory and amicable termination to which he has brought numerous and long-standing disputes connected with the boundaries of townships and manors in this district."

Sir George Murray, Master-General of the Ordnance, requested, "That it might be made known to the gentlemen of Craven how much he felt gratified and obliged by the plan they had adopted of pointing out to the Service a good and deserving officer, particularly as they found the greatest difficulty in selecting those properly qualified for such duty . . . and that not a moment should be lost in forwarding the testimonial to headquarters, where he would do all in his power to forward and promote the interests of Captain Durnford." In 1845, Captain Durnford embarked for service in China.

On 1st April, 1847, Sir John Davies, H.M. Plenipotentiary in China, ordered Major-General D'Aguilar, commanding troops at Hong-Kong, to proceed to Canton and demand reparation for repeated acts of aggression on the part of the Chinese against British subjects.

It was proposed that the attack should be in the form of a *coup-de-main*, and that all guns captured at the Canton forts should be spiked. Captain Durnford was one of the five Engineer officers detailed to accompany the expedition. The forts on the Canton river were taken, and 879 guns were spiked. Captain Durnford was present at the assault and capture of the forts, and blew up the fort known as "French Folly."

General D'Aguilar stated in his dispatches that "Entrances (to the forts) were speedily effected by means of powder bags, which were applied to the principal gates by Captain Durnford and Lieutenant Da Costa," and he further stated, "To Captain Durnford, of the Royal Engineers, I am likewise highly indebted for the excellence of all his arrangements, and the skill, zeal, and efficiency with which he carried them into effect."

Colonel Brereton, Royal Artillery, commanding the 1st Division, in his dispatch to the General, reported : "It is a mere act of duty on my part to bring to your notice the excellent conduct of Captain Durnford, of the Royal Engineers."

On his return from China, in 1849, Captain Durnford served in Scotland until 1855, when he embarked for service in the Crimea. He was, however, detained at Malta and served there until 1856, when he embarked for Ireland where he was employed upon district duties until 1857, being appointed Assistant Adjutant-General to the Royal Engineers serving there. In the meantime, he had been promoted

Brevet Major in July, 1854, and Lieutenant-Colonel in December of the same year.

Shortly after his promotion to full Colonel in 1860, he was appointed Commanding Royal Engineer in Ireland, which command he held until 1866, when he again embarked for Malta as Commanding Royal Engineer and Colonel on the Staff. He remained at Malta until his promotion to the rank of Major-General in 1868. He was promoted Lieutenant-General in 1874, and in the same year he was gazetted to the rank of Colonel Commandant in the Corps. He was further promoted to the rank of General on 1st October, 1877. He died at the age of 85 on 30th January, 1889.

General Durnford was married on 3rd June, 1829, to Elizabeth Rebecca, daughter of John Langley, Esq., of Golding Hall, Shropshire. He had six children, three sons and three daughters. His three sons were Anthony William, Edward Congreve Langley and Arthur George. The eldest and the youngest served in their father's Corps, and the second in the Royal Marine Artillery.

Anthony William Durnford was born on 24th May, 1830. He entered the Royal Military Academy at Woolwich in July, 1846, and was gazetted 2nd-Lieutenant in the Royal Engineers on 27th June, 1848. In October, 1851, he was ordered to Ceylon, where he was chiefly engaged on the harbour defences at Trincomalee. He was promoted Lieutenant on 17th February, 1854. The next year he took up civil in addition to his military duties, being appointed Assistant Commissioner of Roads, and Civil Engineer to the Colony.

The Crimean War having broken out, he volunteered for service there, and was eventually ordered to Malta with a view to being sent on if required to the Crimea, but he was kept at Malta where he served as Adjutant until 1858, when he returned to England. He was promoted to 2nd-Captain in March, 1858, and in December, 1860, he was ordered to Gibraltar in command of the 27th Company, Royal Engineers. He served there until August, 1864, when he returned to England, having been promoted 1st-Captain in January of that year. Towards the end of 1864 he was ordered to China, but was landed at Ceylon suffering severely from heat apoplexy. There he was nursed by Colonel Gordon—afterwards the distinguished General and hero of Khartoum.

Captain Durnford was invalided home to England, and from May, 1865, until 1870, he was stationed at Devonport, and then for a short time at Dublin. At the end of 1871 he was ordered to South Africa. On 5th July, 1872, he was promoted Major. He served for some time at Cape Town and King William's Town, and in 1873 he proceeded to Natal as a member of the expedition that accompanied the Minister of Native Affairs into Zululand, and was present at the coronation of Cetchwayo. Writing of his experience at this ceremony, he says:

"The Zulus are a warlike race, every man a soldier, and ever armed. . . . All are in regiments by ages, and in some regiments all are men of forty, not one married; again another regiment will consist of men of twenty, all married by the King's order. . . . They are very hardy and active, and will march fifty miles a day for a month. . . . At the coronation of the King, about 5,000 of his warriors were present and a wild lot they looked. They sang a war-song—a song without words—wonderfully impressive as the waves of sound rose, fell and died away, then rose again in a mournful strain, yet war-like in the extreme. Altogether it was a scene not to be missed."

In addition to his military duties, Major Durnford also acted as Colonial Engineer.

Towards the end of 1873 he was appointed Chief of Staff to a Field Force under the command of Colonel Miles, which was sent as a reconnaissance to deal with a rumoured native rising under Chief Langalibalele. The Lieutenant-Governor of Natal and the Secretary of Native Affairs accompanied the expedition. Major Durnford was ordered to proceed by a forced night march to seize and hold the Bushman's River Pass to prevent the escape of Langalibalele. He had with him a detachment of the Karkloof Carbineers under Captain Barton, 20 Natal Carbineers and 20 Basutos as guides. After a difficult march up the pass, which was found to be almost impracticable to ascend, and after several men had dropped out from exhaustion, Major Durnford met with an accident by being dragged backwards over a precipice by his horse, which he was leading up a steep incline, and sustained a dislocated shoulder and two injured ribs. He succeeded, however, in reaching his destination at 5.30 a.m. next morning with only 38 rank and file left with him. With the coming of daylight he became aware, after forming his men across the mouth of the pass, that bodies of hostile natives were in front of him and also on both his flanks. Having been expressly ordered by the Lieutenant-Governor "not to fire the first shot," he went forward attended only by his native interpreter, and endeavoured to persuade the natives to disperse peacefully, which they refused to do. As his men were wavering, he ordered a retreat to higher ground from which he could still command the pass. The natives, who were armed with guns, opened a heavy fire, and the retreat became a stampede. Three of the Carbineers and one of the Basutos fell. The native interpreter's horse was shot, and Major Durnford at once rode to his assistance. While helping him to mount behind him the interpreter was killed by a shot, and two of the natives seized Major Durnford's bridle. Thanks to the splendid behaviour of his horse, he was able to ride through the crowd of natives who surrounded him, shooting right and left with his revolver. He received several minor wounds, and an *assegai* through his already helpless left arm. Rallying a few of his men, he covered the retreat of the force, and reached the head-

quarter camp soon after midnight. In spite of his severe injuries, he led out a volunteer party to the rescue of Captain Boyes, who had been sent out with a support two days before and was believed to be in great danger.

For his conduct in this affair, Major Durnford was thanked in Field Force Order for "his courage and coolness." He permanently lost the use of his left arm from the *assegai* wound he had sustained.

In December, 1873, he was promoted Lieutenant-Colonel; and, in July, 1874, he carried out the demolition of the passes in the Drakensburg Mountains in severe winter weather. For this service he received the thanks of the Local Government.

In July, 1876, Colonel Durnford returned to England. He was thanked by the Colonial Office for his services in Natal, and recommended for the C.M.G. Early in 1877, he again embarked for South Africa. He was appointed one of the Commissioners to enquire into the disputed Natal-Zululand boundary. On 11th December, 1878, he was promoted to Brevet Colonel.

On the outbreak of the Zulu War in January, 1879, Colonel Durnford was placed in command of No. 2 Column of the expeditionary force. His command consisted of three battalions of the Natal Native Contingent of 1,000 men each, five troops of the Natal Native Horse, and a Rocket Battery under Major Russell, Royal Artillery. The Natal Native Contingent had been raised and trained by Colonel Durnford, who was appointed Colonel-in-Chief of the Regiment, its three battalions being commanded by Captain Montgomery, 7th Fusiliers, Major Bengough, 77th Regt., and Captain Cherry, 32nd Light Infantry.

On 16th January, Colonel Durnford was ordered to take the mounted men of his force about 30 miles up the Buffalo River to guard the Natal frontier as raids were expected, and a few days later to move up to Rorke's Drift. On 22nd January he was ordered to move up to join the General, who had encamped near the Isandhlwana Hill two days before. Colonel Durnford arrived at the camp about 10.30 a.m. Zulus had been seen in the immediate neighbourhood of the camp, and one column was reported to be retiring in the direction in which the General with the main part of the troops had moved that morning.

Believing that the General would be cut off by this column, Colonel Durnford followed it with a detachment of his mounted men. He had previously sent two troops to reconnoitre a range of hills on the left. After proceeding about five miles these two troops suddenly met the Zulu army, numbering about 20,000 men, and the officer in command rode back to warn the camp. Meanwhile, Colonel Durnford had also come into touch with the enemy. He was forced to retire slowly before the advancing hordes, fighting in good order on

broken ground in front of the camp, and finally formed up to the right of the 24th Regiment, who were holding the camp itself. Colonel Durnford held his position until his ammunition was exhausted, and then withdrew his mounted men to the right of the camp, and galloped towards the 24th Regiment to endeavour to concentrate the force. The Zulu army suddenly dashed forward and surrounded Colonel Durnford's force and the camp itself. He was last seen with a few Natal Carbineers and Mounted Police making a last stand to keep open the only line of retreat for the troops in the camp.

It was not until 21st May, when a reconnaissance force, under General Marshall, proceeded to Isandhlwana, that Colonel Durnford's body was found; it was surrounded by the bodies of 14 Carbineers and their officer, Lieutenant Scott, 20 Mounted Police, and about 30 soldiers of the 24th Regiment. From the place where they were found it was clear that the rush to escape from the camp was within a few yards of where they had made their final resistance.

Colonel Durnford's body was temporarily interred near where he fell, and was subsequently buried with military honours on 12th October, at Pietermaritzburg.

Colonel Durnford was very much beloved by the Basutos, and a touching tribute was paid to his memory by the Basuto Chief Hlubi, who had been with him at the action at the Bushman's River Pass, in 1873. He sent a letter to General and Mrs. Durnford—Colonel Durnford's parents—in which he says: "I grieve deeply for the loss of the *Inkos* (Chief), and things will be very different now for me and my people. While *he* lived we were happy and protected. . . . The Colonel always treated me as kindly and well as though I had been a white man, and where shall we find another *Inkos* who will do that? . . . All the Basutos lament him greatly, both for himself and for their own sakes."

Colonel A. W. Durnford married Frances, daughter of Colonel Tranchell, Ceylon Rifles, on 15th September, 1854. He had three children, a son and two daughters. Only one daughter survived him, the other two children dying in infancy.

General Durnford's second son, Edward Congreve Langley Durnford, was born on 8th May, 1832. He entered the Royal Marines in 1851. After studying at the Royal Naval College, he was appointed to the Royal Marine Artillery in December, 1852.

During the Crimean War he served on H.M.S. *James Watt* in the Baltic, and was present at the siege of Bomarsund on 7th to 15th August, 1854, acting as Assistant Engineer in the bombardment, land battery, and demolition of the forts. From 15th August to 14th September, 1854, he served with the 2nd Company of the Royal Sappers and Miners. He was later appointed to the command of mortar-boats numbers 3 and 32, and served with them at the bom-

bardment of Sweaborg on 9th August, 1855. For this service he was mentioned in dispatches and received the Crimean War medal. He subsequently served in H.M.S. *Forth* until 1856.

On 27th March, 1862, he was promoted Captain. From September, 1867, to May, 1870, he was Staff Captain, Royal Marine Artillery, and during this time he was appointed Superintendent of Artificers, and was in charge of all public works in progress at Eastney Barracks and Fort Cumberland under the Admiralty Engineers' Department.

He was promoted Brevet-Major on 14th September, 1872, and on his retirement at his own request on 8th May, 1877, he was promoted (honorary) Lieutenant-Colonel. He died in 1926 at the age of 94.

Colonel E. C. L. Durnford married Julia, youngest daughter of John Penrice, Esq., of Witton House, Norwich, on 3rd March, 1859. Four children, two sons and two daughters, were born to him. His eldest son and youngest daughter died in infancy.

General Durnford's youngest son, Arthur George Durnford, was born on 9th August, 1838. He entered the Royal Engineers on 21st June, 1856.

He served at Chatham till the latter part of 1857, and then in Ireland until May, 1859, when he embarked for Gibraltar, where he served until 1864. From 1860 to 1864, he was Adjutant at Gibraltar. On his return to England he was appointed to the command of the 40th (Depot) Company, R.E., at Chatham, then transferred to the command of the 10th Company at Shorncliffe in 1865, and then to that of the 33rd Company at Malta, in September, 1866, having been promoted Captain on 8th June of that year. While at Malta he served under his father, who was Commanding Engineer there. In May, 1870, Captain Durnford returned from Malta and was posted to Aldershot. In September he transferred to command the B (Equipment) Troop, and in December, 1872, he took over the command of the C (Field Telegraph) Troop. He was promoted Major in the following August. In December, 1877, he was posted to Dover, and in the following July he was appointed Instructor in Field Fortification at the School of Military Engineering, Chatham. He was promoted Brevet Lieutenant-Colonel on 1st July, 1881, and Lieutenant-Colonel on 7th April, 1882.

In July, 1882, Lieutenant-Colonel Durnford was appointed Commanding Royal Engineer at Shorncliffe, and on 24th September, 1883, Assistant Director of Works (Fortification) at the War Office.

In November, 1884, he was ordered to accompany the Bechuanaland expedition under Sir Charles Warren. For his services in this expedition he was honourably mentioned and recommended for the C.M.G. At the conclusion of this expedition he was promoted Colonel on 1st July, 1885. On 1st July, 1889, he was appointed Colonel on the Staff and Commanding Royal Engineer of the North-Western District (England) on its formation, and subsequently transferred in

the same capacity to the Southern District, where he served until 31st August, 1894, and then, on the completion of his period of Staff service, he retired. He died in 1912.

Colonel A. G. Durnford married Victoria, youngest daughter of Charles Devon, Esq., of Cruwyshaye, Rackenford, Devon, and had two sons and two daughters.

The eldest son, Arthur Cecil Somerset Durnford, was born on 26th January, 1875. He was appointed 2nd-Lieutenant in the West India Regiment on 25th March, 1896, and after serving some months with his regiment at Sierra Leone, he died of malarial fever on 23rd May, 1897.

The youngest son, Guy Edward Jervoise Durnford, was born on 29th May, 1876. In 1893, he entered the Royal Military Academy, Woolwich, and obtained his commission in the Royal Engineers on 3rd August, 1895.

From 1900 to 1905, he was appointed Assistant Instructor of Submarine Mining at the School of Military Engineering, and from 1910 to 1914 he was Instructor (Workshops) at the School of Military Engineering.

He served in the Great War, 1914–1918, being appointed Staff Officer to the Chief Engineer of the First Army in France in 1916, and Commanding Royal Engineer of the 61st Division, 1916 to 1919. He was twice mentioned in dispatches, and awarded the D.S.O. He was subsequently appointed Commanding Royal Engineer of the Athlone, Ulster and Chatham Districts. He retired as a Colonel in 1926. Colonel G. E. J. Durnford married Bessie Muriel, youngest daughter of the late Colonel John Ford, Royal Artillery. He has one son and one daughter.

It is an interesting fact that nine members of the Durnford family served in the Royal Engineers, and that from *1755 to 1926—a total of 171 years—there has been at least one of the family serving in that Corps.

* Augustus Durnford, born in 1735. He was a distant cousin of Colonel Elias Durnford, who joined the R.E. in 1759. Augustus Durnford entered the Corps of Engineers in 1755, became a Captain-Lieutenant, and after serving at Rochefort, Louisberg, and Quebec, under General Wolfe, he died in 1761.

DEMOLITIONS, FIFTH ARMY, 1918.

By MAJOR-GENERAL SIR REGINALD U. H. BUCKLAND, K.C.M.G., C.B.,
Colonel Commandant R.E.

(*Concluded.*)

VIII. 24TH MARCH.

General Situation.

South of the Oise the original front line was still intact, and Condren was held. North of the river the French had taken over the line from Viry Noreuil to Cugny, with our 18th and 14th Divisions in support. The III. Corps was now under the French 3rd Army. In the XVIII. Corps the 36th Division held Cugny facing east, and from the railway south of Ollezy to one mile west of Golancourt facing north, with the French 10th Division in support. The 30th Division held from Villette to Eppeville facing east, and thence along the Somme to opposite Offoy, the 20th Division prolonging to Béthencourt, whilst the 61st had gone into reserve. The French 62nd and 22nd Divisions were arriving in the XVIII. Corps area. The XIX. Corps held from Béthencourt to Biaches.

In the VII. Corps the 21st and 9th Divisions, having crossed the Tortille, held from Cléry to Sailly Saillisel. Their 16th and 39th Divisions had passed through Péronne, and were now south of the Somme (which here flows west), the former in reserve near Eclusier, and the latter forming a defensive flank facing north-east from Biaches to opposite Cléry. The Corps was reinforced north of the river by the 35th Division.

III. Corps.

During the afternoon Condren was evacuated by its garrison, and the bridge over the Oise south of the village was destroyed by the 504th Field Coy. at about 9 p.m.

At 8 a.m. the C.R.E. 58th Division received instructions from his G.O.C. to destroy all the bridges at Chauny. This was done by the 504th Field Coy. and reported complete at 8.30 p.m. (The difficulties in connection with the trestle bridge in Chauny have been mentioned in the report of the C.R.E. for the 21st, quoted above.) The dump at Chauny was destroyed, also a pontoon bridge across the eastern arm of the big bend of the Oise north of Sinceny.

The 511th Field Coy., already responsible for the bridges at Bac

d'Arblincourt, took over from the 135th A.T. Coy. the bridges over the canal at Bichaucourt.

The C.R.E. saw Capt. S. J. Armstrong, and arranged that his dismounted detachment of 20 men of the 2nd Field Squadron should prepare the bridges on the Apilly–Bretigny road, and stand by them pending further orders. (Destroyed on the 25th.)

The 135th A.T. Coy., still with the 58th Division, completed the preparation of the bridges at Manicamp. They blew up one of the minor bridges, also one of those at Abbécourt, and went on to Quierzy, where they took over five bridges from the detachment of the 2nd Field Squadron.

The G.S. diary III. Corps records that the 58th Division reported at 8.30 p.m. that the following bridges had been prepared :—

(1) Bridges at Abbécourt.
(2) Canal bridges at Abbécourt.*
(3) Canal and river bridges N. of Manicamp and bridges in Manicamp.
(4) Bridges S. of Manicamp as far as the bridge over the Ru du Ponceau.
(5) Canal and river bridges at Quierzy.
Personnel standing by in each case.
(6) The bridges on the Apilly–Bretigny road were being prepared.

By this time certain of these bridges had been blown up by the 135th A.T. Coy., as narrated above.

XVIII. Corps.

The R.E. Coys. of the 36th Division were south of Golancourt on the left flank of the line held facing north, and the C.R.E. went to Frétoy to see the bridges which had been prepared and handed over to a detachment of Trench Mortar Battery, detailed by the Division to hold the crossing. The fate of these bridges is not recorded. The bridge at Campagne was also ready, and was left in charge of the C.S.M. and two sappers, 122nd Field Coy., who destroyed it at 6 p.m. the next day on an order from the French. A small footbridge was left standing as being of no importance.

XIX. Corps.

The position map for dawn on this day shows the newly-arrived 8th Division holding the west bank of the Somme canal from Béthencourt to Brie, both inclusive, a front of six miles.

The movements of its 15th Field Coy. during the early hours of the 24th are worth recording in detail, as showing how little work can be achieved when R.E. reconnaissance is impossible, and the sappers are separated from their transport.

* The map references given include the bridges on the canal de l'Oise à l'Aisne down to one mile S. of Bac d'Arblincourt.

The Company arrived at Nesle from Belgium early on the 23rd, and spent the day awaiting orders which did not come until the evening. It was then hurried north in lorries to Licourt, arriving there after midnight; its transport followed but failed to find the Company. After an hour's wait three demolition parties were detailed to blow up bridges. No maps were available.

The first party of six sappers, under Lieut. E. H. L. Jacobs-Larkcom, started off with a guide at 2 a.m. to blow up a wooden bridge. It turned out to be a steel lattice-girder bridge, 3 ft. 6 in. deep and about 60 ft. in length. A German machine-gun was firing down the bridge, but the infantry took this on and succeeded in getting a covering party across. Lieut. Jacobs-Larkcom had with him only six slabs of guncotton and some safety fuze, and he saw at once that he could not tackle both girders, so he put the lot into one charge on one girder and set it off. It was impossible to get near the bridge after the explosion as day was beginning to dawn, but the girder did not fall and it must have been passable for infantry. On revisiting the locality, as a Staff College student many years later, he identified the site of his bridge at Epenancourt.

The second party, under Lieut. C. W. Gidlow-Jackson, went out under orders to demolish any bridge the infantry wanted destroyed. They took with them a few slabs of guncotton and some safety fuze. The only record of the site of their bridge is that Lieut. Jacobs-Larkcom says that it was south of his. Lieut. Gidlow-Jackson found some men of the 2nd Northants in a mill, and the officer in command pointed out a bridge over the canal about 100 yards off. It was now about 2.30 a.m. and a full moon was shining. There was no cover on the approach road so that reconnaissance was difficult. With a sergeant he crawled out on to the bridge, where he could hear the whisperings of the enemy's post at the far end, but for some reason they were not fired on. The charge was fixed and fired, but the result was only partially successful owing to the small quantity of guncotton used.

The third party consisted of Lieut. D. Davidson, a serjeant and three sappers. At 2 a.m., when it was still intensely dark,* they set off for H.Q. 2nd Northants in Cizancourt, and from here a guide led them to their bridge farther south. Instead of a bridge they found a temporary earth dam over the canal, revetted vertically on both sides with heavy timbers tied together at intervals by 1-in. steel bars. The thickness of the dam was about 8 ft., its length is not recorded. There was no sign of any sluice valve which might have provided a weak point to attack. A post of the 2nd Northants held a short length of trench close up to the west bank of the canal.

* The vagaries of the moon in the different accounts are noticeable; it was three days before full moon.

Lieut. Davidson had six slabs of guncotton and some safety fuze. Having had considerable experience of heavy demolitions with explosives in civil life before the War, he at once saw that an effective breach that would satisfy the infantry was out of the question. Mistrusting his fuze, which was stiff and brittle, he made no attempt to bury his charge (which, even if buried, would not have been sufficiently powerful to move the dam), but tried the effect of one slab on a single tie. The fuze had to be relighted several times, but the tie was cut, and, in spite of the same difficulty with the fuzes, five more ties were cut, but this exhausted his small stock of explosives. There must have been other tie bars lower down, as the stability of the dam was in no way affected. He returned to Coy. H.Q. before dawn to see whether the transport had arrived with more explosives, but it had not, and he was told to stand by for further orders.

On the return of his three officers, Major R. M. Taylor, the Company Commander, was heard to observe that the Brigadier's description of the works to be demolished seemed to have been somewhat too optimistic.

VII. Corps.

Arrangements were put in hand at Corps H.Q. for dealing with the bridges between Cléry and Corbie.

The 180th T. Coy. marched to Bray and reconnoitred all the bridges from Cappy to Corbie that were not already being prepared. The four sections of the Company were sent to different bridges in Bray and prepared them for demolition.

On the morning of the 24th the VII. Corps was holding Cléry, and its 16th Division, on hearing that the enemy had crossed at Béthencourt, prepared to defend the line of the Somme against attack from the south, the leads of the charges placed on the bridges being taken to the north bank of the river. The danger from the south was averted by the XIX. and XVIII. Corps, whereas by the morning of the 25th, the VII. Corps was at Curlu, and on the 26th at Bray, so that attack from the north was to be expected by the 16th Division which was transferred to the XIX. Corps at 4 a.m. on the following day. The leads, of course, had to be brought over to the south bank. This sounds simple enough, but such a complete *volte-face* must have had a very disturbing effect on the minds of those who had to execute it.

The C.R.E. 16th Division was told to prepare the bridges Bray, Froissy, Cérisy and Chipilly, and orders were sent to the companies accordingly at 5.30 p.m. Preparations to demolish the road bridge over the canal at Froissy were at once begun by the 155th Field Coy. and completed by 4 a.m. next day. It was a brick bridge of 45-ft. span, arch ring 4 ft. thick, and 160 lb. of guncotton was used. The Company then moved off, leaving 2nd-Lieut. Baines to blow up the

bridge at the orders of the 48th Infantry Brigade.* The Cérisy-Chipilly group was allotted to the 156th Field Coy. Major Holbrow and Lieut. Hall prepared one of the two lattice girder bridges (the other close beside it does not seem to have been attended to, see 26th March, p. 452), Lieut. Norman took on the brick bridge and Lieut. Culver a wooden bridge near it, and all worked throughout the night. Next morning the company marched off to Proyart, leaving Lieut. Hall with his section to blow up the bridges on receipt of orders, but there is no record to show that he was told by whom the orders would be given. The 157th Field Coy. reached Cappy at 4 a.m. and at 5.35 a.m. the O.C. was ordered to hold and prepare for demolition the bridges near the lock between Méricourt and Etinehem. During the night 24th/25th the two bridges, one over the canal and the other across the river, were got ready. (They were blown up on the 26th.)

At 5.15 p.m. the Corps sent an order to all units :—

> " All bridges north to south over the Somme to be destroyed as retirement is made."

It may be of some interest to relate in detail the fate of the shops and stores at Omiécourt, as no records are forthcoming of any such destruction carried out on a large scale elsewhere.

The camp was spread out north of the road from Chaulnes to Omiécourt, some 600 yards west of the latter place, whilst the shops, park and dumps lay south of the road in the following order from east to west :—4th Army Workshop Coy. (Major C. S. Wilson), 353rd E. and M. Coy. (Major B. M. Owen), No. 6 R.E. Park (Capt. C. K. Honeywill), the timber dump and the roads dump. A standard-gauge line from Chaulnes junction ran along the south side of the enclosure, which was about 700 yards long by 150 yards wide. The Army Workshops were in course of construction and had only a few saws running. The E. and M. shops consisted of one long building running north and south (75 x 10 metres), with four small shops teed on to its western side. They were full of machinery, 550 lorry loads having been brought up in eight days from their previous site at La Flaque. The Park contained three or four Adrian huts and an office hut, and Decauville tracks ran through it from north to south, passages being left at intervals between the piles of stores on either side. The explosives were stored in an old German dugout, 30 ft. deep, in a clump of trees 150 yards away from the Park. The timber dump contained mining frames and machinery belonging to the Controller of Mines, and the roads dump some Canadian tip wagons, and, providentially, a large number of barrels of tar.

* This bridge was blown up at noon on the 26th.

At 8 p.m., on the 22nd, Major Owen organized a demolition party of 15 men to be ready to destroy his shops when the unit had quit. A small quantity of guncotton and detonators was at hand, and a good supply of ammonal. After loading on lorries such stores and equipment as were likely to be of use to his Company during mobile operations, the scheme was to wreck by means of sledges and hammers as much of the machinery as possible, and to destroy the shops and heavier machinery with explosives, and finally to start a general conflagration. Oil engines were to be destroyed by drawing back the hollow pistons into their cylinders, and inserting charges of explosives; small engines and other plant being piled up round them to share in the effects of the explosions. Charges were to be placed in the main shop where the smaller shops joined on, and anything likely to burn was liberally treated with tar.

The firing was to be done by men who were to line up on the road on the north side, and walk in pairs down the aisles between the buildings and the piles of stores, kindling fires by means of petrol and matches at certain prearranged spots. Their movements were to be regulated by whistle, as on their way they were to light the safety fuzes leading to the charges. Owing to lack of material these fuzes were unpleasantly short—and it was not expected that the operation would be carried out without casualties. On reaching the railway line the men were to turn west and form up on the road at that end of the enclosure ready to march off. The camp was not burnt, lest the smoke should render the road impassable to our retiring troops, the wind blowing from the north.

The work of preparation went on all night, and at 5 p.m. on the 23rd, two companies of the U.S. Railway Engineers arrived. At 6 p.m., Major Owen got a written order from the C.E. Fifth Army to take charge of the whole depot, whereupon similar arrangements were made for the Park and the dumps, and 20 men of the U.S. Engineers and 20 of the 4th A.W. Coy. were added to the demolition party. Major Wilson had already prepared to set his own shops on fire.

The units, less the demolition parties (U.S. Engineers, 450; E. and M. Coy., 300; Workshops Coy., 120; and 216th A.T. Coy., 100*), marched off at intervals for Moreuil to report to the Cavalry Corps H.Q.

At midnight 23rd/24th, orders came from the C.E. Army that the dump was not to be fired, nor the stores destroyed, until further orders, so the E. and M. and A.W. Coys. were recalled, arriving during the morning of the 24th. Small patrols were sent out to ascertain what was going on, and at 8 a.m. a report came in that our infantry were retiring on, or crossing, the Somme near Béthencourt, only six miles away. It was thought that it might take an hour to get the work of destruction going properly, so the units again started for

* 216th A.T. Coy. had turned up from Péronne.

Moreuil, and the wreckers stood by ready to start work. At 9 a.m. traffic was pouring west through Omiécourt, but by 10 o'clock it had died down to a few parties of infantry.*

At 11.15 a.m. a battery galloped by to take up a position close to Chaulnes, and a patrol reported that the enemy was over the Somme. Major Owen saw that action could no longer be delayed, and at 11.20 a.m. gave the order to start the fires. Ten minutes later the whole place was burning freely, and detonations were frequent; by 11.45 the men had all reached the rendezvous unhurt and before noon marched off for Moreuil.

IX. 25TH MARCH.

General Situation.

Condren having been given up, the front line, intact from Barisis to Servais, ran south of the Oise to Manicamp, the 58th Division being on the right and the 125th French Division on the left. North of the Oise the French held from Abbécourt, through Caillouel–Quesny–east of Freniches to Moyencourt with our 18th, 14th and 36th Divisions in support. From here the 30th and 20th Divisions, XVIII. Corps, held up to one mile south of Potte, where there was a gap of a mile. From north of Potte the XIX. Corps held a line running to the Somme canal south of Cizancourt with the 8th Division, which the 50th, 66th and 39th continued along the canal to Feuillères.

From 4 a.m. the Somme formed the boundary between the Fifth and Third Armies, the river being inclusive to the Third Army.

The VII. Corps was transferred to the Third Army and held from Curlu to Montauban, through which place the army boundary had passed up to 4 a.m. Their 16th and 39th Divisions were transferred to the XIX. Corps.

All troops south of the Somme came under the orders of General Fayolle, who commanded the group of armies in this area. Our III. and XVIII. Corps (the latter less the 20th Division, transferred to the XIX. Corps) were under General Humbert, commanding the 3rd French Army.

III. Corps.

At the request of the French Commander on the spot, the 135th A.T. Coy. blew up one bridge at Abbécourt, and those north and east of Manicamp, some of which were under heavy m.g. fire at the time. It appears that these bridges at Manicamp were immediately afterwards repaired by No. 3 Section, 511th Field Coy. (58th Division), at the request of the French, who wanted them for their motor machine-guns, and again prepared for demolition by the 503rd Field Coy. Finally, all the bridges in Manicamp, together with one over the

* Béthencourt was lost at 7.45 a.m.

Oise–Aisne canal and all those at Bac d'Arblincourt, were handed over to the French.

The bridge over the canal at Quierzy was blown up by the O.C. 135th A.T. Coy. and Serjt. Farr. The first attempt was not wholly successful, and fresh charges had to be laid. They then awaited the order of the 55th French Division to destroy the bridge, but it never came, though in the meantime the Germans had arrived in considerable numbers and concealed themselves along the border of a wood, about 40 yards from the bridgehead. At last a runner came from Lieut.-Colonel W. R. H. Dann, 4/7th London Regt.,* with an order to destroy the bridge. This was done, and the party withdrew under heavy m.g. and rifle fire to the bridge over the river, which they demolished.

Responsibility for the bridges on the Appilly–Bretigny road had been handed over to the French. The bridge over the canal south of Appilly was constructed of 78-ft. steel girders for single-way traffic, and had been prepared for demolition by Capt. Armstrong and his dismounted detachment of the 2nd Field Squadron. He received written instructions from the French 1st Cavalry Corps that it was to be destroyed only on the order of General Feraud, or in the event of Appilly being occupied by the enemy. As all the mobilization equipment was away with the three troops he used explosives and fuze provided by the C.E. III. Corps. No exploder was available. The 1st French Dismounted Cavalry Division held the south bank of the canal, and after all our troops (18th Division) had crossed, gave the order for the bridge to be blown up. The instantaneous fuze failed to ignite all the charges, and Capt. Armstrong had to place two more and fire them with safety fuze before the bridge finally collapsed.

After dark the French retired south of the River Oise and gave the order for the bridge at Bretigny to be destroyed. This was a timber pile bridge, 192 ft. in length, built during the war, and had already been prepared for demolition by Capt. Armstrong. It had been built for two-way traffic, and each bent consisted of six stout piles; these were to be cut by a continuous charge of guncotton across each bent just above the level of the water. The instantaneous fuze again failed, and each charge had to be set off separately by means of safety fuze. Even when most of the piles had been cut the bridge remained standing, being held together by the superstructure which included diagonal decking. It had, however, been thoroughly shaken and it was easily demolished by means of ropes and levers. It would have been simpler to have burnt the bridge, but sufficient petrol was not available. Fortunately, the enemy was not active and did not interfere with either of these operations.

At Varesnes the skew bridge over the canal (117 ft.) was pre-

* 58th Div. In this area British and French units were much mixed up, fighting side by side or alternately supporting each other.

pared by the 182nd T. Coy., and destroyed next day by the 18th Division.

The detachment, 2nd Field Squadron, moved to Pontoise, and, working with the French, destroyed the bridges there over the Oise and canal.

XVIII. Corps.

In the 30th Division, Capt. Hill, 200th Field Coy., was ordered at 3.45 p.m. to prepare the bridges over the Avre, south of Roiglise, for demolition, but nothing more is said about them.

XIX. Corps.

The Corps was informed at 1.15 a.m. that the Somme would be the new army boundary, but the decision that the river would be inclusive to the Third Army did not leave G.H.Q. until 1.15 p.m. At 1 p.m., before it had arrived, A.H.Q. wired to the XIX. Corps: "You will be responsible for the destruction of all bridges across Somme, including those running from north to south in your area." Consequently, at 4.15 p.m., the XIX. Corps wired to Divisions and all concerned: "39th Division will be responsible for destruction of all bridges across the Somme in this area if not already done. Infantry will destroy or damage as much as possible pumps and water points whenever forced to retire past them."

The R.E. units of the Corps Troops were organized by the C.E. in two battalions, of which the 2nd Battalion, under Major T. M. Lowry (173rd T. Coy.), was to be employed on bridging and demolitions.* For the supply of explosives, the C.E. kept at his H.Q. a lorry, which filled up from a dump established by the C.E. Army in a field near Dury, and delivered at bridge sites throughout the Corps area as required.

At 1.50 p.m., A.H.Q. wired: "C.E. will make all arrangements with XIX. Corps for the destruction if necessary of Merignolles ammunition dump, special attention to be paid to 112 1-lb. aeroplane bombs." This dump was on the road between Méricout and Chuignolles, and was destroyed on the 27th by Capt. Byrde and a party from 173rd T. Coy.

The 15th Field Coy. was called upon to destroy a disabled tank at Marchélepot. This was accomplished by a few sappers under the C.S.M.

Capt. H. E. P. Browne and Lieut. Barrowman, 258th T. Coy., started for Sailly-Laurette to prepare the bridges there. They belonged to Major Lowry's battalion.

* The 1st Bn., under the command of Major E. J. B. Buchanan, 5th Field Squadron, was composed of 4 officers and 70 O.R. of his squadron, and officers and the more active men 4th Corps units. Deficiencies in rifles and kits were made up from the 2nd Bn.

*VII. Corps.**

The O.C. 238th A.T. Coy. got orders from the C.E., at about 8 p.m., to go with the C.R.E. Corps Troops in his car and get the bridges over the canal at Eclusier and Cappy blown up. At Eclusier there were the swing bridge, the lifting bridge and two wooden bridges. On his arrival there, Capt. Foster met the O.C. of the battalion holding the line, who objected strongly to the bridges being destroyed as his men and another whole battalion were on the far side. The O.C. sent his second-in-command with Capt. Foster to Brigade H.Q., and the Brigadier at first demurred and questioned the orders as "spy orders," but luckily the C.R.E. (Lieut.-Colonel Vesey) came in and all was well. The battalion holding the bridges came back across the canal, but further delay occurred in warning the other battalion.

Lieut. Rose was in charge of the demolitions. At the first attempt with the exploder nothing happened. He then put in safety fuze, and the charges went off, but though the iron portions of the lifting bridge were cut, the wooden ribands held up the roadway. On the swing bridge only one girder was cut owing to the charges being too small, and no more explosives were at hand. Capt. Foster went off in the box car to a tunnelling company at Bray, and ascertained that they had a store of explosives three miles back. Securing 80 lb. of these he returned to the swing bridge, put 25 lb. on the remaining girder, set off the charge with safety fuze and the bridge went into the river. Turning to the lifting bridge, he put separate charges on each of the ribands and cut them, but the debris was still held up by a broken and damaged steel joist, and two more explosions were required to finish the job. The wooden bridges were demolished with saws, but it was 4.15 a.m. on the 26th before all four bridges were done with.

Lieut. Robinson blew up the swing and lifting bridges at Cappy at 6 a.m. on the 26th. Lieut. Hone went to prepare bridges at Heilly, Bonnay and La Neuville, which he subsequently handed over to the 1st Field Squadron.

The C.R.E. Corps Troops returned from Eclusier to Corbie during the night by the north bank of the river, and gave to the demolition parties as far west as Chipilly (possibly Sailly Laurette also) the C.E.'s orders that their bridges were to be destroyed at 5 a.m. on the 26th.

A retirement behind the Avre was now in contemplation, to be carried out in succession from the right, and the C.E. was made responsible for the destruction of the bridges after the troops had crossed.

In the 9th Division the R.E. were formed into a single company under the command of Capt. Young, 64th Field Coy. The C.R.E.'s diary records that the bridges over the Ancre were to have been

* The story of the VII. Corps is continued, although it had ceased to belong to the Fifth Army.

prepared by a Corps Troops Coy., but on this day the O.C. 178th T. Coy. only began his reconnaissance of the bridges between Méaulte and Méricourt l'Abbé, starting work on those at the latter place on the following day. A party from the 63rd and 90th Field Coys. was therefore sent to destroy the bridges from Dernancourt to Albert, and explosives were provided by an officer from the Corps who was on his way to prepare the bridges at Buire. The diary goes on to say that the bridges from Dernancourt to Albert were destroyed " with a small margin of time," presumably on the 27th, as up to that day the front line was east of Albert. One bridge at Dernancourt seems to have been overlooked as an officer had to be specially sent on the 27th to destroy it. Lieut. Moffat, 63rd Coy., was sent with 20 O.R. and explosives to Maricourt, where he destroyed the pumping station, four water tanks, four tanks and the railway points.

The C.R.E. 35th Division notes in his diary that, at 8.30 p.m., he consulted with the C.R.E. 21st Division about the bridges at Bray, which seems odd, as the 155th Field Coy., 16th Division, and the 180th T. Coy. were already working there. However, at 9 p.m., he sent two sections, 205th Field Coy., to prepare the bridges over the Somme and canal at Cappy and south of Bray, but on arrival they found that all of them "had been prepared by Corps Troops," so they withdrew.

Lieut. Cartwright and a party of the 177th T. Coy. destroyed the pumping station at Bray at 6.15 a.m.

X. 26TH MARCH.

General Situation.

On the right the front line as far as Manicamp was unchanged, but west of that place the canal had been lost, and the south bank of the Oise was held through Varesnes and Pontoise to Pont l'Evêque. From here the line ran west of Suzy, east of Lagny and along the main road to Roye. All of this was under General Humbert's command. Farther north the 20th Division (now in the XIX. Corps) held a slight salient with French Cuirassiers on their left up to Hattencourt ; the 24th Division prolonged up to the railway at Chaulnes. Next came the 8th and 50th Divisions, the latter athwart the Amiens–Vermand road at Estrées, with the 66th and 39th continuing to Frise on the Somme. The 16th Division held the south bank of the river from Frise to Cérisy facing north.

On the right of the Third Army the 35th Division (VII. Corps) held Bray and line past Plateau station to the high ground above Méaulte. The 9th Division filled the space between them and Albert with one brigade, their other brigades being at Dernancourt and Ribemont on the Ancre. The 21st Division was at Chipilly.

III. Corps.

At 4 a.m. the 80th Field Coy. (18th Division) destroyed the skew bridge (117 ft.) over the Oise canal north-west of Varesnes, which had been prepared by the 182nd T. Coy., but the others were handed over to the French, and the bridge over the river (181 ft.) was afterwards reported to have been destroyed by them. Two bridges at Morlincourt, north-west of the destroyed canal bridge, are reported, "not destroyed as far as known. Handed over to the French."

At 4.10 a.m. a report came in from the 2nd Cavalry Division to Corps H.Q. that the bridge at Noyon had not been destroyed. There is no record of its having been allotted to any unit for demolition.

XVIII. Corps.

During the day the 36th Division retired from the neighbourhood of Campagne to between Erches and Guerbigny, north of the Avre. A reconnaissance was made of the crossings of the Avre at Guerbigny, Warsy and Becquigny, but, as it was an insignificant stream fordable almost anywhere, it was decided to destroy only the bridge at Becquigny. The 150th Field Coy. went there at 3.30 p.m., and one section, under 2nd-Lieut. Knox, prepared the bridge accordingly. On the following day the French arrived to hold the crossing, and, when they were withdrawn and the enemy was on the opposite bank, 2nd-Lieut. Knox blew it up.

At 5 p.m. another section, under Lieut. Stapylton Smith, marched to Maresmontiers to prepare the crossings at this village and at Bouillancourt. Here there were brick arch bridges, and in each case a trench was dug across the crown. The bridge at Maresmontiers was blown up at the request of the French at 11.30 a.m. on the 27th, but the other was not destroyed as no orders had been received when the Division was relieved.

At 6 p.m. orders were sent to Capt. R. L. Withington, 122nd Field Coy., to prepare the bridge over the R. des 3 Doms at Hargicourt. Taking with him the C.S.M., three sappers and 224 slabs of guncotton, he arrived there at 10 p.m., and spent the night at work. This bridge was some 24 ft. in length with one brick pier: steel girders carried a reinforced concrete roadway, 20 ft. wide at a height of about 1 ft. 6 in. above the water. He laid out a charge of 200 slabs of guncotton on a plank, stiffened by another plank on edge nailed on underneath it. Finding a leaky fishing punt, which was kept afloat by constant bailing, he managed to get it under the bridge, and, lying down in the water in the bottom of it, he lashed his charge into the angle between the pier and the roadway.* He also prepared with his last 24 slabs a small concrete footbridge close by, with the intention of blowing up the two bridges together, and on the morning of the 27th

* His immediate reward was the loss of his British warm, which was stolen whilst he was at work!

he reported to the French that both were ready for demolition. During the day he destroyed some wooden footbridges.

The following is an extract from the company diary for the 28th : " About 8.0 a.m. a French Engineer officer reported that he had been sent to see the preparations that had been made, and that the French would take over during the day. He was asked for more explosives, and means of firing the charges simultaneously, as owing to the fact that no exploders were available, and no instantaneous fuze carried by a Field Company, safety fuze only was available. This arrived at 11 a.m., and a French corporal placed mélinite petards on the iron girders and connected up the footbridge with detonating cordeau. At 1.0 p.m. a French serjeant of the 9me Cie. du Génie arrived with orders from General Lavigny, 5me Division de Cavalerie, to take over from Capt. Withington. A letter since received from the French serjeant states that the demolition of the bridge took place on the morning of the 29th and was entirely successful."

Extract from letter received by Capt. Withington from Serjt. H. Levesque, 9me Génie :—

" La destruction fut complète : la pile fut pulvérisée, les poutrelles en fer rompues et la brèche de trois mètres de longueur. Jamais, mon Capitaine, je n'ai enregistré pareil résultat. La passerelle en ciment n'a pas sauté en même temps. J'en attribue la cause à la pluie diluvienne qui a duré toute la nuit. Après avoir changé l'amorçage et replacé vos charges j'ai remis le feu une deuxième fois et avec succès. Somme toute, les passages furent détruits et une grande partie des félicitations qui m'ont été attribuées vous revient de droit."

During the afternoon of the 26th, 3,000 slabs of guncotton with primers and detonators were issued to the 172nd T. Coy. with the intention that they should undertake the demolition of the bridges at Moreuil, but these explosives were handed over the same evening to the French Engineers, and our responsibility for the Moreuil group of bridges ceased.

At 8.40 p.m. the 30th Division sent orders to each of their brigades in the line to the effect that they should use their affiliated Field Companies for blocking roads against the passage of armoured cars. The 200th Field Coy. records that No. 3 Section was employed from midnight to 5 a.m. digging trenches, 3 ft. 6 in. wide and 2 ft. 6 in. deep, to block all roads on the 89th Brigade front.

XIX. Corps.

It is very difficult to give a clear account of the demolition of the bridges on the Somme and its canal west of Feuillères. The Corps cannot have known the full number of bridges that existed, as they were not familiar with ground so far behind their original front line. A reconnaissance report by Major J. T. Argent, M.C., 227th Field Coy.,

39th Division, dated 28/2/18, gives full details and map references of the following bridges with a view to demolition :—Feuillères 8, East of Frise 2, Frise 9, Curlu to Vaux 10, Frise to Eclusier 5, Eclusier 7, Suzanne 6, Cappy–Bray road 10, West of Cappy 4—the latter are noted as "leading nowhere." The demolitions reported on this portion of the river and canal are not easily identified with the bridges on this report, and certainly fall short of the total number.

To keep the narrative to the Somme the work of the 180th T. Coy. VII. Corps will be included here.

At 3 a.m., Lieut. Hurt, 173rd T. Coy., improved the demolition of one of the bridges at Frise blown up by the 221st A.T. Coy.

At 2 a.m. the 16th Division wired the Corps that the 46th Infantry Brigade, at Cappy, reported that of the three bridges at Eclusier and on the road north of it, only one had been prepared as their Field Coy. had run out of explosives. The Corps replied that they were making arrangements to destroy these bridges, presumably with the VII. Corps, as the Somme was inclusive to the Third Army. The bridges over the canal were destroyed by the 238th A.T. Coy. at 4.15 a.m., as described above (see 25th March), and the other two bridges, over branches of the river on the road north of the village, were prepared and blown up by the 204th Field Coy., 35th Division, at about the same hour. "The bridge" at Suzanne is reported as having been blown up by the same company, but probably the group of six bridges is meant.

The O.C. 180th T. Coy. blew up four bridges on the Bray–Cappy road, and the large double road bridge at Bray. He was not satisfied with the destruction of the double railway bridge alongside this road bridge, which 2nd-Lieut. Barclay, 119th Rly. Cons. Coy., had rendered unfit for use from a railway point of view. At the urgent request of the O.C. 7/8th R. Inniskilling Fus., and with the assistance of four men of that regiment, he used the small quantity of explosives remaining to improve matters. He also found a road bridge over a branch of the river between Bray and Froissy, which had been prepared by some other unit but not blown, and this he touched off.

2nd-Lieut. Baines, 155th Field Coy., 16th Division (now in the XIX. Corps), blew up his bridge at Froissy at noon. The crown was attacked and a wide gap made back to the abutments on either side. The two bridges over the river and canal between Etinehem and Méricourt (sur Somme) were blown up by the 157th Field Coy. at 9.30 a.m.

At 3 p.m. Lieut. Hall, 156th Field Coy., blew up his three bridges at Chipilly. The fourth (the second lattice girder bridge, see 24th March, p. 443) was found untouched by Major Lowry, 173rd T. Coy., very early on the following morning. Luckily he had with him in his car Lieut. Hurt, of his company, and a supply of explosives, so that officer got out and (apparently single-handed) successfully blew

up the bridge. One of the field company's bridges was only partly destroyed. The C.E. XIX. Corps reported to his H.Q. at 11 a.m. on the 27th that there was still a two-foot way across it, but he was making arrangements for further explosives to be drawn by the 16th Division. At 12.10 p.m. the C.E. reported that the "Chipilly bridge" had been thoroughly destroyed at dawn. His later report probably refers to the demolition carried out by Lieut. Hurt, and it would appear that the two-foot way was not cut, as two aviators of the 82nd Squadron reported personally at XIX. Corps H.Q. that, at 3.9 p.m. on the 27th, they had seen the enemy in Chipilly and Cérisy, that a bridge was there and men were crossing.

The difficulties of the amateur historian are well illustrated by the following irreconcilable accounts of the demolition of the bridges at Sailly Laurette,* which are taken from the diaries of the units concerned :—

258th T. Coy. 26th March,† Capt. Browne and Lieut. Barrowman "arrived Sailly Laurette 2.30 a.m. All troops had retired and enemy's lights could be seen on other side of the river. Of the five bridges one had been destroyed already. The other four had to be charged and fired. This was done, and at 5 a.m. all four bridges were blown and completely destroyed. On the explosion of the first charge the enemy commenced shelling the bridges, and sweeping them with m.g. fire."

180th T. Coy. "At 7 p.m. the same day (26th) Sailly Laurette was evacuated by the troops and outposts withdrawn. My party, who were standing by bridges here, waited for two hours after the rearguard had passed, in order to allow any stragglers to get through, and at 9 p.m. blew up the four road bridges assigned to me for demolition."

173rd T. Coy. 26th. "Interviewed C.R.E. 16th Division at Hamelet, who reported bridge at Sailly Laurette not properly destroyed. Left Gentelles at midnight‡ with five officers and 27 O.R. and proceeded to Cérisy and Sailly Laurette bridges."

From the C.E. XIX. Corps' list of bridges destroyed :—

> "Sailly Laurette. This bridge had been blown by some other unit. The 173rd T. Coy. improved the demolition by further charges. 5.15 a.m., 27th."

C.R.E. 16th Division. 26th March. 10 p.m. "Capt. Jennings to Sailly Laurette bridge to reconnoitre effects of the demolition."

* The French 1/100,000 map shows the canal and two branches of the Somme. Each of these branches is marked with the conventional sign of a mill, so there was probably a mill-race beside each of them, making five bridges in all.

† Col. Butterworth suggests that this date should be the 27th, and Lt.-Col. Vesey is of the same opinion. Major Pope, writing from South Africa, is inclined to think that they must be right.

‡ Midnight 26th/27th.

27th March. 5 a.m. "Capt. Jennings to Sailly Laurette bridge to report on second demolition." He could not get close to it as the enemy were on the opposite bank.

Capt. Adam, 239th A.T. Coy., was sent by the C.E. XIX. Corps to Villers Bretonneux to prepare three road-over-rail bridges for demolition: they were ready by 4.35 p.m., when he handed them over to Capt. Whitehead and Lieut. Young, 173rd T. Coy. In the diary of the 258th T. Coy. it is recorded that Captains Browne and Thorburn were sent on the 27th to prepare two bridges at Villers Bretonneux. Capt. Thorburn's bridge was on the road to Gentelles. At Capt. Browne's bridge, over the railway at the station, the charges were prepared but kept ready at different points for safety, as there was no immediate prospect of the demolition being carried out. The wisdom of this was seen when, during a heavy bombardment, one case of explosives was hit by a shell which entered the building in which it was deposited. It went off without doing any harm to the rest of the explosives. These officers stood by their bridges until the 3rd April, when they were relieved by an officer of the 173rd T. Coy., but no bridge at Villers Bretonneux was ever blown up.

Major Lowry, commanding the R.E. Demolition Battalion, took Lieutenants Henderson, Parker and Podd to Corbie to prepare the bridges there, and they were ready next day. They were later handed over to the Australian Corps and preserved intact. He then sent Capt. Byrde with a party to put up the dump at Chuignolles,* and Capt. Thorburn to 258th T. Coy. to Rainecourt to prepare the bomb dump for destruction. These dumps were both destroyed on the 27th.

Capt. Browne and Lieut. Barrowman, 258th T. Coy., fixed charges on a wooden bridge at Hamelet, but it was never destroyed.

VII. Corps.

The work of the 180th T. Coy. has been included in the XIX. Corps. At 8.15 a.m. the VII. Corps asked the Cavalry Corps to take over the bridges on the Ancre, south of Ribemont, but they were never destroyed.

In the 21st Division, Lieutenants W. P. F. McLaren and Guthrie, 98th Field Coy., prepared one railway bridge and three road bridges over the Ancre at Ribemont, and two road bridges at Heilly, some of which had been begun by the 178th T. Coy., and the 238th A.T. Coy. An officer and party were left at each place to destroy the bridges when the last of our troops were across, or when the enemy were actually seen approaching. These bridges were handed over to the

* The Merignolles dump referred to above. (See 25th March.)

10th Coy. Australian Engineers, but there was never any necessity to destroy them.

In the 9th Division the 64th Field Coy. destroyed the Pontoon Park at Méaulte. Lieut. Jones, 63rd Field Coy., was sent in a car with two men to Dernancourt and destroyed the road bridge over the Ancre, 1½ miles east of that place. On the following day Lieut. Moffatt, of the same Company, with two men destroyed the bridge in Dernancourt. "This was a difficult operation gallantly carried out as the village had been evacuated and was being shelled by our own artillery."

There must have been a great deal of handing over of bridges in this neighbourhood, as it is recorded in the diary of the 1st Field Squadron that on this day they took over the arrangements for the demolition of the bridges over the Ancre begun by the 238th A.T. Coy. at Heilly, Bonnay and La Neuville, and those over the Somme at Corbie and Daours begun by the 172nd T. Coy., and that during the afternoon they handed over the bridges at Heilly to the 126th Field Coy., 21st Division. None of these was ever destroyed.

XI. 27TH MARCH.

Subsequent to the 26th March, very few demolitions were carried out, but, in view of the possibility of further retreat, all the bridges on the Somme as far west as Amiens, on the Avre, and on the Noye as far south as Moreuil and Morisel, and on the Celle between Vers and Amiens, were prepared for demolition.

No. 3 Water Boring Section was placed at the disposal of the Controller of Mines (Lieut.-Colonel R. S. G. Stokes), with various spare officers such as the Army Water Officer, etc., to prepare for demolition the bridges along the Avre from Moreuil to Camon. His work was taken over on the 30th by Major Lowry, commanding the R.E. Demolition Battalion.

The only demolitions recorded are the bridges at Demuin and Hangard on the Luce, on the 29th, and at Morisel on the Avre, on the 30th.

The bridges at Domart and Berteaucourt on the Luce (three in all), at Castel, Hailles, Fouencamps and Le Paraclet* on the Avre, and at Dommartin and Cottenchy (three) on the Noye, were prepared and handed over to the French on various dates.

The 173rd T. Coy. destroyed all the footbridges in Corbie (the road bridges here were preserved intact), and the 204th and 205th Field Coys. all the plank bridges between Buire and Dernancourt.

The 104th Field Coy., 24th Division, drove six mines under the cross-roads in Caix, and, in the VII. Corps, No. 2 Section, 180th T. Coy., at Baisieux, was employed on mining cross-roads in that vicinity, from the 27th to the 31st March.

* Not shown on the map. A small village opposite Fouencamps.

At 12.55 a.m., A.H.Q. wired XIX. Corps that the railway bridges at Aubigny–Vecquement and Lamotte Brebière were being prepared on the following day for demolition, but the Corps was to be responsible for their destruction. They were not destroyed.

XII. 28TH MARCH.

At 7.30 a.m., 2nd-Lieut. Hurtzig, 173rd T. Coy., blew up the dump at Wiencourt. This is the last dump of which the demolition is recorded.

The C.E. XVIII. Corps obtained from the C.E. Army 2,000 slabs of guncotton with primers and fuzes, and delivered them to the C.R.E. 36th Division for work on the bridges over the R. des 3 Doms.

The preparation of the bridges on the Luce and Avre went on continuously, the work being carried out by the 288th A.T. Coy. and the 173rd T. Coy., but all were gradually handed over to the French, except the bridge at Morisel which was blown up by Lieut. Hurt, 173rd T. Coy., on the 29th, after consultation with the French who were holding the village.

The *pont-levis* over the Somme canal at Bouzencourt was prepared by the 173rd T. Coy. On the 31st it was partially destroyed by a shell which detonated a charge and cut one of the girders, the charge on the other girder being shaken off by the concussion. The officer on the spot salved as much of the explosive as he could, and did his best to wreck the rest of the bridge. In this state it was found by the C.R.E. 16th Division, who thought it fortunate that the demolition had not been more successful as this bridge formed the sole line of retreat for the troops in the front line. He sent Capt. Hughes, 155th Field Coy., to the bridge after dark with a limber full of explosives to prepare it for complete demolition in the event of further retirement. Some days later it was blown up by the Engineers of the 3rd Australian Division.

The story of the demolitions ends here, though the preparation of bridges went on for a considerable time after the line had become stationary.

A "Statement of bridges destroyed and not destroyed in V. Army area from reports from Corps, R.C.E.4 and 24th Division" gives the following numbers :—

	Destroyed.	*Not destroyed.*
XVIII. Corps	.. 78	11
III. ,, ...	.. 48	43
VII. ,, ...	.. 51	2
XIX. ,, ...	.. 52	2
R.C.E.4	.. 11½	9½
24th Division	.. 8	–
Total ..	.. 248½	67½

1. Initial Action by Forward R.E. Units.

This consists of reconnaissance. The method of reconnaissance and form of reports are laid down in the manuals, and need not be discussed. The main effects of mechanization are:

(*a*) Officers and men are less tired.

(*b*) Increased mobility allows a much wider range of reconnaissance.

(*c*) Time is such an important factor, that it should become the automatic duty of leading R.E. units to reconnoitre rivers and other such obstacles for assault and medium bridge sites as soon as possible, and without waiting for orders to do so.

At times, the reconnaissances would be wasted, but on the useful occasions the saving of time would be most valuable.

(*d*) The approaches to site on both banks have become the ruling factors in site selection. Special attention should be paid to the proximity of good roads, possibilities of unloading bridging units at site, and covered approaches.

Any site which entails a lot of improvement to approaches should be ruled out for the "primary medium bridge," although it might be useful for a semi-permanent structure to be erected later.

(*e*) Intercommunication and method of forwarding reports to higher formations have been improved considerably by the increased establishments of motor bicycles with a Mechanized Field Company.

2. Action by C.R.E. on Receipt of Reconnaissance Reports.

(1) He would probably choose the most promising site for a short personal reconnaissance. Mechanization has made this possible in a very short time.

(2) Discuss with "G" Staff, who finally decide on site, to suit the tactical situation.

(3) Discuss site for forward rendezvous of bridging vehicles. Both "G" and "Q" are affected, and the decision will rest with them.

(4) *Decide time of rendezvous.*

The normal time for an assault across a river in the face of the enemy being just before dawn, there are three alternatives for the time of assembly of bridging units at the rendezvous:

(*a*) *Before dark the same night.* This depends on the time of arrival at the river, but mechanization has increased the chances of getting up bridging stores from the Pontoon Bridge Park during daylight.

(*b*) *During the night.* This is not recommended, as lorry convoys at night are awkward things to move. They can probably use lights to within two miles of site, and average 10 miles per hour, allowing for other traffic. The remainder of the journey would have to be carried out with the leading vehicle only showing lights (rear vehicles show tail light only). This reduces the average to about 5 m.p.h. maximum, and can only be done with experienced drivers on fairly straight and good roads. It has the advantage that, from the enemy's point of view, the convoy is reduced to one vehicle, which is unlikely to draw fire.

(*c*) *After dawn.* This means delay in starting bridging operations, and the convoy may get entangled with other convoys.

The best is (*a*), but can only be adopted where reports are received early from forward units.

(5) *Arrange for guide-convoy to rendezvous.*

Indent for stores will go back by D.R., and if alternative 4 (*a*) is adopted, the same D.R. can probably be spared to bring the convoy up. In any case a D.R. will have to be provided as guide.

(6) *Order up bridging stores.*

These will have to come up from the Pontoon Bridge Park, through C.E., as the Field Park Company has only two trestle units and a spare bay.

The store order should be by bridging units (see *S.M.E. Pamphlet* F. 29, para. 9 (3)), as the Pontoon Bridge Park is a R.A.S.C. unit, not necessarily conversant with the uses of the bridging equipment, although it has some R.E. personnel.

It should also contain an " Order of March " of units, to ensure that units arrive at site in their right order. This saves a lot of reshuffling at the last moment.

(7) *Issue orders to unit for carrying out bridging.*

Simplified by additional D.R's.

3. ACTION BY UNIT COMMANDERS.

(1) Probably more detailed reconnaissance of site and its environs.

(2) *Issue orders to sub-unit carrying out the work.*

The Normal Bridging Detachments will take the whole of one section of a Field Company. Unloading party of 40 men per bridging unit will be necessary. If no infantry are available a further section of the Company will be

required. The number of bridging and unloading parties depends entirely on the possibilities of unloading at site, and can easily be calculated.

(3) *Get parties to site.*

No lorries will be necessary if the unit is forward. If somewhat distant from site, a careful liaison with other units will be necessary to avoid traffic jams.

(4) Arrange guides' rendezvous on site.

(5) *Arrange for control of vehicles on site.*

This needs careful consideration, as speed of unloading is entirely dependent on it. Movement of vehicles is more likely to attract the enemy's attention than actual bridging, which makes it most important that they should be unloaded and cleared as quickly as possible.

4. At Bridging Site.

Details have been worked out for a water gap of 100 feet, with trestle bay at both ends. This gives sufficient data for calculations if longer bridges are required.

The times are based on actual experiments carried out by the 17th Field Company during the last two years. The site chosen for experiments was the east bank of the Fleet at Wyke Regis (well known to many officers), which is as bad for bridging and control of vehicles as any site which would be chosen. Lorries had to come up singly, their trailers had to be manhandled for some distance, and the lorries had to turn in a very confined space before getting away. The unloading party, although having a knowledge of the uses of bridging equipment, had never seen a bridging unit loaded. The " carry " was about 30 yards.

(1) *Vehicles involved in their " Order of March."*

1st Pontoon Unit.
2nd Pontoon Unit.
1st Trestle Unit.
2nd Trestle Unit.
1st Odd Bay Unit.

As a matter of interest the road spaces of units are :—

Pontoon Unit (with trailer)	... ...	14 yards.
Trestle and Odd-bay Units	... ...	7 ,,

Owing to the fact that few medium lorries have windscreens, the distance between vehicles, for long journeys on dusty roads, should be increased to a minimum of 50 yards. This also improves conditions for faster traffic moving in the same direction.

On an average, three yards of road space are required for each foot length of medium bridge.

(2) *Organization at site.*

The importance of good vehicle control, and provision of " IN " and " OUT " roads cannot be too heavily stressed, especially for night work. The following are some of the points which should be kept in mind.

(*a*) Where there are any soft patches of ground at the unloading site, it is better to deal with them before any lorries arrive. A little broken brick or similar material scattered over the area will give the wheels sufficient grip to get them over most places. This is quicker than putting " tracks " on the lorries. In the case of the latest lorries with large single tyres, the tracks weigh over five cwt., and it is a laborious task putting them on. Once a loaded lorry is allowed to get stuck in the mud, it is not always an easy job to get it clear, and the delay is considerable.

N.B.—The medium derrick lorry with the Field Park Company is very handy for this job.

(*b*) All bridging units unload over the back and the sides, except for pontoon unit trailers, which unload over the front or draw-bar end. A few manœuvres are required in order to get vehicles into convenient position for unloading. The easiest method is as follows :—

Pontoon unit—approaches river at right angles to the bank—about 10 yards from the bank lorry starts to turn and halts—trailer is unhooked and is roughly in the correct position for unloading—lorry continues the turn until facing away from the river—lorry reverses into position beside trailer.

Other units—make the complete turn and reverse into position.

(*c*) *Ruling Dimensions.* No lorry or trailer should be nearer than 30 feet to the river-bank, or manipulation of long stores becomes very awkward. This also leaves room for dumping of stores pending use.

A space of at least six feet must be left between vehicles as some stores are unloaded over the side.

Bridging units need, for manœuvre, an area roughly 40 feet square. This should be increased on very soft ground as lorries take a wider sweep at greater speed in order to avoid getting stuck.

A pontoon unit parked ready for unloading takes up about 21 feet of river frontage.

(*d*) Vehicles should be brought up singly, *i.e.*, no units should be allowed on site until the preceding unit has completed its parking manœuvres. This helps to reduce the total manœuvre area required.

It helps drivers if they are shown their line of approach by means of a marker, human or otherwise.

(*e*) The evacuation of empty vehicles is simple, as they are facing away from the river. In the case of the pontoon unit, it is quicker to manhandle the trailer to the lorry than to manœuvre the lorry to the trailer.

(*f*) The fact that several unloading sites can be used for each bridge should not be forgotten. Floating units can be unloaded well upstream and rafted down. This simplifies vehicle control, reduces casualties, and helps to mislead the enemy as to final bridge site.

(3) *Timings.*

(*a*) *Unloading.* Party { 24 for pontoons / 16 for superstructure } Total, 40.

Unit.	*Detail.*	*Time of Arrival.*	*Time for Unloading.*	*Completion.*
1st Pontoon ...	1st Pontoon 2nd Pontoon Superstructure	Zero	8 minutes 8 ,, 16 ,,	z plus 16 mins.
2nd Pontoon	1st Pontoon 2nd Pontoon Superstructure	z plus 18	8 minutes 8 ,, 16 ,,	z plus 34 mins.
1st Trestle ...	Whole	z plus 36	11 minutes	z plus 47 mins.
2nd Trestle ...	Whole	z plus 49	11 minutes	z plus 60 mins.
1st Odd Bay	Whole	z plus 62	11 minutes	z plus 73 mins.

(*b*) *Bridging.* Parties { A. 1 N.C.O. and 22 men, rafting. / B. ,, ,, 8 ,, off-shore trestle. / C. ,, ,, 8 ,, in-shore. }

3 N.C.O's and 38 men

PARTY A.—RAFTING.

Job.	*Time of Start.*	*Time of Finish.*
Lay out stores as they are unloaded ...	Zero	z plus 34 mins.
Form medium raft	z plus 34	z plus 49 mins.
Load off-shore trestle bay on raft... ...	z plus 49	z plus 61 mins.
Drop anchors, unload bay on far bank, and launch trestle	z plus 61	z plus 81 mins.
Come into bridge, launch R.B's to off-shore trestle, complete off-shore bay ...	z plus 81	z plus 96 mins.
Assist C Party with odd bay	z plus 96	z plus 101 mins.

PARTY B.—OFF-SHORE TRESTLE.

Job.	*Time of Start.*	*Time of Finish.*
Assist Party A	Zero	z plus 36 mins.
Assemble trestle, collect trestle-bay stores	z plus 36	z plus 49 mins.
Load trestle bay on raft	z plus 49	z plus 61 mins.
Unload bay on far bank, launch trestle	z plus 61	z plus 81 mins.
Receive R.B's from raft, adjust trestle, complete shore bay	z plus 81	z plus 101 mins.

PARTY C.—IN-SHORE TRESTLE.

Job.	*Time of Start.*	*Time of Finish.*
General assistance	Zero	z plus 60 mins.
Form in-shore trestle bay	z plus 60	z plus 75 mins.
Collect odd-bay stores	z plus 75	z plus 81 mins.
Launch R.B's to raft, complete odd bay	z plus 81	z plus 101 mins.

Allowing for alignment of bridge, clearance of small stores, etc., the time for completion of bridge would be 110 minutes.

ADDITIONAL DATA.

Time for booming out a bay of medium bridging ... 8 minutes.
Time for forming up a bay of medium bridging ... 8 minutes.
Times taken from the moment when the incoming pier is in position close up to the previous pier.

General. It has been assumed that no erection takes place until the whole unit has been unloaded. This would probably be the case with an unloading party which did not understand the equipment, as the stores required first might not be unloaded until last.

In ideal conditions for unloading with no carry, and for short lengths of bridge, it is quicker to cut out the unloading party. The bridging party unload and erect at the same time. By this method it takes about 20 minutes to complete each bay, *i.e.*, a party of 40 will complete a trestle bay and one floating bay in 20 minutes. The off-shore trestle bay is always the part which takes most time.

5. CONCLUSION.

In order to solve the problem correctly the C.R.E. has to consider three phases :—

(*a*) *The actual bridging.* This is comparatively short, and can easily be calculated from the data given.

(*b*) *Time, rendezvous to site.* This should be short also ; and can easily be calculated, taking into consideration distance and light factors.

(c) *Time, rear to rendezvous.* This is the longest, and most difficult to assess accurately, as it is not easy to gauge the state of traffic in the back areas (see Section 2, para. (4)).

Mechanization clearly tends to simplify the problem, owing to increased means of communication and increased speed of movement. At the same time it has encouraged the idea that such bulky units as the Pontoon Bridge Park can be kept well in rear, relying on their increased speed to bring them forward when required. This would only work well with good roads and little traffic of other kinds, conditions which rarely prevail.

It seems essential, therefore, that there should be a forward unit capable of forming medium bridges up to 100-ft. span, under the direct command of the C.R.E. There are two possible alternatives:

(1) The Staff and the C.E. can foresee a river-crossing, and from the map or air photographs can probably estimate the width of the river. They cannot foresee either the number of bridges which will be required, depending on the tactical situation at the time, or the types and number of bridging units required for each bridge, which depend on factors not obtainable except by personal reconnaissance. The C.E. would, therefore, have to guess, and would probably detach temporarily a section or sub-section of the Pontoon Bridge Park to the C.R.E. concerned. The existing organization of the Pontoon Bridge Park into roughly two medium bridge sections and one heavy bridge section, each with only one officer, does not make this very easy.

(2) In place of the trestle equipment with the Field Park Company (which does not seem to be of great value as it stands now), there should be five units of the types given in Section 4 (1). This would give a C.R.E. enough material to put a " primary medium bridge " across most rivers, as it would only increase the road space of the Field Park Company by about 120 yards. The saving in time and worry to the C.R.E. would make it well worth while.

An additional reason for adding this material to the Field Park Company is that, normally, the Field Companies would be very busy with water supply and many other jobs with the forward units, and would not have sufficient men available to carry out the medium bridging operation. There is always a possibility that this would fall to the lot of the Field Park Company, and it is therefore essential for this unit to be fully conversant with the uses of the equipment.

SKI-ING ON THE ARLBERG.

By LIEUTENANT C. A. SWETENHAM, R.E.

WHILST seeking a suitable environment in which to learn some German, the writer visited a place which, though not ideal for his original purpose, has characteristics which may prove of interest to other members of the Corps.

From the accounts of his acquaintances he had always understood that it was impossible to ski without staying at an extremely expensive Swiss hotel, where ski-ing during the day was merely a prelude to dancing through the night after an indispensable period of recuperation at the bar. Moreover, that few foreigners dared to intrude into what had become British preserves. It sounded, in fact, a financially unbalancing form of holiday.

The Austrian Tyrol, however, in normal times, caters primarily for the impoverished Teuton, who is not accustomed and cannot afford to pay fabulous sums for the privilege of enjoying the mountain snow, sun and air. Furthermore, since the *hochtourist* follows the same trails in summer that the *shilaufer* does in winter, the overhead costs of the *gasthofe* are distributed over a twelve-month season.

Though the writer can only vouch for the Arlberg, he believes that the cost of living is much the same throughout the whole of Austria, and there are numerous other localities in which good ski-ing is obtainable.

The Arlberg Pass connects the western end of the Tyrol to the province of Vorarlberg. St. Anton-am-Arlberg, the principal village of the district, lies at the eastern end of the five-mile Arlberg tunnel, and has the highest main-line station in Europe. To the English skier it offers the following advantages :—

(1) *Accessibility.*—There are three express services each way every day, all of which reach London in under 24 hours. It is unnecessary to change carriages between the Channel and St. Anton. Thus expensive mountain railways and irritating changes are eliminated.

(2) *Cheapness.*—The writer managed to get housed and fed for the total cost of Sch. 12 *per diem* (about 8s.). Although this was perhaps exceptional, those who are prepared to live modestly in that state of Napoleonic penury, which is necessitated by the subaltern's rate of pay, should be able to obtain meals and accommodation for 11s. a day.

(3) *Facilities for Instruction.*—The ski school of the renowned Hannes Schneider is available for those who wish to learn to ski in a

systematic and scientific manner. The size of the school, which always has about twenty classes in action, renders it possible for the beginner to be separated from the more experienced skier, to their mutual benefit. Pupils vary from the rawest beginner to the veteran, and none of them who employs a little faith and assiduity fails to benefit from the instruction of the teachers.

(4) *Touring Facilities.*—There are numerous good tours in the district, amply marked and hutted, but the precipitous character of the mountains necessitates a little experience to enable one to negotiate (without an overfrequent assumption of the prone and recumbent positions) the difficult portions which occur on every trail. Caution is required to avoid avalanches, which often occur under appropriate weather conditions, so the services of a guide are very advisable on all but the most frequented routes. Their fee is about a pound a day.

(5) *Cosmopolitanism.* The writer went to what he expected to be a quiet German-speaking mountain village, but found that the fame of the Schneider ski school had gathered together inhabitants of the five continents and representatives of every nation in Europe —Portuguese and Bulgarians alone were excepted from his acquaintances there.

From this it follows that it is an excellent place for anyone to practise their colloquial fluency in any tongue, but the excellence of the English spoken by the average educated foreigner makes it very hard for any but the strongest-minded beginner to exercise his halting and ungrammatical attainments in a strange language. But the competent can converse in French, Italian, German, Dutch and Hungarian all day.

Having summarized the principal characteristics of the place, it is proposed now to go into those details of interest to the intending visitor.

Travel.

By avoiding those luxurious expresses advocated to the Yankee and the Englishman by Cook and his ilk, and travelling by the trains deemed adequate by the local inhabitants, the writer was able to travel rapidly and cheaply in the third-class carriages intended for the indigenous population. Moreover, since travellers in all classes are equally entitled to make use of the restaurant car, long periods of relief from the possible overcrowding in one's own compartment may be obtained by partaking of the meals provided, although their cost at the present rate of exchange appears very high.

The few francs and forethought expended in reserving a seat prior to the journey will be found to be amply repaid.

For those who live west of London, the Southampton–Havre route with its seven hours' sleep on the boat will be found to have advantages. If desired, the journey can then be broken by a night in

Paris, a city not without facilities for cheap accommodation and amusement.

For those travelling through France the only piece of scenery worth seeing lies east of Zurich, where the mountains, rising sheer out of the blue waters of the Walensee, provide a wonderful spectacle from the windows of the train.

ACCOMMODATION.

The most economical way of living in St. Anton is to take a room in one of the village houses, all of which have *fremdenzimmer zu vermieten*, and to feed in one of the *gasthofe*. The cost of a room and breakfast varies between Sch. 6 and Sch. 12 *per diem*, and personal arrangement can settle whether this includes gratuities or not. There is an irritating, if logical, local custom of charging one or two schillings a day for heating, in addition to the nominal price for the room, so as to compensate for the extra expenditure required for this in winter.

It is a good plan to arrange to have tea supplied at one's residence, as this is much cheaper and simpler than repairing to hotels for tea.

A priced list of available accommodation, and any other information desired, can be obtained from the London office of the Austrian Federal State Railways. It is always possible to bargain for reduced terms for a long stay.

The daily cost to the writer, for a prolonged stay, of room, heating, service, breakfast and tea was Sch. 5.50. He can, from personal knowledge, recommend Haus Marth for simple accommodation, and Haus Maur for those who desire something more luxurious; but it is hard to make a bad selection; the Tyroler has not yet acquired the normal rapacity of the sophisticated hotelkeeper.

The principal places in which to eat are the Hotel Post, the Gasthof Post and the Gasthof Schwarzen Adler, all of which are quite moderate, considering the classes of fare provided. The writer, by eating in the *gaststube* of the last-named, was very adequately fed for Sch. 7.00 *per diem*.

Extra sunshine can be obtained by living a mile or so up the Arlbergstrasse, at such places as the Pension Solleder and Gasthof Moosekreuz. The latter now is owned by an English naval officer.

INSTRUCTION.

There are actually two ski schools at St. Anton, the D.A.K.S. and the Schneider. The writer, like most foreigners, attended the latter, which is larger and better known, so will confine his description to it, though he believes the former is run on similar lines and is also very good.

The cost of lessons is Sch. 6 for one or Sch. 30 for six. A ticket or

card of six tickets is bought at Schneider's shop, and the *ski-lehrer* collects one from each pupil at every lesson.

A lesson lasts from ten to twelve in the morning and is continued from two to four in the afternoon. They normally take place on the practice slopes within five minutes' walk of most of the houses. It is advisable to be punctual, as once the classes have moved off it is very hard to distinguish one's own, and much time may be wasted ere it is discovered.

On first arrival, one is graded by Hannes Schneider on one's description of one's ability, and is sent to an appropriate class. This classification is naturally very difficult with a constant influx of fresh visitors, and it is at present the weakest point of the School: for many newcomers of the ineffectual type have spent several seasons tumbling perfunctorily down the nursery slopes of some Swiss resort without any sort of instruction or ambition, and are thus apt to start in higher classes than their abilities justify, where they tend to impede the progress of the rest, especially on the tours in which the higher classes indulge about twice a week.

Again, from the same cause, it pays not to await the unsolicited reward of merit, once one has learnt all that one can in any class, but to suggest tactfully that promotion might be justified.

Herr Schneider does not instruct personally nowadays, but he and his assistant, Herr Schuler, supervise the classes, speeding down the local Olympus in a series of *stem-christianas* to watch the feeble efforts of their would-be imitators ere they vanish over some seemingly impassable declivity.

The *ski-lehrer* themselves are both expert runners and efficient instructors. Most of the classes are taught in German, but a certain number in French and English. The standard of German required to attend the German ones is not very high, and the essential phrases such as "*Spitzen zusammen*" (points together), "*Zu steif!*" (too stiff) and "*Langsarmer!*" (slower) become indelibly impressed on the memory.

The system of tuition is based on Herr Schneider's premises that it is desirable in downhill ski-ing to keep as far as possible the ski on the snow and the heel on the ski; and that it is superfluous to learn more methods of turning than are necessary to render an efficient turn possible under all snow conditions. From this he deduces that, apart from the jump turn for very bad snow, all that is required is the *stem-bogen* for soft snow, the *christiana* for hard snow, with all the intermediate shades of *stem-christiana* for use as the state of snow and terrain dictate to the subconsciousness of the experienced runner. The *telemark*, whose contortionistic posturings necessitate a loose heel-strap, and consequent decrease of ski control, is taboo.

The instruction itself is too Teutonic in its thoroughness to suit the English temperament, and is based on the mistaken idea that it is

impossible to run at all before one can walk perfectly. In other words, there is lack of variety and over-insistence on correctness of details.

For this reason it is probably advisable to take not more than four lessons a week, and to practise by oneself or to tour on the remaining days.

The synopsis of the course is roughly :—climbing, simple slow running, "snow-ploughing," *stem-bogen*, *stem-christiana*, *christiana*, jump turn. *Slalom* practice is occasionally undertaken by the more advanced classes.

All turns are begun slowly, and on incredible slopes. No self-respecting class practises on a slope of less than one in two, with occasional diversions on one in one. Trying to turn slowly on such gradients becomes a test of the morale when both skis point downhill, but it is necessary to obtain confidence on such slopes before one really enjoys some of the local tours.

Should the snow be really hard, the beginner would be well advised, after a week or so of orthodox practice, to spend two or three days teaching himself to *christie*. This will greatly enhance his feeling of security, and reduce his liability of damage should any emergency occur.

The presence of difficult portions in all tours, and the fact that a cable railway has not yet been built, are great disadvantages to those who can stand and turn, but require a quantity of reasonably easy downhill running to increase their speed and confidence. For such, one of the eleven places in Austria which possess cable railways would be preferable for a portion of their ski-ing.

EQUIPMENT.

Skis and sticks can be hired for Sch. 1 *per diem*. For those who wish to buy, both Norwegian and Austrian skis can be purchased locally. Steel edges are practically indispensable to those who value their safety on frozen snow. Their dangerousness to the user exists only in the imagination of the expert. There are two very good bootmakers in the village who supply ski-boots to London firms. All minor items of equipment can be bought locally in the village, and, like boots and skis, are rather cheaper than in London. English clothes are definitely superior to Continental ones and are worth bringing out.

As to garb: the average German skis in plus-fours—many of which are not exactly snow-proof. A few local guides and experts are lengthening their plus-fours to the ankle. They wear them black, navy blue or brown. The ladies wear likewise. Indeed, it is advisable to remove oneself rapidly from the path of any lady wearing a skirt. None but an expert can afford to be impeded by such a garment.

Something readily adjustable as to warmth is indicated. For

climbing on a sunny day would overheat a practising nudist, whilst being frozen by a gale removes the pleasure of the most fanatical.

However, although a considerable latitude in dress is allowable, there is no need to appear unnecessarily conspicuous, like one Englishman who combined a pair of worn-out breeches and an oil-stained motor-cycling helmet. Mr. Burton can do one better than that.

In the evenings anything can be worn. The Hotel Post prefers its visitors to wear dinner jackets, but many of them do not. At the other hotels a dinner jacket is distinct overdress.

Diversions.

Skating is available, though not very popular. The local inhabitant drags his sledge up the Pass and careers down the Arlbergstrasse to his own enjoyment and everyone else's danger.

There is a distinct lack of the "Gather-round-the-bar spirit," but dancing is available for the price of one's drinks at the "Post," and the "Schwarzen Adler."

Language.

A slight phrase-book knowledge of German greatly increases one's chances of obtaining the victuals desired or arriving at the correct destination.

The writer was much puzzled on his arrival by the habit of the peasantry of muttering "Scott!" whenever he passed. Research beyond the limits of his phrasebook proved this to be the local greeting, "*Gruss Gott,*" which is employed on every sort of occasion.

The reader is reminded that when rapidly changing from another tongue to French, he must not fail to harden the "k" and to talk of "*faire du ski.*" Otherwise he may be misunderstood.

Exchange.

At the beginning of last season the internal rate of exchange in Austria was maintained at the gold standard, though the outside rate was considerably lower. Furthermore, the foreigner was forbidden to take out of the country more than Sch. 500 of Austrian money. Consequently, unless arrangements were made before entering the country, the visitor sustained a loss of approximately 25 per cent. It was practically impossible to obtain schillings through the ordinary banks. The only solution was to buy a "frozen credit" in Austria with an English cheque from a firm which had no other means of getting the money out of the country. Lillywhite's Travel Bureau used to act as agents for such a firm. Later foreigners were allowed to change cheques at the external rate. But enquiry before arrival may save many pounds.

NEIGHBOURHOOD.

The hospice of San Christoph (5,900 ft.), at the top of the Arlberg Pass, can be reached by foot or bus from St. Anton, three miles away. Accommodation and instruction are to be had quite cheaply. Ski-ing is possible there at times when there is insufficient snow lower down. From it the Galzig, down which the Arlberg-Kandahar Races are run to St. Anton every March, can easily be climbed.

The palatial Ulmer-hutte, on the ascent to the Valluga, has about 50 beds and a complete domestic staff. It is a good starting or halting point for several tours. The descents hence to St. Anton, Stuben, and to Zurs from the Valluga, are all very good.

Stuben, at the Vorarlberg end of the Pass, has several good tours in the neighbourhood, but the snow is apt to get more windswept than on the Tyrolese side. The Gasthof Post is good and cheap. Ski-ing instruction is available.

Langen is the station for both Stuben and Zurs. It has a good *gasthof* and an interesting modern church designed to deflect avalanches as well as to fulfil its more normal functions.

Zurs (5,600 ft.) is reached by horse-sled from Langen, going through Langen and then up the Flexenstrasse, which is a fine example of road engineering. Zurs' height tends to allow ski-ing there when it is impracticable at practically every other Alpine resort. There is a branch of the Schneider ski school here and the tours are good. Its chief disadvantage is that the absence of a village, which forces one to live in an hotel, increases the expense. The "Edelweiss" is one of the less expensive.

Lech (4,600 ft.) is a small village of which some experienced skiers speak highly. The Gasthof Goldener Kreuz is reputed to be comfortable and cheap.

ADMINISTRATIVE.

There is no bank at St. Anton, but Schneider's ski shop or the Tiroler Landes Reiseburo will cash cheques at the official rate of exchange. (The latter is a very courteous and efficient travel agency.)

There are two doctors and a dentist in the village, but it is customary, in the case of broken bones, to send the victim by train to Innsbruck, where an expert does the final setting.

CONCLUSION.

The Arlberg is well worth a trial by the keen skier who wishes to restrict his expenses and to improve his technique, provided that he is neither averse to the foreigner nor insistent on an organized continuity of nocturnal revelry.

DISMANTLING THE INGLIS BRIDGE AT BARA.

By LIEUTENANT M. C. A. HENNIKER, R.E.

1. GENERAL.

THE Inglis Bridge, near Bara Fort, on the Kajuri Plain west of Peshawar was built during the operations against the Afridis in 1930. It was not unlike the Mazarai Bridge over the same river, a description of which appeared in *The R.E. Journal* in March, 1932. Photo No. 1 was taken shortly after the bridge was built by No. 4 Field Company, K.G.O. Bengal Sappers and Miners, and shows its general features. In 1932 this bridge was replaced by a concrete arch bridge more in accordance with the solid traditions of the *Pax Britannica* that now embraces this threshold to the Tirah.

The Inglis Bridge was, therefore, superfluous, and the task of dismantling and transporting it back to Peshawar was given to No. 2 Field Company, K.G.O. Bengal Sappers and Miners. Dismantling this bridge provided some quite interesting work, which it is proposed here to describe, but before embarking on it it is necessary to give a few details of the bridge itself.

2. TYPE OF BRIDGE.

It will be observed from Photo No. 1 that the bridge was a Mark I Inglis with 12 twelve-foot bays between the piers and three subsidiary bays at either end to span the gaps between the piers and the bank-seats. The maximum span over which this type of bridge will take the necessary loads is 10 bays, or 120 feet, whereas the span here was 144 feet. The problem had been solved by casting two heavy blocks of concrete into the extreme bays of the " tails." The effect of these weights was to give a " hogging " stress to the bridge and so counteract the " sagging " stresses produced by the loads upon it. Thus :

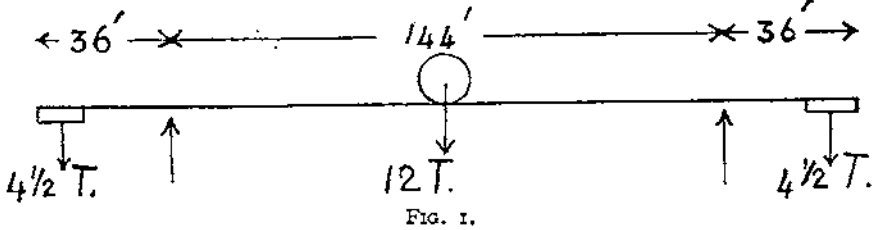


FIG. 1.

The second point of importance is the method by which the bridge had been launched. Only 10 bays of Mark I Inglis can be launched by cantilever methods, whereas the clear span was 12 bays. This

had been overcome by launching the bridge in two halves—six bays from either bank—and joining the parts together in the middle. The diagonal member in the middle had to be cut and clamped together with a sleeve when in position; but the other members, being horizontal, all fitted together in the normal way.

3. POSSIBLE METHODS OF DISMANTLING.

The natural way to set about dismantling this bridge was the exact reverse of the way in which it was built. But between the time of its building and its dismantling circumstances had changed. The building was part of an operation against the Afridis, when reasonable expense was not grudged. The dismantling was a monetary affair during a time of "financial stringency," when it seemed that every penny spent would react upon the income tax. The normal launching trollies with which the Inglis Bridge is provided were out of the question. The nearest serviceable one was four hundred miles away, and to bring it up was too expensive.

Secondly, the conformation of one of the banks—the south bank—was not suitable for de-launching. The south bank sloped up from the bankseat, and although rolling the bridge downhill had been feasible in launching, the prospect of hauling it back again on an improvised trolly up a considerable slope was not hopeful. The north bank, however, was reasonably flat, and half a day's work on this bank made de-launching in the normal way practicable.

It was, therefore, decided to dismantle the south half *in situ* overhanging the gap, but to roll the north half on shore before dismantling.

The counter-weights necessary for this operation presented no difficulty, as a section of the company had just dismantled another Inglis bridge in the vicinity and the parts were easily available.

4. THE PLAN ADOPTED.

The plan adopted can conveniently be divided into four phases:

a. Adding sufficient counter-weight to the tails.
b. Removing the locking pins, etc., in the middle of the bridge.
c. Rolling back the north half on an improvised trolly to dismantle it on shore.
d. Dismantling the south half *in situ*.

There is nothing of particular interest in *a*. It was a mere combination of arithmetic and man-power. The remaining phases will be described in some detail.

5. UNDOING THE PINS IN THE MIDDLE OF THE BRIDGE.

Fig. 2 shows the general lay-out. The exact weights cannot be given owing to a peculiar circumstance. The night before the two

halves of the bridge were separated a violent dust storm swept the Kajuri Plain and uprooted the store tent that was pitched on the site of the bridge. Inside the tent was a file of the nature of an F project—tables of stresses, Bow's notation diagrams, transport indents, ration returns, etc. All were unceremoniously removed, never to be seen again. Possibly this saved them from lurking for generations on a dusty shelf in a dusty office until some zealous reformer destroyed them, but it was a little disappointing at the time. That, however, is a digression that only serves to emphasize the necessity of preserving important work from the vagaries of the weather.

From Fig. 2 it will be seen that jacks were placed under the tail of the bridge on the north bank. By raising these the top boom of the bridge was put into compression and the two securing pins in it were easily removed.

Two treble tackles were then reeved between the transoms and

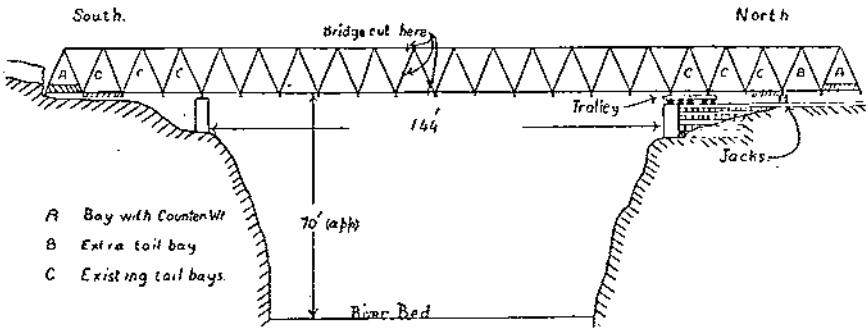


FIG. 2.—Dismantling. Lay-out.

stiffeners on either side of the cut in the form of an X. By suitable pulling on these and adjusting the jacks under the tail, it was possible to reduce the stress in any particular member to practically *nil*. This was, therefore, done until it was supposed that the diagonal member to be cut had no stress in it. The covering sleeves that were clamped on to the diagonal member were then gingerly removed, after which the jacks at the end were lowered still further.

After a little manipulation, the lower boom was put into a state of compression instead of tension and one of the pins came out with remarkable ease, leaving the two halves of the bridge only connected by one pin, and that one firmly wedged. This was definitely " not according to plan," for the only logical reason that accounted for the pin's obstinacy was that it was being subjected to some tremendous stress that had somehow evaded all the calculations ; and that when the pin was removed the whole bridge would disintegrate like a box of matches, or become a tangled mass of twisted steel. As is usual, however, in such circumstances as these one of the Sappers rose superior to academic doubts and made the pin react

to the persuasion of a sledgehammer. The cause of the trouble was not discovered.

6. ROLLING BACK THE NORTH HALF.

It is practically impossible to launch and de-launch an Inglis bridge over fixed rollers, such as are used for most steel bridges, because the transoms each project about a foot below the lower boom. It was, therefore, necessary to make an improvised trolly that would support two transoms at the point of balance of the half-bridge and that could be rolled back with them as far as was required. The trolly, consisting of heavy R.S.J's " on the flat " and spare bridge tubes, is visible in Photo No. 2.

The process of rolling back the north half was a tedious but successful operation. The usual pitfall in launching bridges over moving rollers is caused by the rollers becoming crooked and thus throwing the whole bridge out of alignment. This tendency was partly counteracted by making the runway over which the rollers were to move with much more accuracy than is usually devoted to this task, and partly by arranging the hauling tackles so that some lateral control of the bridge was possible.

7. DISMANTLING THE SOUTH HALF.

Dismantling the south half of the bridge provided considerable interest and not a little excitement. The derrick gear with which the more modern Inglis bridges were issued for building and dismantling was not considered suitable. Its weight is such that at least five men are needed to move it from transom to transom and a roadway of some sort would be required for them on both sides of the bridge. It was, therefore, decided to erect two jibs, more or less in prolongation of the top boom, and to lower the pieces of bridge one by one into the river-bed. The photos probably give a clearer idea of the process than description.

For the beginning stages of the operation jibs specially designed for the purpose were used. But although their design rested on principles, figures and statistics wrenched from the tangled undergrowth of that tropical jungle of festooned mathematics—the theory of structures—they cannot be described as successful. In fact, after dismantling one and a half bays they were replaced by two 60-lb. rails each 20 feet long. These, being the only substitutes available, were pressed into service, where they gave almost complete satisfaction.

The original jibs are shown in Photo No. 5. When they were replaced by rails it was decided to support them as in Fig. 3, which is worthy of note in connection with paragraph 6, in which a better way is suggested.

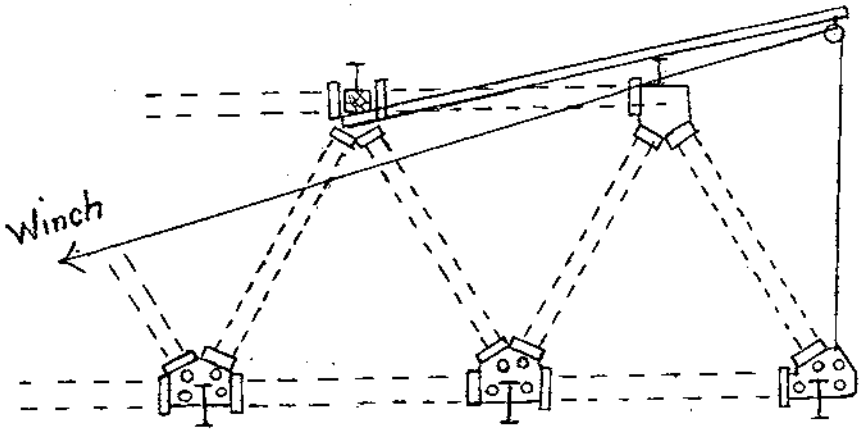


FIG. 3.—Method of fixing jib.

The sequence in which the pieces were lowered is shown in the following sketches.

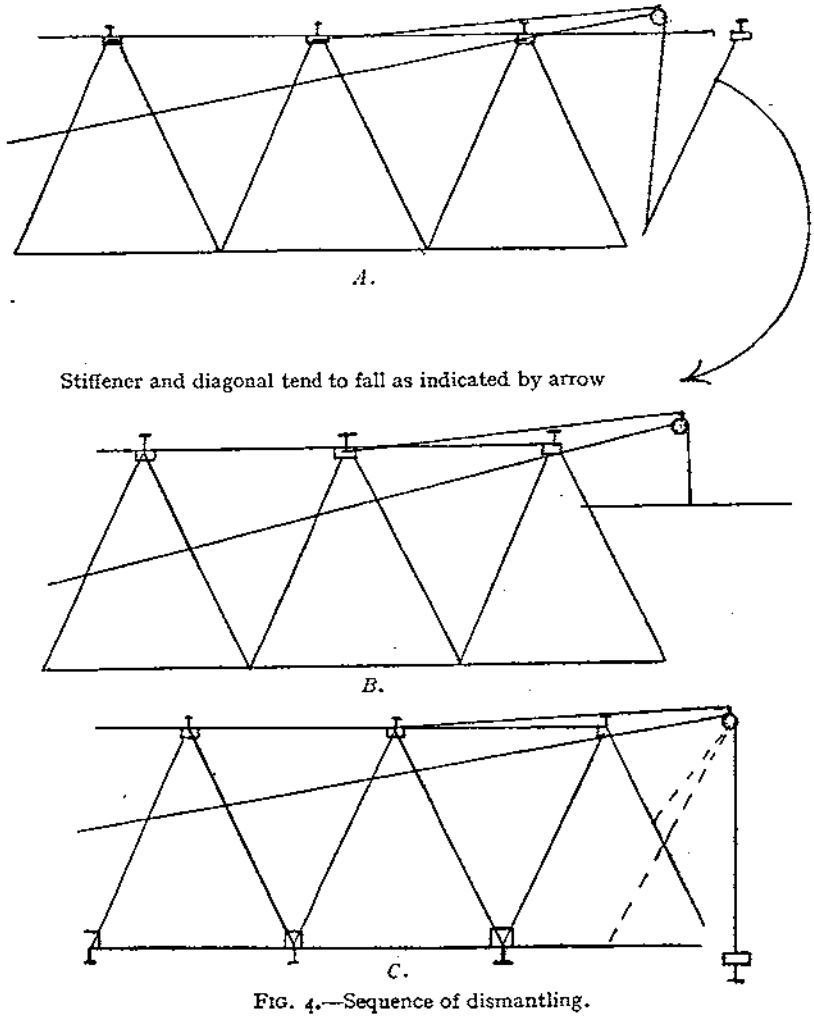


FIG. 4.—Sequence of dismantling.

It will be observed that the stiffener and diagonal in figure A. are not supported at their point of balance, and this was the cause of what might have been a fatal accident. The stiffener itself was always easily detached from the horizontal tube to which it had been joined, but trouble was often experienced in persuading the lower end to leave its socket. Before the behaviour of these recalcitrant members was fully understood, a havildar was rash enough to try and force the pace with a crowbar. As soon as the diagonal member came free, its butt, prompted by the laws of gravitation and in spite of various lashings not shown in Fig. 4, struck the havildar in the chest and knocked him backwards off his feet. Luckily, he landed safely on a transom, his head on one side, his feet on the other, and his *pugree* only lying in a crumpled heap on the shingle 50 feet below. It is on such occasions as this that Nature cuts a notch in her wand to record another triumph of matter over mind.

8. TIME AND MEN.

This job ran concurrently with another, so that exact figures for labour are not available. An approximate statement is two numerically weak sections (app. 70 men) for eleven days (88 hours).

This does not seem rapid progress, but the temperature should be taken into account. The minimum night temperature never went below 75° F., while the shade temperature during the day usually reached 110° F. Work started daily at 5.30 a.m., but by 10 a.m. the ironwork of the bridge was too hot to handle without sandbags for protection. Casualties were *nil*: one man reported sick.

9. CRITICISM OF THE METHOD OF DISMANTLING.

It is easy to be wise after the event, but several improvements on the actual method can be suggested which may be of some interest.

If it is decided to dismantle an Inglis bridge without de-launching it, it is a mistake to have the footway on the lower boom. The photographs show the footway on the lower boom, and it can be seen that to climb to the top boom to manhandle the jibs from place to place was most unpleasant. (Not that the Sappers themselves paid the slightest heed to their often precarious position; but in a job like this there are risks enough without introducing unnecessary ones.)

The footway should undoubtedly have been on the upper boom, as in Fig. 5. Working on a footway in comparative comfort on the top boom, it would have been quite easy to manhandle the jibs; whereas descending to the lower boom to dislodge the transoms, etc., would not have been so troublesome as the reverse procedure.

Secondly, the jibs were supported on top of one stiffener and under the next (see Fig. 3). This was to give them the slope

in its position as determined from the camera calibration (5). The visible horizon line is ruled on each photograph.

A perpendicular is drawn from the principal point P to the visible horizon and continued beyond it. The length of this perpendicular is measured. This perpendicular is the principal line. From the height of the aircraft, and the height and distance of the visible horizon, the depression of the visible horizon is calculated, allowing for atmospheric refraction. From this and the distance of the visible horizon from the principal point the distance of the true horizon along the principal line is calculated.

This is plotted on the photograph and through it a line is drawn parallel to the chord of the visible horizon. The line is a sufficient approximation to the true horizon and is referred to hereafter as the true horizon.

Horizontal Rectification.—The principle of extending control by means of the photographs only is as follows. The end pair of photographs have the positions of their plumb points fixed by resection from the three points fixed on the ground. Three points (called minor control points) are selected in the area common to the first three photographs in positions similar to the ground control points (one foreground and two background). The positions of these three points are obtained by intersection from the radial line plots of the first two photographs and serve as fixed points for the resection of the plumb point of the third photograph. Three more points are intersected from photographs Nos. 2 and 3 for resecting No. 4, and so on through the strip.

The object of the horizontal rectification is to make the radial line plot, which gives the directions of the selected points radially from the plumb point of the photograph. These directions represent those which would have been obtained if it had been possible to set up and level a plane-table at the place where the photograph was exposed and draw a series of rays to the actual points in nature with a sight rule, so that once this radial line plot is obtained the resection and intersection of detail is identical with ordinary plane-table survey.

The method of rectification is to reproduce the conditions existing at the time of exposure in diagrammatic form. The points it is required to rectify, that is, the ground points, minor control points and points required for sketching detail, are marked on the photograph and perpendiculars from them to the principal line are drawn. On a piece of tracing paper (Fig. 1) LP is drawn equal in length to the principal distance of the camera (obtained for the particular camera and lens by calibration) (5).

AA is at right angles to LP through P. The photograph is placed under the tracing paper with the principal line under AA and P below P. The position of the true horizon H and the feet of all the

photograph overlaps the previous one by one-half along the foreground edge. The strip is continued, until the whole area is photographed and a further accessible ground area is reached.

The height at which the aircraft is flown is chosen to secure a good visible horizon at a sufficient distance. This will generally demand a preliminary air reconnaissance. The line of flight of the aircraft is selected so that the nearer border of the area to be mapped will be included in the foreground when the aircraft is tilted to its maximum accidental tilt (about 3°).

Contact prints of the photographs are made, care being taken that they are not distorted whilst being dried.

Ground Control.

Before plotting can be commenced it is necessary to know :—

(i) The approximate height and distance of the ground which appears as the visible horizon. This is only required very roughly. It can be obtained usually from existing reconnaissance surveys or from intelligence reports, with sufficient accuracy.

(ii) The position and height of three or preferably four points appearing in the end overlaps of the strip. These must be fixed by a ground party. One point is required in the foreground and two in the background as far away as possible, whilst still distinguishable without doubt on the photograph.

Plotting.

The various stages of plotting are :—

(i) Drawing the visible and true horizon lines and the principal line on the photograph.

(ii) The horizontal rectification of the necessary control points and main topographical points to form a radial line plot.

(iii) The resection of the plumb points (the map position of the point vertically below the aircraft at the moment of exposure) of the photographs with the radial line plot by the tracing paper method.

(iv) The resection and sketching of detail.

(v) The vertical rectification of the photograph and determination of heights.

(vi) The contouring of the map.

Horizon and Principal Lines. See Photograph.
The principal point (the centre) P of each photograph is pricked

A GRAPHICAL METHOD OF MAPPING FROM LATERAL OBLIQUE AIR PHOTOGRAPHS.

By CAPTAIN D. R. CRONE, R.E.

(*Numbers in brackets refer to the Bibliography at the end.*)

THE principles of the topographical mapping of hilly country from vertical air photographs by the graphical methods perfected at the War Office, and also of the topographical mapping of flat country from oblique air photographs by the methods extensively employed in Canada, are generally widely known. This article is an attempt to describe briefly a graphical method of mapping hilly country from oblique air photographs which has been used with considerable success on the North-West Frontier of India.

The need for such a method arose from the fact that there are considerable areas on the North-West Frontier over which aircraft is forbidden to fly, in order to avoid violating the frontier which is mainly undemarcated. It was desirable to complete the topographical mapping on the one inch to a mile scale of this area at the same time as adjacent areas were being mapped by the more usual vertical photographic methods.

The method evolved borrows its system of rectification from the first principles employed in the evolution of the Canadian oblique method for flat country (laid down by Dr. Deville as early as 1889 (1), (2)), and its system of extending a control from the photographs themselves from the radial line method for vertical photographs of Major Bagley, U.S. Army (3) (later improved by Lieut. Hotine, (4)).

PHOTOGRAPHY.

A strip of lateral oblique photographs is taken from an aircraft flying as straight, as level, and at as constant a height as possible. The camera (the R.A.F. Service F.8 7-in. by 7-in. automatic film camera with 10-in. lens) is set in its oblique position in its mounting at right angles to the fore-and-aft line of the aircraft (or as near as possible whilst getting an unobstructed view), with its axis depressed so that the visible horizon is about 3° from the top of the picture (about 18° depression with the 10-in. lens).

The strip is commenced over ground accessible to ground surveyors for fixing ground control and exposures are made to secure that each

necessary for the pulley to function. Had they been supported as in Fig. 5, much time and trouble would have been saved.

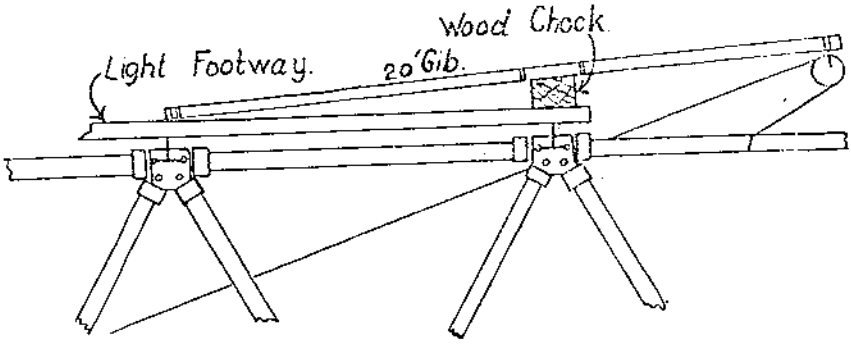


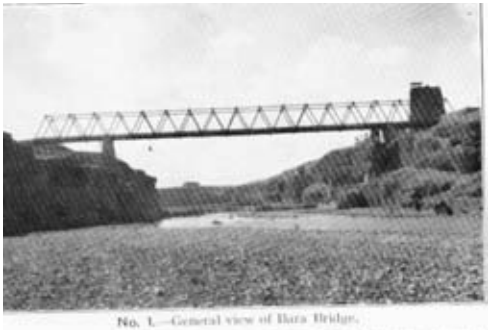
FIG. 5.—Correct method of fixing jib.

10. CONCLUSION.

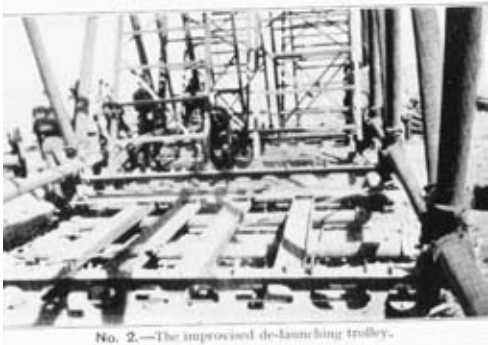
This work brought out two lessons. The first was that the orthodox method of dismantling an Inglis bridge is considerably easier and quicker than to dismantle it without de-launching it.

On the other hand, if it is difficult to de-launch an Inglis bridge owing to the shape of the ground, lack of stores or any other cause, it is eminently practical to dismantle it as described here. It is not a mere "stunt." Furthermore, if for the same reason it is difficult to launch an Inglis bridge there does not appear to be any insuperable difficulty in building it out over the gap, in converse to this method of dismantling.

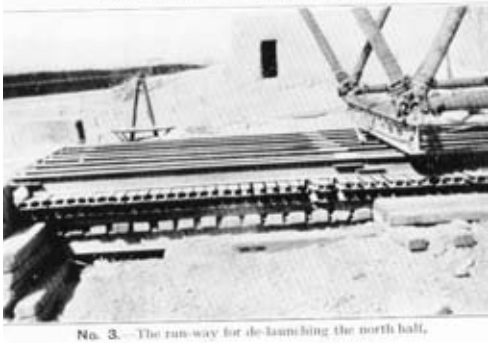
In order to launch a steel girder bridge by the orthodox method, a straight runway of at least the width of the gap is required—and a longer runway makes it easier. But in order to *build out* a bridge (as opposed to launching it), it would only be necessary to have sufficient space for the counter-weight—say one-third of the width of the gap. In mountainous country it is often difficult to get enough runway without extensive rock cutting, and a method of "forming up" a steel girder bridge like a pontoon bridge might be of the utmost value. Experiments in this direction, carried out over a bridging pit that is not dangerously deep and under good conditions, might well produce some useful results both for the design of new bridges and for ways of building those already in the Service.



No. 1.—General view of Bara Bridge.



No. 2.—The improvised de-launching trolley.



No. 3.—The run-way for de-launching the north half.

Dismantling the Inglis bridge at Bara 1-3

No. 4.—The two halves of the bridge coming apart.

No. 5.—Lashing the jibs in position.

No. 6.—Preparing to detach a transom, before lowering it into the river bed.

Dismantling the Inglis bridge at Bara 4-6.

A graphical method of mapping from lateral oblique air photo.

FIG. 1

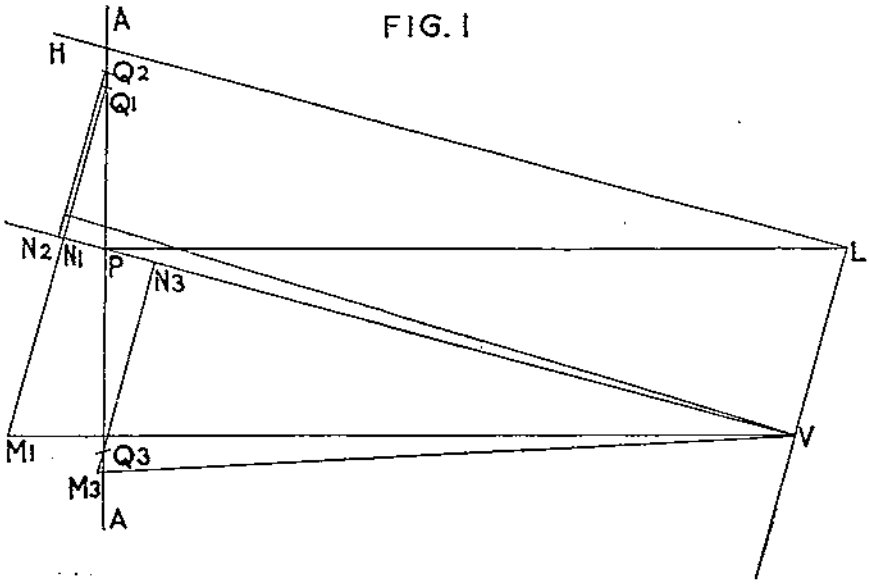
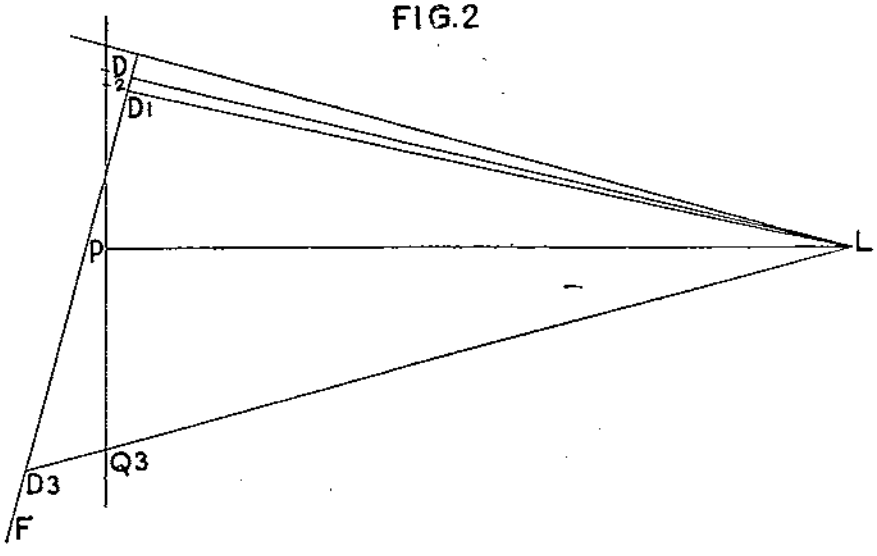


FIG. 2



perpendiculars QQ, etc., are traced through. The "map" radial direction of any point O in the photograph is found as follows :—

In Fig. 1 let VP be the map projection of the principal line.
LH is joined.
VL is at right angles to LH and
VP is parallel to LH.
QN is at right angles to VP and extended to M so that NM equals OQ on the photograph.
VM is joined.

The radial directions of all points being rectified are obtained similarly.

This piece of tracing paper is the radial line plot.

Resection of Plumb Points.—The ground control points are plotted on drawing paper on the scale of mapping. The radial line plot of the first photograph is placed on the map sheet and moved until the radial lines to the ground points pass through their plotted positions. The point V_1 and the line V_1P_1 are pricked on the map sheet. With the radial line plot of the first photograph in position, that of the second photograph is correctly set on the ground points and V_2 and V_2P_2 pricked. The intersection of the radial lines to the minor control points for photograph No. 3 are pricked and the plots removed and the pricked points marked in pencil. This procedure is continued through the strip.

The last photograph will have two positions for its plumb point, one derived through the strip, the other directly from the ground control points appearing on it. The difference of position is distributed through the strip like the closing error in a plane-table traverse.

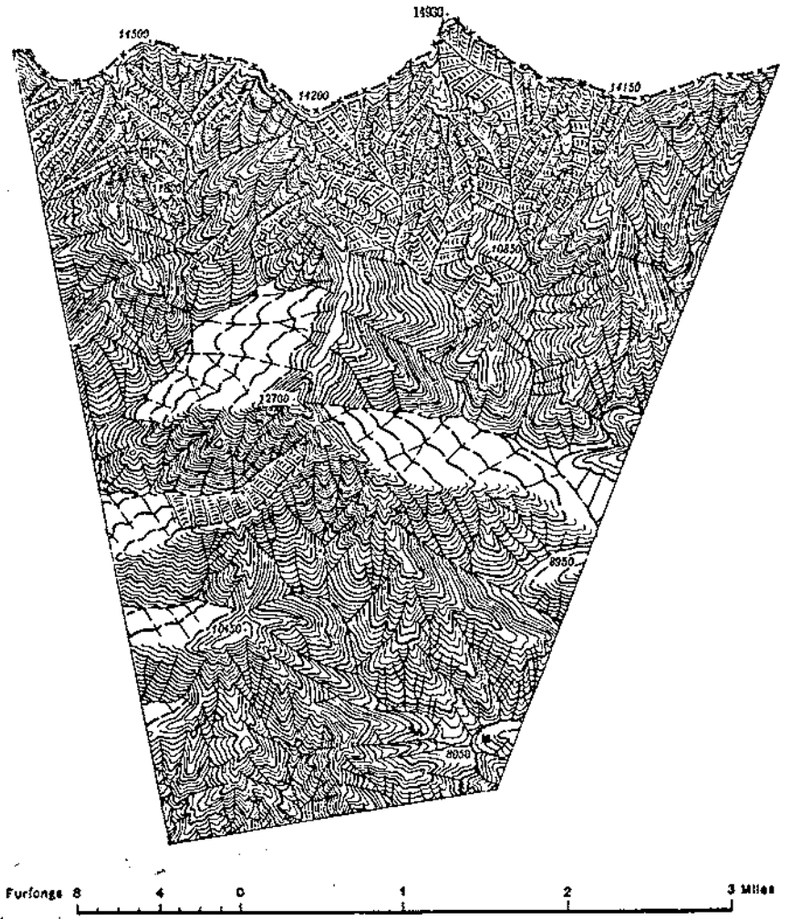
Intersection and Sketching of Detail.—The radial line plots are now fixed in position on the map sheet. Intersection of points of detail and sketching of the remainder is ordinary plane-tabling procedure. Spur lines are normally considered as detail to facilitate contouring.

Vertical Rectification.—The points Q on the photograph have the same height as the object, O. The distance away on the map is obtained by dropping the perpendicular from O on the map on to the map principal line. The tangent depression from the air station is obtained on the radial line plot (Fig. 2) as follows :—

LE is ten inches.
FE is at right angles to LE.
LQ is produced to cut FE in D.
DE is measured in inches and divided by ten to give the tangent depression.

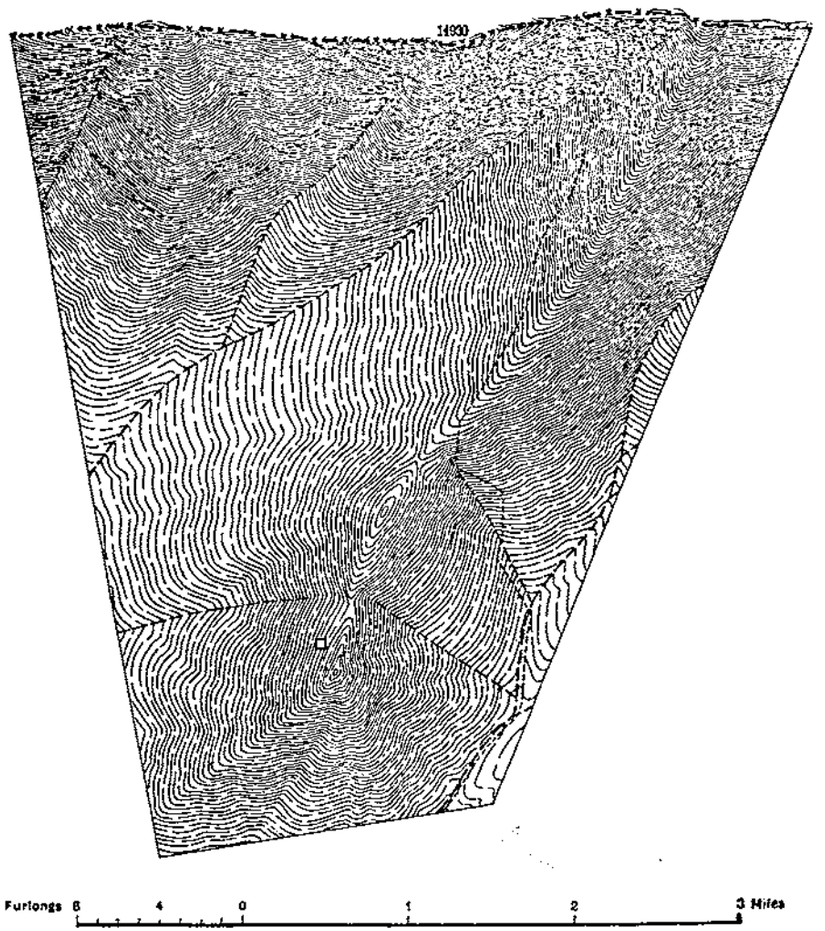
The calculation of the height of the air station from known ground points and of points of detail from the height of the air station then

MAP FROM LATERAL OBLIQUE AIR PHOTOGRAPHS OF AREA IN PHOTO 07345.



PREVIOUS RECONNAISSANCE MAP OF SAME AREA.

Fig. 3.



follows the normal procedure adopted in plane-tabling with the Indian pattern clinometer.

Contouring.—The sketching of the contours between fixed heights is normal plane-tabling procedure.

General.

The actual sketching of detail and contours can only successfully be carried out with the aid of a stereoscope to appreciate the relief of the ground. The aid given by this instrument overcomes to a large extent the disadvantage of working off a distant base with narrow intersections.

The accuracy of fixing of minor control is not high on account of the narrow angle available for intersection and resection (about 30° with the 10-in. lens) and in mountainous country dead ground is bound to occur.

The method does provide a means of obtaining the topography of country not otherwise accessible and its close analogy to ground survey enables normally intelligent ground surveyors to undertake the work with the minimum of special instruction. Out-turns on the first areas allotted to Indian surveyors without any previous training are probably higher than they could have achieved on the ground and the cost is very considerably less.

Fig. 3 shows the final map from oblique photographs of the area covered by the photograph compared with the previous map from reconnaissance surveys.

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THE SUDAN CAMEL STAMP.

By COLONEL E. A. STANTON, C.M.G.

Now for over 35 years in use, the Sudan Camel Stamp came into being under somewhat unique circumstances which may have interest for others besides stamp collectors.

It is not often that a British officer on active service finds himself called upon to design a stamp for use in the country he is engaged upon conquering, more especially as a painting outfit forms no part of an active service kit. Possibly the reason for the honour of having been selected to make a design was due to the fact that, shortly before, I had furnished Headquarters with various desert road reports which I had embellished with pen and ink sketches in the margins to relieve the otherwise drab appearance of miles of rock and sand. These reports evidently met with approval, judging by the official letter of appreciation that I received for my efforts. However little these sketches added to the military value of the maps they, at any rate, proved I had actually reached the wells and points depicted, and had not based my reports on Arab hearsay.

Towards the end of 1896, the Sirdar of the Egyptian Army, Sir Herbert Kitchener, having reconquered the large province of Dongola from the Dervishes, was anxious to have a postage stamp different from the Egyptian ones in use, and instructed his staff to communicate with a British artist then travelling on the Nile with a view to submitting a design. In due course the artist submitted a really beautiful design of the great rock temple of Abu-Simbel, the value of each stamp to appear on the doorway, adding that his terms for the same if accepted were 25 guineas.

Whether it was the 25 guineas, or the fact that this temple was on the fringe of the Sudan boundary, then not demarcated, that did not meet with approval, the design was rejected, and I received orders through Sir Herbert's A.D.C., a personal friend, to send one in instead.

I replied that I would do my best, but could not hope to produce anything as artistic or good as the artist's drawing, and would the Sirdar say what kind of design he required.

The reply stated that the Chief was shortly coming to Korti, where I was stationed with part of Macdonald's Sudanese Brigade, and that on his arrival I was to see him and ascertain his wishes.

" K," as we called him, arrived in due course. The interview was brief. " I want you," he said, " to go on drawing designs till you produce something I like, but remember there is to be no caricature of myself or anybody else on it. Good morning." As I saluted and was leaving he said he was returning in five days' time, when something was to be ready for his inspection.

Three days had gone by and I had not thought of a suitable subject, and my brother officers began tormenting me on my fate if I failed to produce something satisfactory before " K's " return. I really got very worried about the design. Suddenly the mail, several days late, appeared, but not by the usual sternwheel steamer but on a camel, and I was saved!

Being at that time in charge of the local friendly Arabs in addition to my regimental duties, I at once got hold of the Sheikh of the Howawir tribe, made him put on his war kit, and with four sacks filled with chopped straw to represent the mailbags, trot his camel to and fro before me while I sketched him.

On a piece of office foolscap with my one and only rather large paintbrush I produced a drawing of the camel, and further to brighten up its rather dull appearance in sepia, I drew a set of stamps in colours underneath, but my brush being too large for fine work I had to make these some three to four times larger than the average stamp. I also added with a fine pen to the bags the words " Khartoum " and " Berber," the two largest towns at the time in the Sudan, still hundreds of miles away from us and not then conquered, and trusted to luck that this piece of justifiable bluff would not be discovered. Somewhat in fear I approached the great man on his return and submitted my drawing. He looked at it critically for a few moments and remarked, " That's not so bad; that I think will do—Good morning."

Feeling a great relief and load off my mind, I returned to my duties and thought no more about the matter.

In March the following year at Berber, which had been reoccupied, the new stamps suddenly appeared, and to my surprise I found the engravers had not only discovered my piece of bluff, which was faithfully reproduced, but had also actually reproduced the stamps on the large size I had painted my examples for want of a smaller brush, though I fancy the combinations of colours had been slightly changed to fall in with the Postal Union usages.

Feeling distinctly elevated that my design had really been accepted and the stamps produced, I wrote to my friend the A.D.C.* and told him that, although my terms were not 25 guineas, I should very much appreciate a set signed by Sir Herbert Kitchener to the effect that I had designed them. The reply when it came made me burst with laughter; whether my friend " Jimmy " was pulling my leg or not history has never revealed, for it stated: " ' K ' says certainly, old boy—provided you pay for the stamps "!!

However, very shortly afterwards I duly received a complete set signed by Sir Herbert Kitchener that they were designed by myself, and so far as I am aware their value, some 4s. 6d., was never deducted from my pay. I still have them.

* Colonel Jimmy Watson Pasha, C.M.G., D.S.O., etc., at that time Bimbashi Watson of the 60th, attached to the Egyptian Army.

MOVEMENT OF PONTOON BRIDGING.

By COLONEL H. N. NORTH, D.S.O., *late* R.E.

FOR many years past efforts have been made to discover a suitable site, within the Northern Command, at which pontoon bridging could be carried out by the R.E. units (Regular and Territorial) in the Command.

An excellent site was found on the River Trent, which had the additional advantage of being next door to the Ordnance Depot at Chilwell, where the bulk of the equipment was stored.

The Trent Navigation Board, while unofficially favourable to the scheme, found themselves, as statutory custodians of the public right of unrestricted navigation, obliged to enter an official objection and in consequence a fresh site had to be found.

The River Ouse, though geographically well placed, is not an ideal river for the purpose, but a possible site was found at Moor Monkton, about seven miles N.W. of York.

The first problem that arose was the transport of the equipment from the Ordnance Depot at Chilwell to this site, seven miles from the nearest station capable of handling such stores. Access by road involved passage over a rough farm track, and three hundred yards of meadowland.

There were several possible alternatives :—

(*a*) by rail and road,
(*b*) by road only,
(*c*) by water only (Trent–Humber–Ouse),
(*d*) by combinations of the above.

Expense was a ruling factor and concerned the R.E., because the training grant had to bear a proportion of the cost.

Various quotations were obtained by the R.A.S.C., and a comparison may be of interest :—

(*a*)	Rail and road	£56
(*b*)	Road only	£98
(*c*)	Water only	£78
(*d*)	Rail, water and road, as carried out	£50

The decisive factor in the selection of rail transport was an offer by the railway authorities to off-load direct into the river. This

had, in fact, been considered before, but as the only suitable places were railway bridges it was thought that traffic considerations would rule these out. However, the railway authorities found themselves in a position to make the " Scarborough Bridge " available between 4 a.m. and 8 a.m. on Sunday mornings, and the off-loading was planned accordingly. This bridge crosses the River Ouse in two " through " spans quite close to the York Railway Station. It carries a double line of railway at an average height of 28′ 6″ above summer river-level. A group of telegraph wires 10′ 6″ from the upstream girders and about level with their top flanges offered a slight complication.

The handling of the superstructure needs little mention. The final transport over the meadowland had to be by ordinary Morris 6-wheeler, which is not a suitable vehicle for road bearers.

The handling of the pontoons was more interesting. Owing to the fact that after 8 a.m. intensive seaside holiday traffic began, it was essential to eliminate all possible causes of delay. Fortunately the railway side of the job was under the direction of Captain J. R. Sadler, R.E. (S.R.), whose war service had accustomed him to working with soldiers. Actually the railway were responsible for all handling until the pontoons touched the water, when the Army, who were also responsible for avoiding interference with navigation, took over charge.

The preliminary preparations were as follows :—

(*a*) A small staging was erected on the cut-water of the centre pier capable of accommodating two men.

(*b*) All lashings used for securing the pontoons to the trucks while in transit were cast off.

(*c*) Trials were made with one pontoon to ascertain the exact positions for fixing the slings in order to ensure the pontoon remaining strictly horizontal—these positions are shown in the sketch.

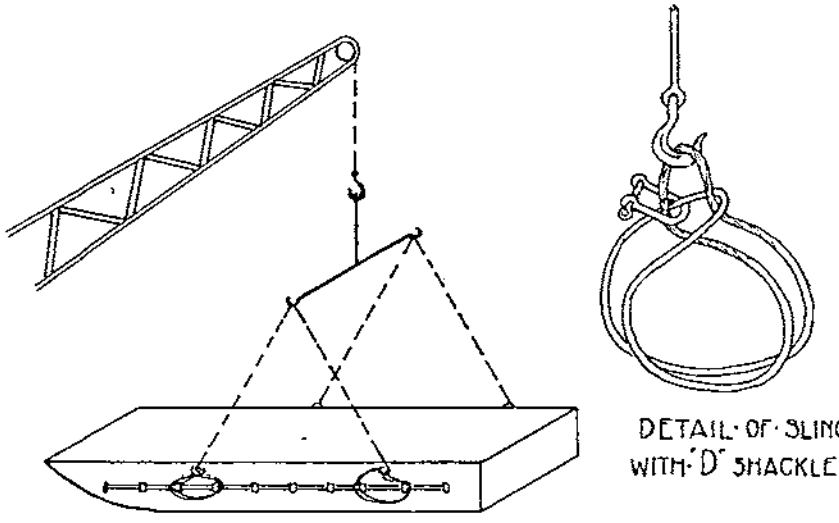
(*d*) Breast lines were fixed to three pontoons fore and aft of sufficient length to reach from the bridge to water-level.

On the day selected (July 31st), a detachment of 1 officer and 18 N.C.O's and Sappers left camp at 3.30 a.m. and arrived at the bridge at 4 a.m. A railway steam crane (of the ordinary type used for minor breakdowns) was run on to the upstream line, while the train carrying 16 pontoons was run on to the downstream line with the last truck under the crane. Slings were attached to the first two pontoons as indicated in (*c*), and, at 4.20 a.m., there being sufficient light, work started. A " spreader " 7′ in length with two chains and hooks at each end was used on the crane hook itself to obviate any danger of crushing the pontoons inwards. Each pontoon was suspended at four points by four 2″ slings 14′ long, and each

sling was passed round two of the points of attachment of the hand-rail to the pontoon—the sketch shows this method of suspension.

The weather was fine but misty, a wind of about 15 m.p.h. was blowing downstream, *i.e.*, tending to blow the pontoons against the bridge ; and the river, slightly swollen by recent rain, was running 2½ knots.

As each pontoon was lifted over the bridge parapet it was first steadied ; the breast lines were then thrown down to the men on the cut-water and the river-bank respectively, and lowering proceeded. When it touched water four men boarded it and cast off the slings.



The pontoon was then towed by hand fifty yards upstream and formed into a raft (without superstructure).

The slings were passed up to the line of trucks and fixed to the third pontoon while the second was being lowered.

The work proceeded with absolute regularity and without the slightest hitch, and was actually completed in considerably less than half the time available. From the detailed time-table given below, it will be seen that in this system of loading or unloading a rate of one pontoon per five minutes can be relied upon.

In the loading up (which was an exact reversal of the process described above) the only difference was that the slings were provided with shackles, to obviate the risk of the slings falling into the water after they had been placed in readiness on the pontoons.

The raft was formed by coupling the pontoons, lashing them together, three abreast, by the handrails ; the second row of three such coupled pontoons being lashed by their bow bollards to the stern bollards of the first row, this lashing being tight ; that is to say,

the bows of the second row of pontoons were chock-a-block with the sterns of the first row.

The "prime mover" for the tow was a pleasure motor-boat, petrol-driven, of 30 h.p. nominal. During the tow, the raft was manned by men with boat-hooks, to fend-off if it were required. This proved to be unnecessary, although there were some fairly sharp bends in the stretch to be navigated. It is noteworthy that the tug-master insisted on the chock-a-block lashing of the raft, with this object in view; so that any tendency to swing on the part of the rear pontoons would be checked by the closeness of their packing.

While the occasions in war on which a suitably-sited railway bridge will be available are necessarily limited, the ease and speed with which pontoons can be so launched is worthy of note.

Where the approaches to a desired bridge site are difficult, it has the advantage that launching and making into raft can proceed simultaneously with work on the former, and it avoids congesting the road with the empty pontoon lorries and trailers.

Such employment presupposes the possibility of a safe passage from launching point to bridge site. If all these conditions be necessarily infrequent of attainment they are not unknown, and the possibility of taking advantage of them is, perhaps, worthy of attention.

Unloading.

31*st July.*	4.20 a.m.	—Crane and train in position on bridge.
	4.25	—1st pontoon in water.
	4.39	—2nd pontoon in water.
	4.43	—3rd pontoon in water.
	5.36	—16th pontoon in water.
	6.13	—Tow ready.
	6.18	—Tow under way (upstream current 2 knots).

The interval between the unloading of the last pontoon and the tow being ready could have been less, in that an experiment in the reverse process of loading from water to rail was carried out.

Loading.

14*th Aug.*	4.42 a.m.	—1st pontoon lifted.
	4.53	—2nd pontoon lifted.
	4.59	—3rd pontoon lifted.
	5.02	—4th pontoon lifted.
	5.51	—16th pontoon lifted.

ACHORUTES VIATICUS.

By MAJOR G. MACLEOD ROSS, M.C., M.ENG., A.M.INST.C.E., R.E.

THE raw sewage from all War Department buildings at Catterick Camp is dealt with at a sewage disposal plant working on the artificial bacterial method, situated at Colburn. The liquid sewage, after treatment in the sedimentation tanks, is led to the two filter-beds, distribution being by means of four automatically-operated sprinklers. The effluent is subsequently evacuated to the River Swale, and since this is a fishing river of some note, it is essential that the high standard of purity of the effluent should be maintained.

Now the limiting factors in purification works of this type are the capacities of the sedimentation tanks, and the bacterial filter-beds; the rate of flow being regulated to prevent their overtaxing.

In this case the combined capacity of the four filters which distribute the sewage over the surface of the filters is 35,000 gallons per hour.

This rate of flow is, of course, ample for all normal sewage demands, but it so happens that there are still some very serious leakages of surface water into the foul drainage system, with the result that after heavy rainfall it is usual for the capacity of the plant to be exceeded, and recourse has to be made to bypassing a proportion of the very weak sewage to prevent the aerobic micro-organisms being washed out of the filters.

In April, 1931, it was noticed that "ponding" was occurring on the filter-beds. The expression "ponding" refers to the large puddles of liquid sewage which gather on the surface of the filter-beds, indicating that the pores or interstices between the media of the top layer in the filters have become clogged up. This clogging is effected by a species of fungous growth, and as it becomes more and more aggravated, so is the flow through the filter lessened, and the capacity of the sewage plant as a whole reduced. Owing to the fact that the Colburn filters were often required to work at capacity, coupled with the desire to bypass as little sewage as possible, it became evident that active steps must be taken to clean the filters. An estimate was prepared for digging out the whole of the media from the two filter-beds, one at a time, cleaning and replacing it. As, however, the estimated cost of doing this was over £1,000, it was decided to try and find some other method of dealing with the trouble.

The difficulty was reported to Mr. W. C. Tyndale, who for so many years past has been guide, philosopher and friend to every Royal Engineer officer on matters pertaining to sanitation and water supply. Mr. Tyndale replied by sending a copy of a small book dealing with the inoculation of filter-beds with insects known as *Achorutes Viaticus*—the part-author of the book being Mr. H. D. Bell, F.I.C., F.C.S., of Barnsley. These insects have a particular affinity for the fungus responsible for the clogging in bacterial filter-beds, and when suitably introduced on to the surface of the filter-bed, eat away the fungus and so keep the filter clean and clear of obstruction. Although the media of a bacterial filter-bed form such an admirable habitat for the propagation of these insects, it is interesting that they are only found native in certain parts of the country, and consequently it is usually necessary to obtain a colony of eggs and adult insects in the first place, after which there should be no difficulty in maintaining them for an indefinite period.

For a very moderate fee, about 1-200th of the cost of mechanically cleaning the filters, Mr. Bell sent down particulars of the construction and working of a suitable experimental filter, in which the propagation of the *Achorutes Viaticus* could be accelerated. The photograph shows the filter erected alongside one of the filter-beds at the Colburn Sewage Works, Catterick Camp. The one constructed was a double filter to increase the rate of propagation.

Each filter consists of two twelve-inch glazed stoneware drain-pipes filled with suitably graded clinker. The clinker is retained in the pipes by means of a perforated tile or slate set at the bottom of the lower pipe. Below each set of drainpipes are four wooden boxes with perforated bottoms, filled with media from the filter-beds. Above the pipes stands a tank containing fresh liquid sewage as delivered to the filter-beds, which is led to the top of each pair of drainpipes, the flow being regulated by cocks.

It is important that the rate of flow, which is small, should be carefully regulated, since the insects must not be washed out of the clinker. An initial rate of flow is maintained for a few days, after which it is reduced.

On arrival of the *Achorutes* from Barnsley, the clinker in the drainpipes was first thoroughly wetted by drippings of liquid sewage. Portions of the *Achorutes* nucleus were then carefully placed in the clinker at the top of each pipe. The regulated drip of sewage was then begun for specified periods each day for about four weeks. At the end of this period the top box of media was carefully removed from beneath each filter, and its contents deposited in a prepared hole dug in the surface of the main filter-beds. The spots chosen were those at which "ponding" was worst. The boxes having been provided with sliding bottoms, their contents could be deposited with a minimum of disturbance to the *Achorutes* they

now contained. The contents of each box was sufficient to inoculate an area of 10 feet radius.

Subsequently, the empty boxes were refilled with media from the filter-beds and were then placed in their respective experimental filters immediately below the fourth box down. This resulted in the second box being raised to a position of more intimate contact with the liquid sewage percolating through the drainpipe portion of the filter.

At the end of a further week, a regulated drip of liquid sewage having been continued throughout the period, boxes number two from each filter were removed and their contents planted in suitable spots on the main filter-beds. From this point onwards the cycle of operations was continued at weekly intervals, until a sufficient number of spots had been inoculated on all three main filter-beds.

The first two boxes were transferred to the filter-beds about August 15th, 1931, and in six weeks' time a great diminution in "ponding" was noticeable over the areas which had been treated at that date.

At the conclusion of one year's inoculation, the whole of the three filter-beds had been completely freed from "ponding." To-day, almost exactly two years since the first box of media was deposited, the beds remain clear and are working to full capacity. As far as can be ascertained, the *Achorutes* are now firmly established and the need for further propagation in the experimental or incubator filters has disappeared.

As will be appreciated, this short description necessarily omits many essential details as to dimensions and procedure, which are the copyright of Mr. Bell. It is desired to acknowledge his great courtesy in permitting the publication of this general account, and at the same time to recognize all the prompt assistance and interest he showed throughout the operation of a most successful experiment, which was instrumental in saving the taxpayer close upon one thousand pounds.

In conclusion, it is hoped that this account of experience gained at Catterick may serve to assist in the solution of similar problems at other W.D. sewage plants.

Experimental Filter for the propagation of *Achorutes Viaticus* at Colburn Sewage Plant, Catterick Camp.

Achorutes Viaticus

THE BRIDGING OF THE ADOUR, FEBRUARY, 1814.

By COLONEL L. CHENEVIX TRENCH, C.M.G., D.S.O., *p.s.c.*

(*Numbered references appear on p.* 506.)

AT the close of the Peninsular campaign, in December, 1813, Wellington crossed the Spanish frontier and established himself on French soil. His headquarters were at St. Jean de Luz, and his army extended from the coast about Biarritz to the river Joyeuse 15 miles inland.

Until the winter rains should end neither side could move: mud was master.[1]

The great "Route Royale" into France led away to the north, crossing the River Adour by a permanent bridge at Bayonne. This place was a first-class fortress and contained a garrison of 13,660 men, including an excellent fighting division under General Abbé. The rest of the garrison was composed of second-rate troops, but behind the strong permanent defences, on which a great deal of work had been done during the last four or five months, even second-rate troops could be expected to give a good account of themselves. General Thouvenot was the governor. The greater part of the town and its defences lay on the left bank of the river, but on the right there was a strong work, known as the Citadel, sited so as to protect the northern side of the town.

The capture of Bayonne was an essential part of Wellington's plan for the invasion of France, but first of all he had to drive away the French field army under Soult, so that operations against the fortress could go on without interference. On the 12th February, therefore, he moved with the greater part of his forces against that commander, leaving 18,000 Anglo-Portuguese and 16,000 Spaniards, under Sir John Hope, to deal with Bayonne. On the 19th February, Soult having been pushed right back, Wellington returned to St. Jean de Luz to see how his plans for crossing the Adour and completing the investment were progressing.

THE PLAN FOR THE RIVER-CROSSING.

On the 7th February Wellington had written to Admiral Penrose, who was co-operating with him by sea, as follows[2]:—

"St. Jean de Luz,
7th Feb., 1814.

"SIR,

"Upon considering all the different modes of carrying on our operations, and of having a communication across the Adour, it

has appeared to me that that which is most practicable and will in its result be most beneficial, is to establish our bridge below the town.

"The consequence of adopting this measure will be, that we shall have the immediate use of the harbour; and we shall have a better road of communication with it from this side, and one equally good from the other.

"I propose that our bridge should be constructed of vessels of from fifteen to thirty tons burthen, two masted, and each well ballasted, and provided with anchors and cables, to be anchored by head and stern, of which I have ordered the Commissary General to provide forty; and I will be very much obliged to you if you will aid Mr. Wright, of the Commissariat at Passages, with your influence to provide these vessels, in case he should require it. The owners of them will be hired for the service of the Commissariat for the moment, and will be sent round here with cargoes of supplies.

"I propose to lay cables across these vessels from bank to bank, which we have reason to believe is an extent of 400 yards; and on the cables we shall tie the planks, with which we are in a great measure provided.

"I shall be obliged to you if you will assist us in getting from the transports at Passages ten cables, of $4\frac{1}{2}$ inches diameter, which I should likewise wish to have sent round here.

"We shall besides require a few small boats, etc., about which I should conceive there would be no difficulty.

"The mode in which I should propose to perform this operation is as follows:—

"On the day that all our preparations shall be completed, I shall move our pontoons to the Adour, with which I shall make rafts to send over a sufficient body of men to get possession of the work on the right of the river, and thus give you the free entrance; and I will establish a battery of heavy guns, with red hot shot, on the left of the river against the frigate, with which I hope to set her on fire.

"I should propose, then, that your gun boats and other craft should enter, and that they should anchor above the spot intended for the bridge, in order to cover its formation. They should be followed by the vessels intended to form the bridge, each loaded with its proportion of plank, etc.

"As soon as the gun vessels and craft have been anchored, I should propose that they should form a boom across the river ahead of themselves, in order to cover themselves and the bridge from any attempt the enemy might make to destroy either by fire.

"The mode in which I should propose this boom should be

formed is of spars, of from fifty to sixty feet long, attached to each other by chains, if they can be got; if not, by cable, leaving an interval between each spar of about ten feet. We calculate the breadth of the river above where we shall place the bridge at about 520 yards, and we ought properly to have about 600 yards of boom anchored by six anchors; that is to say, thirty lengths of boom and chain or rope.

"We shall endeavour to make here ten lengths of the boom; and I shall be very much obliged to you if you will have the other twenty lengths made at Passages. These would be carried by the gun vessels and craft.

"For the anchors of the boom six small cables or hawsers will be required, which I shall be obliged if you will get out of the transports.

"I send Major Todd over with this letter, who will explain to you the want of a few blocks, etc., for purchases, which, however, I hope there will be no difficulty in supplying.

"It is very desirable that we should perform this operation as soon as possible after the preparations shall be completed, which I hope will be by the time that the next fair weather shall enable us to navigate the coast with small vessels.

"I have the honour to be &c.,
"WELLINGTON."

There seem to have been no special measures to secure secrecy, except an order by Wellington to Colonel de Lancey, his A.Q.M.G., to stop all communication between the inhabitants of St. Jean de Luz and Bayonne from the 13th February, "without making a piece of work about it."[3]

The use of the "Chasse-marées" as the local boats, of which the bridge was to be made, were called, for carrying cargoes of supplies, was probably as much a measure of economy as of deception, though it may have served the latter purpose to some extent. On the other hand, Wellington had allowed himself to be observed by the French while making a reconnaissance of the site of the bridge on the 23rd of January.[4]

The river was, in fact, only 260 yards wide at the site of the bridge, not 400 yards, as estimated by Wellington. The difficulties in getting a correct estimate of the width of a river, when conditions do not permit of actual measurement, are no less now than they were then.[5]

The current was very rapid, especially during the spring tides, when it sometimes reached to as much as seven miles an hour. The rise and fall of the tide was up to fourteen feet.

Between the town of Bayonne and the mouth of the river there

was about five miles of water. Over part of this the river was confined between stone walls, built with a view to increasing the current and so sweeping away the bar, which constituted a great danger to shipping. The walls were fourteen feet thick and stood about the same height above low water. On the left bank the sand dunes came up level with the top of the wall for the greater part of its length, but on the right bank the ground behind the wall was of nearly the same level as low tide, and was flooded to a depth of several feet at every high tide. It was at the point where these walls came closest together that the bridge was to be made.

The bar which obstructed the mouth of the river was a very serious obstacle. Even in calm weather the surf was such that no small undecked vessel could cross without grave danger, and if conditions were at all unfavourable it was impassable without the most skilful navigation and the guidance of the landing marks set up on shore. These, of course, had been removed by the French. Admiral Penrose's reports are full of references to the " vile bar."

The right bank was, for the most part, overlooked by the left, and a bend in the river hid the site of the bridge from the town, though it could be seen from the top of the cathedral.

Wellington, as has been seen, estimated the width of the river at 400 yards, and ordered 40 boats. It looks as if he had omitted to allow for casualties, for when subsequent estimates of the width put this at only 300 yards, the number of boats was increased to 48.

They varied in size from 30 to 50 tons ; the larger were 53′ long, 15′ 4″ in the beam, with the deck 3′ 10″ above water-level. The smaller were 40′ long and 10′ 2″ in the beam.

They were organized in five divisions, each under a Sapper officer, while each boat, beside its crew of native fishermen, carried two Sappers and the following stores :

28 three-inch planks, twelve feet long, for use as chesses. These were got by cutting up the siege-gun platforms.[6]

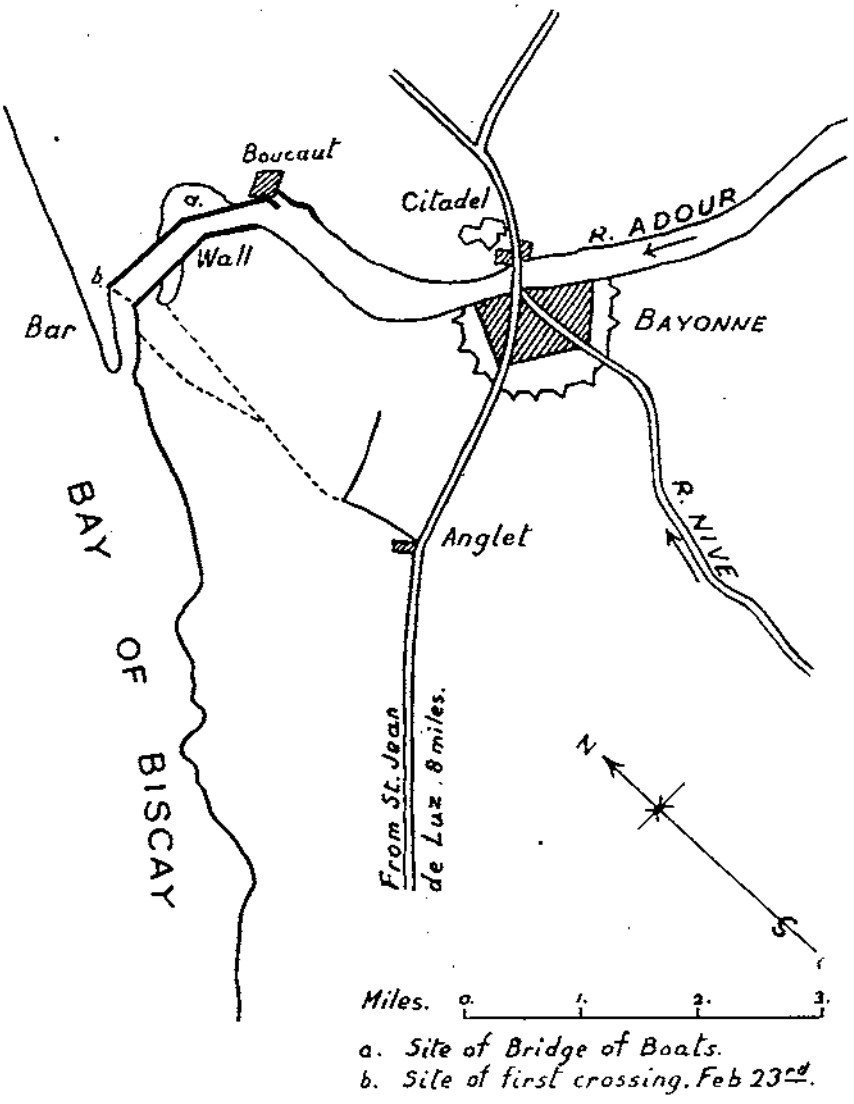
One baulk 10″ square, with five grooves cut in it to receive the five cables and keep them at the proper distance apart. This baulk was to be spiked down to the deck of the boat.

Two hand-saws ; two axes and two " skeins " of hambro line for lashing the planks to the cables.

The five great road-bearer cables were embarked on the boats, which were to be placed in the middle of the bridge, and coiled so that they could be paid out in both directions at once. They were served with green bullock hides to protect them from chafing at points of friction.[7]

The whole flotilla was placed for navigation under the command of Captain O'Reilly, R.N., and was to be escorted by Admiral Penrose in the frigate *Porcupine*, with the brig *Lyra* and five gun boats.

All were collected in the harbours of St. Jean de Luz and Socoa, twelve or fifteen miles down the coast from the mouth of the Adour, by the time Wellington came back on the 19th February from driving off Soult.



The Crossing.

A strong wind was blowing, which held all the flotilla fast in harbour. So rough had it been that the entrance to the Socoa harbour had been blocked by shingle, which the Guards had had to clear away at low tide.

On the 20th things were no better ; on the 21st Wellington decided that he could not stay any longer, so, leaving the whole operation to the care of Sir John Hope, he rode back to where the rest of his army lay facing Soult.

Sir John Hope was a man of exceptional physical courage, but was unable to resist joining personally in any fight which might be within reach. Already he had given Wellington anxiety on this account.[8]

He was, perhaps, of a nature somewhat rash for the control of an enterprise such as this, in which time, tide and the elements were his most formidable enemies. Thanks, however, to the good fortune which favours the brave, he did succeed in circumstances which would have deterred a more prudent commander.

On the afternoon of the 22nd the wind fell sufficiently to allow the flotilla and the escorting warships to leave harbour and put to sea. At 1 a.m. on the 23rd Sir John moved his troops forward, with a view to establishing a bridgehead on the right bank before daylight.

For the passage of the troops composing this bridgehead he had five small rowboats borrowed from the fleet, each capable of taking six to eight men, and twelve pontoons, of which six were at hand and the remainder on the road to join him. The pontoons could be used either as rafts or as single boats, but were not very seaworthy.

As the British were already almost in touch with the Bayonne outposts, they did not have very far to go before reaching the river, but, as is usual in night marches, things went wrong from the start. The pontoon wagons stuck in the sand, and a gun, upset in a ditch, blocked the road for a long time, with the result that it was long after daylight before even the left bank of the river was gained. The spot selected for the initial crossing was quite near the mouth of the river and below the retaining walls, which, of course, would have prevented the use of boats and pontoons. Wagons could not get within 500 yards of the water's edge, so their loads had to be manhandled for that distance, which caused more delay.

Farther upstream, opposite the village of Boucaut, lay a French corvette and a number of gun boats. These were driven off by a battery of 18-pdrs. and did not appear again on the scene.

It was not till 11 a.m. on the 23rd that the first wave of fifty men in boats was ready to cross. By great good fortune a French battalion and battery posted on the right bank, had been withdrawn on the previous day, and there remained nothing but a small patrol, which fell back without firing a shot. Advantage was taken of slack water to pass a cable over the river and form pontoon rafts, worked to and fro along it. It was a risky business, which could not have been carried on in the face of even weak opposition, but all went well till the strength of the ebbing tide made the rafts unworkable. They were then broken up into single boats again, and the crossing went on as best it could.

By the end of the afternoon some 700 men were safely over, though more than one pontoon had narrowly escaped being swept down into the bar. Now at last the French began to show some signs of life, and a column of about 1,100 men came out from the Citadel to attack those companies of the 60th Rifles and the Guards which had got over. They were received with a salvo from the new-fangled rockets, and with artillery fire from the left bank of the river, which so shook them that they only sustained a short exchange of musketry before breaking off their attack, and making their way back to the Citadel.

All accounts, whether French or English, condemn the Governor for his inaction during the 23rd. The orders which he gave to General Maucomble, who commanded the 3,000 men in the Citadel, were, "To take two battalions and reconnoitre the forces which have crossed, to act according to their strength and position, without compromising the troops necessary for the defence of the Citadel, or exposing them to the risk of being cut off."

Such orders were not likely to produce any very vigorous action. Maucomble, who marched out at 6 p.m., was back again by 8 p.m. with the report that he had encountered 2,000 of the enemy.[9]

The ensuing night was fortunately calm and moonlit, though bitterly cold, and the crossing went on without interruption, in spite of the difficulties of the current. By daylight on the 24th many more troops were over and the situation was not quite so precarious. An even greater relief for Sir John Hope was the sight of the flotilla waiting outside the bar for an opportunity to come in.

Crossing by boat and raft, however, could not be discontinued, since the construction of the bridge was certain to take a long time. It, therefore, went on till, by the morning of the 25th, there were 5,000 troops across, and a move could be made to complete the investment of the northern face of the fortress.

The Construction of the Bridge.

As soon as the flotilla appeared, and Admiral Penrose saw what the situation was, he attempted to get into the river without waiting for conditions, which were very unfavourable, to improve. The first boat, steered by Captain O'Reilly, was capsized and several of its crew drowned. O'Reilly himself was pulled ashore stunned but alive. As soon as he had recovered he took his boat to help in the ferrying. Meanwhile two other boats had got in without mishap, and the channel was fairly well established. The state of the tide, however, now made further attempts too dangerous, and they had to be suspended till later in the afternoon, when the Admiral judged that he could order the *chasse-marées* to go in. A boat from the *Lyra* under Mr. Boyle, the master's mate, led them. It was at once capsized with the loss of all lives, but the others were not deterred.

Before darkness stopped operations, all the *chasse-mareés*, except 12 which could not get over in time, and two which were wrecked, were ready to take their places in the bridge next morning. In all about forty lives were lost in crossing the bar, but Admiral Penrose says that he expected more than that, and would not have attempted going in if he had not seen for himself how necessary it was.[10]

Next morning, the 25th, bridge building began. Owing to the fact that some cables were contained in the missing *chasse-marées*, there was a little delay, which was increased by the difficulty of anchoring the boats in the strong tide. In some cases the strain on the anchors was so great that 18-pdr. guns had to be used to reinforce them.

The mooring of the boats was done under the direction of Lieut. Collins, R.N., and as soon as all was ready the road-bearer cables were paid out from shore to shore. On the left bank, where the sand came up to level with the top of the retaining wall, an elaborate anchorage was fixed. It consisted of a wooden frame 32 feet long and 14 feet wide, sunk three feet below ground-level and weighted down with sandbags. Five tackles, one for each cable, were rigged so that they could be taken up and paid out by capstans. In this manner it was hoped that it would be possible to deal with the rise and fall of the tide, and after some difficulty at the outset, the plan was found to work fairly well.

On the right bank a very simple method of making fast the cables was adopted. They were each lashed to two 18-pdr. guns, which were then thrown over the stone wall into the marshy ground on the far side.

On the walls, as on the boats, the cables were served with green hides to protect them from chafing.

The approach to the bridge on the left bank presented no special difficulty because the sand came up level with the top of the wall. On the right bank, however, the wall itself had to be used as a roadway, which traffic had to follow for about half a mile upstream, before it could get off on to the ground.

Owing to the fourteen-foot rise and fall of the tide, vehicles and animals could only cross at or near high tide, when the bridge came nearly up to the level of the top of the walls.

The Chief Engineer, Lieut.-Colonel Elphinstone, had promised that the bridge should be finished by the evening of the 26th. Colonel Jones says it was done by noon on that day,[11] but Sir John, in his dispatch to Wellington, [12] reported that it was opened to traffic on the morning of the 27th. Both may be right.

By the same time the boom was moored in position, and batteries placed to deal with any fire-ships which the French might send down.

The Completed Bridge.

When the bridge was finished it was found that the width of the river was only 260 yards, and that 26 *chasse-marées* were enough to reach across. For some time after completion the cable road-bearers continued to stretch, and dipped so much that, at times, waves washed over the bridge, and stopped traffic, but with stronger capstans they were hauled so taut that the bridge was always passable except in very rough weather, when the pitching of the boats made it unsafe.

Hostilities ceased in the middle of April, without the French making any attempt to attack the bridge by water, but the possibility of such an attack was a constant source of anxiety to Sir John and his naval advisers, who arranged an elaborate system of signals to give warning of danger.

Soon after the Armistice, a cut was arranged in the bridge to allow the shipping which had accumulated in the mouth of the river to pass up to Bayonne. It is not easy to see how this was worked. According to Captain Batty,[13] " The cables, forming the support to the planking of the bridge, were cut in the middle, and, by pulleys being attached to them, all the objects of a drawbridge were accomplished, one of the *chasse-marées* weighing anchor and dropping astern the others to admit the passage of vessels up to Bayonne."

Soon afterwards the cables were replaced by baulks, got from the boom and the local pinewoods. These baulks allowed the number of *chasse-marées* to be reduced to 19, and the daily cost of their hire from 123 to 72 pounds a day, with a proportionate reduction in the number of rations issued to the crews. Wellington had to think of money all the time, and 50 pounds a day was a serious matter to him.

The bridge remained in constant use till it was dismantled on the 18th May.

The actual siege of Bayonne was not pushed with much energy, probably because it was thought that if peace did not soon bring operations to a close, then the garrison would be forced by hunger to surrender, without the loss of life inevitable if an assault were made. The only incident of importance was the inexplicable sortie by the French, after it was known, at any rate unofficially, that peace had been concluded. This was a savage affair and resulted in 1,600 casualties on both sides and the wounding and capture of Sir John Hope himself. As usual he could not keep out of the fight, more especially when it was probably the last chance he would get for a long time.

Remarks on the Operation.

1. The first thing which appears from the accounts of the operation is that the French did not show their true form. Had they

done so, there were plenty of chances for them to have nipped the whole thing in the bud, or, if they had allowed it to continue, to have inflicted a sharp defeat by attacking those who had crossed before they were strong enough to maintain themselves.

There is not much to show how far Wellington or Sir John counted on the passivity of Thouvenot. In his first report to Wellington, Sir John admitted that he felt he was incurring considerable responsibility in attempting the crossing without the expected naval co-operation,[14] and on the 25th he wrote to the Q.M.G., "it was at first, you may be assured, rather a nervous operation."[15] Nobody will disagree with him. With an enemy nearly 14,000 strong in a strong fortress less than four miles away, able to cross the river at will, Sir John divided his forces by an obstacle which precluded one part from helping the other for hours together. He may well have been nervous. However, Wellington never blamed him.

2. The initial crossing, even though it was unopposed, was something of a feat in the conditions of wind and tide. Getting the cable across the four hundred yards of swift current which had to be faced at the place where the ferry was worked, cannot have been very easy. No steel wire ropes were to be had in those days, and the drag on the hempen cable must have been very strong.

3. No accounts mention any co-operation by the navy in this first crossing, until Captain O'Reilly and his half-drowned crew from the capsized boat, lent their aid. If the whole of the first part of the crossing was done by Sappers, they must have been uncommonly fine watermen. Lieut.-Colonel J. F. Burgoyne specially mentioned a small corps of Portuguese pontoneers under Lieut. Tapp, R.E.[16]

Most probably they were selected men, for no landsmen, unless exceptionally well trained, could hope to be of much use on waters such as those of the Adour.[17]

4. The use of cables as road-bearers was a favourite device of Lieut.-Colonel Sturgeon, who, under Lieut.-Colonel Elphinstone, was responsible for the design of the bridge. He had used it successfully at Alcantara and Almaraz, and employed it here partly because he was short of suitable timber, and partly with a view to allowing for the rise and fall of the tide. As at Alcantara, special precautions were taken to protect the cables against chafing.

5. In the whole operation, nothing is more remarkable than the manner in which the crossing of the bar was effected. All accounts agree as to the formidable nature of this obstacle; even in calm weather there was a heavy surf and in rough weather it was almost impassable. At the time of the entry into the river there appears to have been a good deal of wind, and casualties among the navy's boats were heavy. The feelings of the two Sappers in each *chasse-marée* cannot have been very pleasant. They had been tossing about in the

Bay of Biscay for 36 hours in small fishing boats with native crews, possibly hostile and certainly not very sympathetic, and they had seen the sailors wrecked. Then they had to face the bar themselves. Seasickness alone must have been a great ordeal. Admiral Penrose generously acknowledged their services in his dispatch of the 25th February, in which he wrote, "That so many *chasse-marées* attempted the experiment I attribute to there having been in each boat two or more sappers, and a captain and eight Lieutenants of Engineers commanding them in divisions. The zeal and science of these Officers triumphed over the difficulties of the navigation, and I trust none of their valuable lives have fallen a sacrifice to their spirited exertions."[18]

6. The whole operation is a fine example of co-operation between the army and the navy. Whatever Wellington's relations with other naval commanders on the coast of Spain and Portgual may have been, with Admiral Penrose they were always frank and cordial. The results were very happy; regardless of conditions or consequences, as soon as the Admiral saw that the army was in a ticklish position he decided to risk the bar and its dangers, without any further delay. Though his decision cost a good many lives, it very likely saved the army from a very bad time.

7. It is doubtful if a bridge to carry "medium" loads could be improvised, under modern conditions, across such a river as the Adour, without the expenditure of far more time than was required in 1814. It could be done, much as Elphinstone and Sturgeon did it, but it would take time. With "consuta" equipment a bridge could be made a great deal more quickly, especially if steam or petrol launches were available; but it would probably be more liable to interruption by bad weather than the *chasse-marée* bridge, because it would be closer to the water.

Getting on and off the bridge would still be a difficulty. Taking the fall of the tide at fourteen feet, there would be a drop to the first trestle of at least seven feet, *i.e.*, one in three, at low tide. Even with a 60-foot light box girder out to a heavy raft, as the first bay, there would be a drop of one in five. It would, therefore, be necessary to control traffic very strictly and only to allow wheels to cross at or near high tide.

Getting off the bridge on the right bank would be difficult, owing to the cramped space available for turning on the top of the wall. Probably either a turning space would have to be built up, or a causeway continued over the flooded ground beyond the wall. Either would take time.

On the other hand it would not be necessary to bring material round by sea because, if the bridge was to carry medium loads, the pontoon wagons would be able to get up to the site.

With the increase of modern loads, improvisation gets more and

more difficult, but it will still be necessary at times, and whether it is or not, watermanship will always be in demand. Conditions exactly like those on the Adour are not likely to occur again, but others just as difficult will certainly do so.

NOTES AND REFERENCES.

[1] Wellington's Dispatches, Vol. II, p. 384. "There are some things which cannot be done; one of them is to move troops in this country during or immediately after a violent fall of rain."

[2] *Ibid.*, p. 505.

[3] *Ibid.*, p. 516.

[4] Vidal de la Blache, *L'Invasion de la Midi*, Vol. 2, p. 259.

[5] In connection with this considerable error in estimating the width of the Adour, and with recent efforts to devise a suitable instrument for the more accurate measurement of rivers in general, the following story, told by Mr. Larpent, Wellington's Judge-Advocate, in his entertaining *Private Journal*, p. 475, is of interest. He says, "I must tell you a little anecdote about the pontoon bridge (near Toulouse). The French were very jealous of any attempt of the kind, and had cavalry videttes, etc., all along their bank of the river. The Engineer wished to measure the width of the river at the spot intended; and for this purpose got into conversation with the French vidette a long time, but had no opportunity. At last he pretended that the calls of Nature were imperative. The Frenchman, out of decency, withdrew. The Engineer popped out his sextant, took his angle, etc., and was off."

[6] Larpent's *Private Journal*, p. 397. This must have been a trial to Colonel Dickson, the C.R.A., but he never made difficulties, which was one of the reasons why Wellington, who did not get on very well with his gunners, always liked him.

[7] Colonel J. T. Jones, *Journals of Sieges in Spain and Portugal*, p. 106.

[8] Wellington's Dispatches, Vol. II, p. 371. "I have long entertained the highest opinion of Sir John Hope——. We shall lose him, however, if he continues to expose himself in fire as he did in the last three days; indeed his escape was then wonderful. His hat and coat were shot through in many places, besides the wound in his leg. He places himself among the sharp-shooters without, as they do, sheltering himself from the enemy's fire. This will not answer."

[9] Vidal de la Blache, p. 263.

[10] Supplementary Dispatches, Vol. VIII, p. 591.

[11] Colonel J. T. Jones, p. 108.

[12] Supplementary Dispatches, p. 604.

[13] Captain Batty, *Campaign in the Western Pyrenees*, p. 171.

[14] Supplementary Dispatches, p. 590.

[15] *Ibid.*, p. 592.

[16] *Ibid.*, p. 595.

[17] The Pontoon Train with Wellington in the Peninsula always contained "Portuguese seamen," who were men of many different nationalities. *Editor.*

[18] Colonel J. T. Jones, p. 117.

Brigadier General Noel Montague Lake, CB

MEMOIR.

BRIGADIER-GENERAL NOEL MONTAGUE LAKE, C.B.

I FIND it somewhat difficult to write a satisfactory description of the career of the late Brigadier-General Lake, as he was one of those R.E. officers (not very few in number) who did much very important and valuable work which was practically unknown to the public at large, and his natural modesty was such that he kept few records, saying as he sometimes did, that his claim to fame was shared by all true R.E's, "That they ever did their duty to the best of their ability."

However, with the assistance of some of his brother officers who worked with him at various periods of his service, I have tried to describe in general terms what, I think, will be generally acknowledged to have been a life entirely devoted to duty and friendship.

He was born at Eastwoodie, Berks, in 1852, his father being Colonel Sir Henry Atwell Lake, better known as Lake of Kars, owing to his part in the fine defence of that city during the Crimean War.

He was educated at the Gosport Naval School and passed into the R.M.A. when he was only just sixteen years old, high up in his batch (which was also my own), and by far our best mathematician. He maintained his position at the R.M.A. and received a commission in the Royal Engineers in August, 1871, being known in both schools as hardworking and conscientious, with a high sense of duty and a very kindly but somewhat retiring personality.

Soon after completing his course at the S.M.E., Lake was selected to accompany a draft of the R.E., under the command of Captain Stewart, R.E., to proceed to the island of Fiji, which had just been occupied by the British Government as a Crown Colony. I have received a very interesting account of their pioneer work in Fiji from Mr. A. B. Brewster, who was one of the earliest settlers in that Colony, but I regret that for reasons of space it cannot be included in this memoir; suffice to say that the duties of the R.E. consisted chiefly in survey work, in roadmaking and in providing temporary buildings, and one of the chief qualifications was tact when dealing with the civilian inhabitants and the natives. The R.E. detachment left after about three years, and Colonel Pratt, R.E., who was Surveyor-General, also returned to England, leaving Lake to officiate

in that capacity for a further two years. Mr. Brewster speaks highly of the work done by the R.E. in Fiji, and when they left they received the thanks of the Governor, Lake being specially commended.

On arrival home, Lake was employed for two years in the Public Works Department in Dublin, when at his own request he reverted to R.E. duties after being commended by the Commissioners.

Shortly afterwards he was ordered to join the Ordnance Survey in which service he remained for five years; he then had a tour of duty abroad at Malta, where he remained another period of five years. It was there that he met and married Miss Parnis, daughter of the late Mr. Parnis (Councillor to the Sublime Porte, Constantinople), a singularly happy stroke of good fortune as all his friends have realized.

When at Malta, he appears to have got possession of an unsolicited testimonial (found amongst his papers) from one of his own N.C. officers, which is so much to the point as indicating the thoroughness of Lake's work that I cannot refrain from quoting it. It is an extract from a letter written by Serjeant —— to Q.M.S. ——, dated 16th March, 1890, and runs as follows :—

> " but things are altered to what they were, Major Lake is in charge of the office and acts as Chief Draftsman but styles himself D. O. Lands and is knocking about the office all day long."
> " C.R.E's name is——and Executive Officer——we don't see either of *them* much, we see Lake all day long and that is *enough* : he is up to every move on the Board, all the work you do outside must be in Ink and nothing cancelled unless the page is, and every level that is taken are taken by three readings : he even takes us out star-gazing at night."

On returning to England, Lake was posted to Woolwich where he remained four years, and was then selected for employment at the War Office as Assistant Inspector-General of Fortifications, with the rank of Lieut.-Colonel. He remained in this appointment for six years, being then promoted to Deputy Inspector-General (with the rank of Colonel) for another three years; both these appointments were associated with the construction of new barracks and were highly important posts, being concerned with the expenditure of very large sums of public money and requiring much technical knowledge combined with very considerable power of administration. The marked improvement in barrack construction about this period speaks for itself, and Lake is entitled to his full share of praise for these improvements.

Major-General Hemming, who assisted him at that time, writes :—

> " As Deputy Inspector-General of Fortifications at the War Office in 1902-3, Lake was in administrative charge of the Military

Works Loan and will always be remembered by his Staff as an ideal Chief. This undertaking involved the consideration and design of every description of building for military purposes and the expenditure of many millions.

"Although Lake was a genius in administrative detail and routine and a master of his job, he was neither fussy nor masterful.

"He commanded the most loyal devotion amongst his many subordinates by his ever modest example and seemed to carry them with him and inspire them with his ideals and purpose by the magnetism of his character.

"It was a real pleasure to serve under him and one never felt the burden of the long hours and often uneventful work, which brought his administration to a successful issue.

"As in his office, so in his home he displayed the same gentle strength of character, generous and lovable, and was always ready to interest others in his hobbies and affairs, and to help them with theirs.

"A truly delightful friend and charming personality to the end: a fine gentleman, greatly beloved and greatly missed by all who knew him."

Lake completed his normal service as Chief Engineer of (1) the London District and (2) of the Eastern Command before he retired in 1909, being granted the rank of Brigadier-General (Hon.) in 1912.

But soon after the outbreak of the Great War, he was recalled to the Active List and received the highly important appointment of Brigadier-General in charge of the administration of the Northern Command, a force which eventually numbered about half a million officers and men. Lieut.-General Sir Henry Lawson, who commanded this force, has sent me the following remarks regarding the manner in which Lake carried out his duties:—

"As regards Lake and the Northern Command, he was its administrative head for a period of two years during the busiest period of the war.

"I do not think that the expansion of the Home Commands and the work entailed therein by the war has ever been adequately recognized, partly because most people were too busy to think of anything but their immediate job.

"In no Home Command was the expansion so great, the numbers involved so large, and the work so arduous as in the Northern Command, due to a population and area larger than any other of the Home Commands.

"The improvisation and provision of the housing, feeding and

equipping of the colossal numbers who joined or served there, entailed a work which beggars description, and it fell on Lake's shoulders and, thanks to him, the huge organization, constantly increased, worked with efficiency and without hitch or friction. Lake had an immense staff under him, drawn from all quarters, and his patience, kindness, industry and ability made him beloved and admired by all who worked under or with him. None of those who served at the time in the Northern Command will ever forget Lake and all he did—he made many a friend and never an enemy. The Command, a very happy family, received more than one encomium from those in high places, and the good name it bore was very largely due to Lake's personality and to his admirable administrative qualities.

"It was a joy and a privilege to me to be associated with Lake, we worked as brothers, and I can never forget the charm and kindness which made him so beloved in my own immediate family circle."

Having had some personal experience of the duties connected with such an appointment, and bearing in mind the fact that many of these duties were quite new to General Lake, I consider the highly successful accomplishment of his work, as stated by Sir H. Lawson, to have been a very remarkable achievement. He was mentioned in dispatches, 1917, and received the C.B.

Such is a skeleton description of Lake's very useful official career. After his retirement from the Northern Command and his reversion to the Retired List, he devoted much of his time to charitable and other organizations connected with the Corps, and he was also an active member of the Royal National Lifeboat Institution Committee.

I must not omit to mention one particular hobby for which he had a special talent, *i.e.*, carpentering. After the Great War he designed some remarkably light and efficient artificial limbs which were favourably received by the medical authorities. He also designed some very useful forms of book rests and bed tables.

It was a very sad circumstance that, during the last part of his life, he was so much afflicted with loss of sight that he could not continue this, his favourite form of recreation. He suffered this deprivation with his usual fortitude and resignation.

In conclusion, I attach two extracts from various appreciations which I have received, written by officers who were closely associated with him after his retirement.

(1) Major-General R. L. B. Thompson, Director of Works, writes :—

"Almost everyone who had been associated in any way with him must have had the greatest respect for his opinions, which were always sound and most carefully considered. I know I had, and found everyone else of the same view. His work for the R.E. Charitable Fund extended over many years. I remember when the War broke out and he came to the War Office and got a chair in a basement room and for some months carried on single-handed all the work of the Fund. I was fortunate enough to serve on the Committee with him, '25 to '29, and I know we all appreciated his sterling worth ; in addition to a very sound judgment, he had more than his share of the milk of human kindness."

(2) Major Sir Maurice Cameron, a fellow-member of the Lifeboat Institution Committee, writes :—

"Lake was long a member of this Committee. He was distinguished by his thoroughness and profound commonsense : he studied every branch of the organization and every important question. After a discussion with conflicting views expressed, he had an invaluable faculty for suggesting some course which appealed to all. Every Member of Committee and staff alike felt in him a friend. He could not make an enemy."

Here again is shown Lake's exceptional capacity for friendship as an essential feature of his administration.

If the sentiment recorded more than 2,000 years ago still holds good that "Friendship is the only thing in the world concerning the usefulness of which all men are agreed," surely our old friend Brigadier-General Lake should take a very high place amongst our most useful officers.

R.M.R.

PROFESSIONAL NOTE.

AIR SURVEY CORRESPONDENCE COURSE, CONDUCTED BY SURVEY SCHOOL, S.M.E., CHATHAM.

PRACTICALLY every technical activity in which a Sapper engages can find its counterpart in civilian life. The more extensive opportunities of civilian technicians for research may be freely drawn on during peace, and the personnel is available in event of war. There is, however, one important exception: topographical survey. The need for accurate maps is increased rather than diminished by the increasing complexity of engines of war. Meanwhile, the Survey Departments of the Empire are being forced to restrict their operations more and more to cadastral rather than topographical survey, and at the same time a corresponding reduction has had to be made in the survey training it is possible to give at the S.M.E. It is under these conditions that the development of the new technique of air survey has to be undertaken. The importance of the subject needs no emphasizing. The new technique, however, throws an additional burden of training on to the surveyor, already unable to get adequate experience in the more classical methods, which still remain fundamental. Any R.E. officer serving on a boundary commission in the future, or carrying out work in connection with the R.A.F. (*e.g.*, Egypt, Aden, Iraq), may be called upon to organize an air survey, and though it has now been found possible to include the rudiments of the subject in the Survey Course at the S.M.E., there are many who have not had this advantage or who may afterwards wish to refresh their knowledge. As with most practical problems, the subject cannot be learnt entirely from books. Fortunately, however, the materials involved in the cartographic part of the job are simple and light (air photographs, drawing celluloid, simple stereoscopes), and this, following various enquiries in the Corps, led to the experiment by the Survey School of an ingenious correspondence course on the subject. The initial trials were encouraging, various improvements were suggested, and the course now emerges in its completed form with sets of printed notes, directions, and diagrams to guide each stage.

The whole course is divided into four periods of about three weeks each, and a certain standard in each period must be reached before passing on to the next. One of the difficulties of any course on this subject is that, although most of the ideas are simple to understand intellectually, they cannot be fully appreciated without a certain standard of craftsmanship in two respects, drawing and stereoscopy. The art of draughtsmanship has so many other applications that

this case is merely a special one, and although the highest possible standard is required for actually plotting a map, a less perfect effort will enable the student to appreciate the factors of skill and time involved. That is the point: an officer will not ordinarily be required to do the plotting himself, but he must be able to supervise with understanding the draughtsmanship of others. Stereoscopy, a knowledge of which is less widely disseminated, is nevertheless an art easily learnt by almost anyone with normal binocular vision, if a little patience and practice is added to correct teaching. It is almost continuously in action in normal human beings, but is seldom brought into play *consciously*. It must, however, have been an important factor in evolution, since carnivorous mammals share with a few advanced species of fish the distinction of having their eyes suitably situated. The conscious development of this faculty of beasts of prey is one which can be easily acquired by most people and should by no means be a disadvantage in modern life. The method of training adopted in the course is most entertaining and practice can be carried out in a variety of ways.

Having achieved a good stereoscopic sense it is a simple matter to fuse two air photographs to give an impression of the ground in topographic relief. Contours may then be drawn in and added to the detail plot. All this is dealt with in the last period of the course. Finally the problems of organizing a party for air survey work are discussed.

The subject is still in its infancy, but it may be predicted with some confidence that, from the military point of view, all advances in technique will build on the foundation of present practice. New possibilities are opened up, *e.g.*, infra-red photography, multi-lens cameras, gyro-controlled aircraft, more precise instruments, better materials, etc., but the principles remain the same.

One new side-line of considerable importance is the application of the same principles to the precise measurement of river gaps and the form of their banks. Photography for this purpose can be carried out by the aircraft of an A.C. Squadron in the form of a short strip of overlapping verticals taken, if necessary, by flattening out after a dive. Present experiments indicate that measurements of width and depth should usually be obtainable with an accuracy of 3 ft. or less. Those who have taken this course will then have an additional tool of great value to add to their fieldworks equipment.

A correspondence course is a modern idea and may now be taken in anything from pig-keeping to personality. It has its limitations and dangers, but the present course arose, like most others, in response to a need. Not only should it fulfil that need admirably, but by spreading a knowledge of the subject over a far wider circle it will create a refreshing breeze of criticism and invention without which any new activity runs the risk of withering before it has borne its promised fruit. J.S.A.S.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

GRANT AND LEE.

By MAJOR-GENERAL J. F. C. FULLER, C.B., C.M.G., D.S.O.

(Eyre & Spottiswoode. Price 10s. 6d. net.)

For many years, in spite of the publication of the standard work on the American War by Woods & Edmonds, most students of military history confined their attention to the campaigns of Stonewall Jackson, so marked was the influence of Henderson's life of that General. Since 1918, the studies of Captain Liddell Hart and of General Fuller have stressed the importance of the campaigns in the west. In this book under review, " a study in personality and generalship," the pendulum has perhaps swung too far. One cannot help feeling that the apotheosis of Grant in place of Lee is really a piece of special pleading : the truth is to be found somewhere between the two schools of thought. To a devotee of Henderson, it is possibly a shock to be told that " in several respects, Lee was one of the most incapable Generals-in-Chief in history."

The book is interesting but irritating—irritating particularly in its somewhat dogmatic assertions, its continual quotations from documents (though the author explains in the preface his belief in the necessity for this procedure) and in its amateurish outline maps and sketches, which are difficult to follow. At the same time, the contrast between the two men that the author paints is deeply interesting. Grant was, according to General Fuller, simple and self-reliant : a man of modesty and common sense, with great physical and moral courage, whose reason had control : Lee, humble and submissive, with a very deep religious sense, but without the quiet authority of his opponent. But it must be remembered that, in this war which made such demands on physical powers, Grant was but 39 and Lee 53.

Lee, General Fuller considers, was a bad grand strategist : he was obsessed by Virginia and the moral aspect of war, the importance of the Federal capital casting a spell upon him. His one and only grand strategical principle was to terrify Washington. He was convinced that the war would be won by foreign intervention, and he had no real plan of campaign. At the same time, he was unable to inspire stability or a sense of direction in politicians or people. " His most notable defect was that he never had conveyed any inspiration in the war."

Grant was the antithesis. He saw clearly and continuously a true strategic plan. " At Cairo, in 1861, he at once saw the strategical importance of Paducah ; after the capture of Donelson he saw the importance of the Mississippi which led to his Vicksburg campaign in which he gained control of this river. Immediately after the fall of Vicksburg, he suggested an expedition to capture Mobile, so that from there operations might be directed against the rear of Bragg's army."

While his outlook was general, embracing the whole theatre of war, his leading idea was single, the destruction of the enemy's main army. The outlook of the Confederate leader, on the contrary, was parochial.

Tactically, the two are placed on the same level—a high level—while Lee excelled in the defensive, though both suffered from ignorance of what the author considered

the main lesson of the years prior to the war—that the bullet was dominating everything.

This book is one which should be read by all interested in military history, although they may not agree with the author's assertions, and it is a fitting complement to General Fuller's *The Generalship of Ulysses S. Grant*. Perhaps the real truth of these two men was summed up in General Gordon's words, with which the author ends this book :—

> "The strong and salutary characteristics of both Lee and Grant should live in history as an inspiration to coming generations. Posterity will find nobler and more wholesome incentives in their high attributes as men than in their brilliant careers as warriors."

H.G.E.

THE TACTICS AND STRATEGY OF THE GREAT DUKE OF MARLBOROUGH.

By Hilaire Belloc.

(Arrowsmith, 10s. 6d.)

In his preface, Mr. Belloc points out that "this book does not attempt a full survey of Marlborough's military career, and the many problems raised by his actions and their preliminaries. It only professes to be a study made with the object of rendering as simply as possible the main lines of a certain number of his more important operations."

Strategy and tactics are but two elements in the great art of war, and the author finds it necessary to extend his study into the realms of command and administration, without which no study of the Great Duke, even in its most elementary form, would be complete. While still another element, policy, might be considered too advanced for a treatise aiming at simplicity, it is not possible to appreciate the strategy of Marlborough even in selected land operations, without some reference to the political situation. The author has chosen for his examples, besides the better-known campaigns of Blenheim, Ramillies, Oudenarde, and Malplaquet, the forcing of the lines of Brabant in 1705, and those of Flanders and Artois in 1711. Even in these, policy frequently has almost a dominating effect on strategy. The march to the Danube in 1704 for the Blenheim campaign is a case in point. Without a clear understanding of the importance of maintaining the Empire as an active member of the Grand Alliance; of the peril with which Vienna had been threatened in 1703 by the double thrust through Italy and Bavaria, while the Hungarian rebels rapped at the back door; of the probable effect of the detachment of Bavaria from France; without a clear understanding of all these political factors, the grand strategy of the march to the Danube loses much of its point. Especially in the case of Marlborough, not only Commander-in-Chief of the Allied armies, but principal director of the war policy in England, and minister plenipotentiary to every court in Europe, strategy cannot be divorced from policy in the simplest study. We cannot but regret that Mr. Belloc has largely sacrificed this important aspect on the altar of simplicity.

The author's treatment of each of the six campaigns is extremely clear, and his points are so well illustrated in such simple language that the study is of equal value for the professional soldier and for the general reader. It is to the latter that the author particularly addresses his remarks. In certain points he is not content blindly to accept the views of standard authors, and he presents his case well. If we cannot agree with him in every particular, his arguments are plausible and worthy of investigation.

In particular, we cannot agree that the Duke did not make up his mind to march to the Danube till, on May 23rd, he heard that Tallard had successfully passed reinforcements to Marsin through the Black Forest. His dispatches show that certainly as early as May 11th, before the march from the Netherlands began, he had decided

to go to Bavaria; while his correspondence with Heinsius leads us to infer that the decision made provisionally in England in March was confirmed in collaboration with the Grand Pensionary on Marlborough's arrival at the Hague in April. Certainly, as the author points out, there were always the alternatives of a campaign up the Moselle or through Alsace, but these were almost certainly not Marlborough's intention.

In the realms of tactics Mr. Belloc is very clear in his descriptions, but again some of his conclusions are open to question. For example, he condemns out of hand the attacks on the angle of the Schellenburg, and on the village of Blenheim. These attacks deserve more than passing consideration, for they seem to exemplify one of the Duke's principal tactical methods. The two attacks mentioned, with that of Orkney at Ramillies, and possibly the attacks on the Bois de Tiry at Malplaquet, all bear the same imprint—an attack launched in great strength at a point vital to the defence, with a force and energy sufficient to show that it is no feint, and the whole so arranged that if the point is not carried, but the opposition only pinned, troops could be diverted to the final decisive attack. Thus the Hanoverians were diverted when Cutt's attack on Blenheim was stopped, and the foreign cavalry and one line of English infantry were switched to the decisive centre from Orkney's attack at Ramillies. One may criticize the extent to which Marlborough allowed these subsidiary attacks to become involved, but one cannot condemn their inception without fuller discussion, for in every case they brought about the situation which permitted the decisive act to be played.

A very interesting point on which Mr. Belloc lays much stress is Marlborough's use of ground in moving cavalry to his left centre from his right at Ramillies. Evidence is not conclusive one way or another, and the author's recommendation to students to study on the ground this, as well as the other Marlburian battlefields, is strongly to be supported. One must accept Mr. Belloc's facts as regards visibility, but it is doubtful if the most practised eye could judge from the high ground east of Ramillies, the degree of invisibility of troops in the stream valley from French lookouts in, say, the church of Autre Eglise. On the other hand, Marlborough's army had been encamped in the neighbourhood for a considerable period in 1705, and, doubtless, in view of its strategic importance, the Duke had then studied the field. But apart from the question of visibility, the troops who were so diverted to the centre, were the foreign cavalry of the right wing, and we have no record of these having supported Orkney's attack. Only Lumley's English cavalry are so mentioned, and these remained on the right wing to the end of the action. If the foreign cavalry did not support this attack it is unlikely they would have been moved into the valley of the Geete, and from south-east of Folx-les-Caves, where they would have been stationed, there is another dip, not shown on Mr. Belloc's sketch map, up which the road now runs from Folx to Ramillies, and by which the cavalry could have trotted unseen by the French to the south-east of Ramillies in ten or fifteen minutes. The point, however, is novel and worthy of careful study.

It has been mentioned above that Mr. Belloc is constrained to pass from pure strategy and tactics into the realms of command and administration. Those portions of the book dealing with Marlborough's powers as a commander are of special interest, more especially, perhaps, in view of recent criticism of the art of command as evinced by our generals in the Great War. Of his courage, at all events, there can be no question.

On page 126 there is an obvious misprint. The colours of the two forces, one concave and one convex, have become interchanged between the diagram and the text.

Altogether the book is highly to be recommended as a useful addition to the literature relating to the campaigns of an Englishman who certainly stands in the front rank of the world's great soldiers.

R.P.P-W.

MODERN MILITARY ADMINISTRATION, ORGANIZATION AND TRANSPORTATION.

By MAJOR-GENERAL J. C. HARDING-NEWMAN, C.B., C.M.G.

(Gale & Polden. Price 2s. 6d.)

In this little book of 81 pages the author sets out to reform the British Army on the basis of his experience in the Great War. That experience was gained on the Q.M.G.'s Staff of the B.E.F. in France. The problems of administration in consequence tend to overshadow those of command.

Amongst the variety of subjects discussed are Staff organization, transportation problems, traffic control, the expansion of the Army in war, and the mobilization of industry.

Some of the proposals derived from these discussions will have a wide appeal. For instance, it is suggested that no commander should be over 40. To pay for this reform the author favours the reduction by 60 per cent. of the officer establishment outside units. The reorganized Staff is to be smaller, better educated, better co-ordinated, and relieved of its tiresome peace administrative duties.

In his mobilization plans the author brigades three Territorial battalions with one Regular battalion. He regards the Regular Army solely as the nucleus on which the National Army expands. To link it more securely with the nation he gives it the job of running national gymnasia as a holiday task in the individual training season.

The author argues logically in support of his proposals, but fails to present fully the arguments against them. In his plan for the reorganization of the Staff he substitutes six branches of the General Staff for the present four Staff branches. He entirely ignores the problem of fitting such an organization in with the War Office organization. He favours the German plan of making the Chief of Staff the sole adviser and counsellor of the Commander-in-Chief. His Chief of Staff is, in addition, the superman who co-ordinates the work of six Staff branches.

The reformed Army is designed primarily for war in organized countries well provided with communications, and with a temperate climate. These conditions enable the author to write from his personal experience, and so develop fully his arguments in favour of reform. He ignores the primary consideration in the organization of the British Army, namely, that it must be prepared to fight in any terrain, and under all climatic conditions.

In his case for a Ministry of Defence he presents no new arguments. The Ministry is charged with the co-ordination of effort and provision. Instead of a Minister in charge it is to be run by a Committee of National Defence. No solution is given of the many difficult problems which hinder the amalgamation of all three Services under one Ministry.

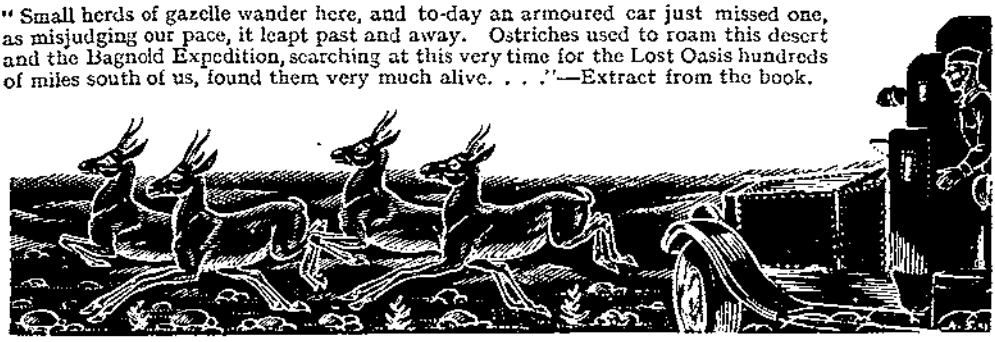
Napoleon is cited as an example of the advantage of having more youthful generals. No attempt is made to explain the success of older men such as Hindenburg in the East Prussian campaign, Moltke in the Franco-Prussian War, and Grant in the American Civil War. The fact which the author neglects is that the only safe basis for the selection of young commanders is the test of war. Success in peace manœuvres and political support are apt to produce the McClellans and other "Young Napoleons."

A great deal of space is devoted to describing the traffic arrangements for the Aldershot Tattoo in order to prove the necessity for studying both ends of a transportation system and all possible bottlenecks in order to ensure the maximum traffic flow. It is a practical illustration of the principles laid down in the *Manual of Movement*.

The book provides a certain amount of fuel for controversy. It will have a limited appeal to those who argue on military matters, but hardly to the general public, as the author ventures to hope. To those who are studying military administration for examination purposes, it may provide some food for thought, but should not be regarded in the light of a text-book.

C.P.W.

"Small herds of gazelle wander here, and to-day an armoured car just missed one, as misjudging our pace, it leapt past and away. Ostriches used to roam this desert and the Bagnold Expedition, searching at this very time for the Lost Oasis hundreds of miles south of us, found them very much alive. . . ."—Extract from the book.



FROM CAIRO TO SIWA, ACROSS THE LIBYAN DESERT, WITH ARMOURED CARS.
By MAJOR T. I. DUN, D.S.O., M.C., R.A.M.C.

We have received a prospectus of the above book, which we desire to bring to the notice especiall of the many officers of the Corps who have served in Egypt, and also to that of Mess Secretaries The book is written by an officer well known in Chatham within recent years. Major Dun accom panied as M.O. a squadron of the XIIth Royal Lancers on an armoured-car reconnaissance from Cair to the oasis of Siwa, a round trip of over 1,100 miles; and those who remember the enthusiasm wit which the author pursues any subject which is engrossing his attention will not be surprised to hea that this production is to be something out of the ordinary.

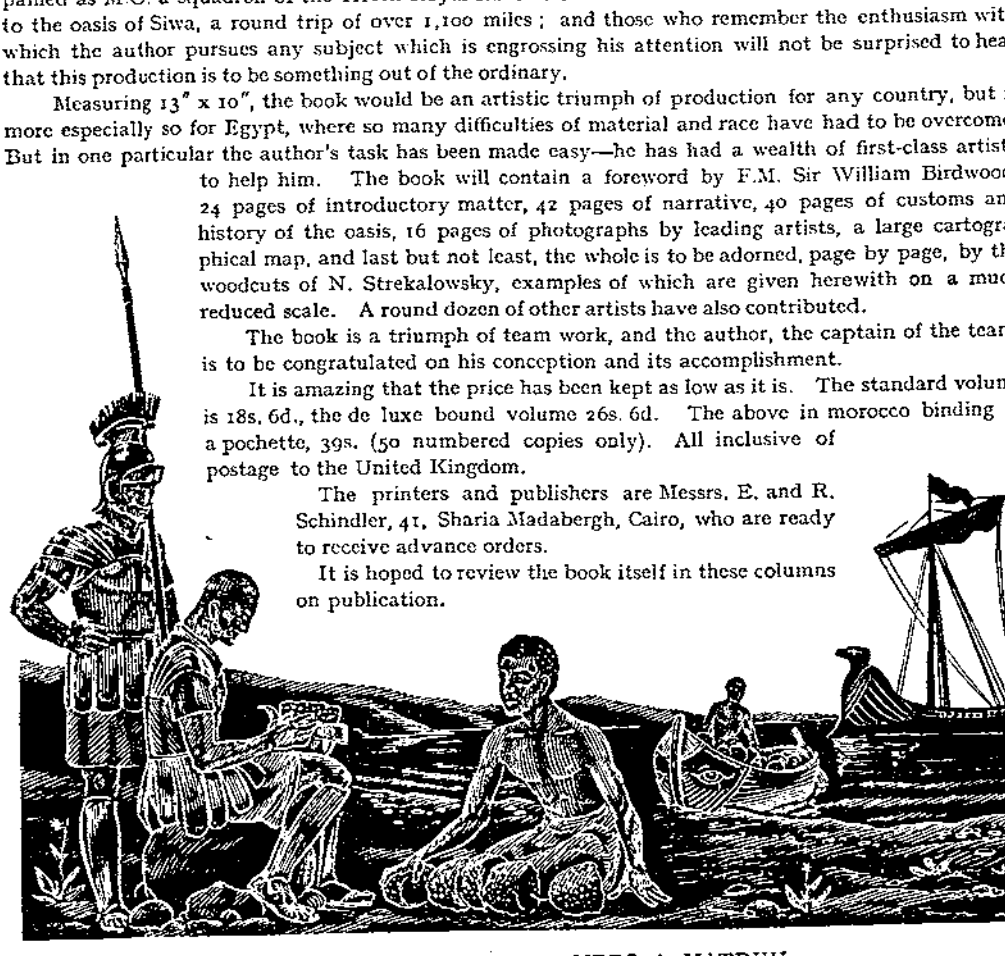
Measuring 13" x 10", the book would be an artistic triumph of production for any country, but more especially so for Egypt, where so many difficulties of material and race have had to be overcom But in one particular the author's task has been made easy—he has had a wealth of first-class artist to help him. The book will contain a foreword by F.M. Sir William Birdwoo 24 pages of introductory matter, 42 pages of narrative, 40 pages of customs an history of the oasis, 16 pages of photographs by leading artists, a large cartogr phical map, and last but not least, the whole is to be adorned, page by page, by t woodcuts of N. Strekalowsky, examples of which are given herewith on a muc reduced scale. A round dozen of other artists have also contributed.

The book is a triumph of team work, and the author, the captain of the tea is to be congratulated on his conception and its accomplishment.

It is amazing that the price has been kept as low as it is. The standard volu is 18s. 6d., the de luxe bound volume 26s. 6d. The above in morocco binding a pochette, 39s. (50 numbered copies only). All inclusive of postage to the United Kingdom.

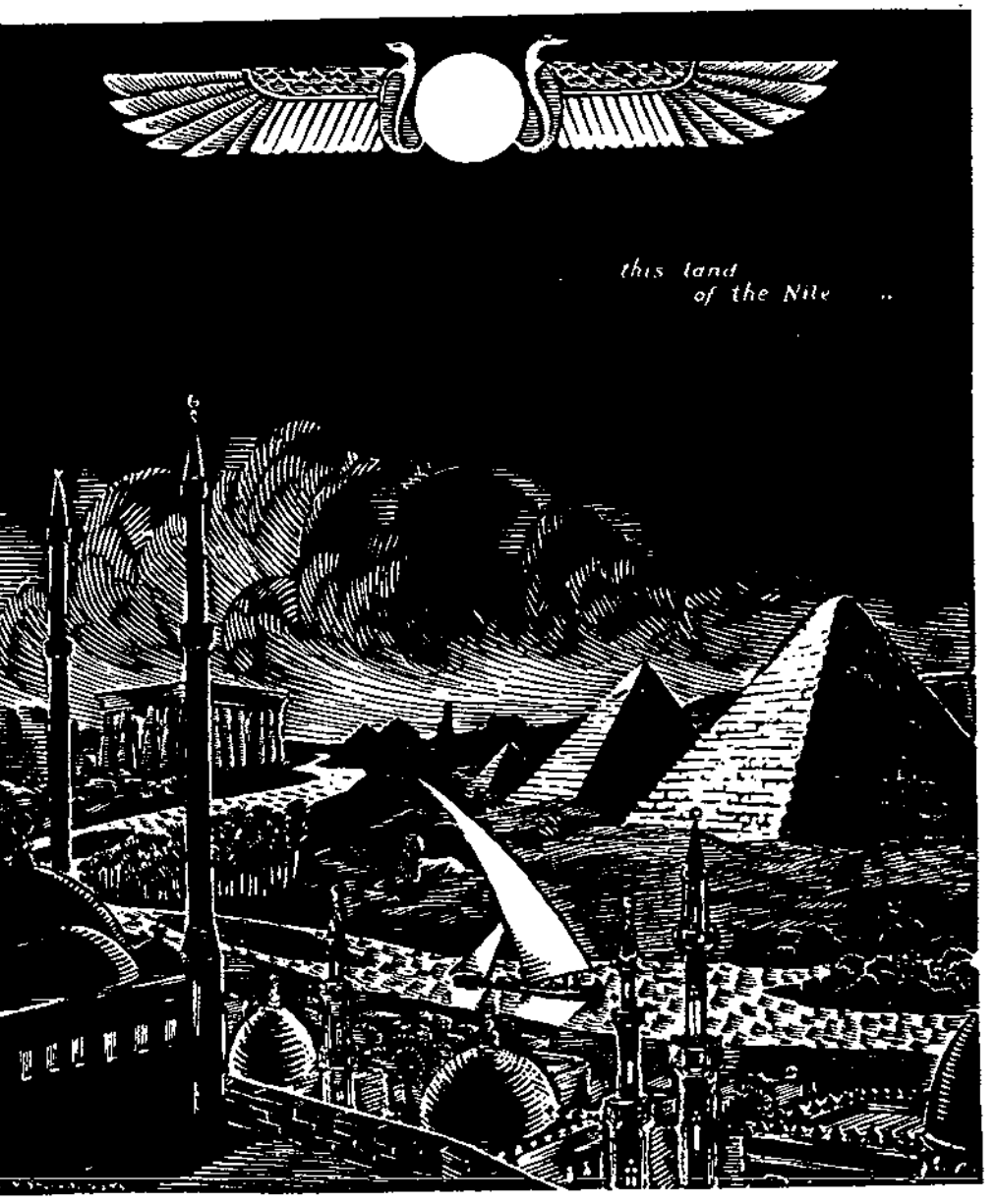
The printers and publishers are Messrs. E. and R. Schindler, 41, Sharia Madabergh, Cairo, who are ready to receive advance orders.

It is hoped to review the book itself in these columns on publication.



THE SPONGE FISHER OF MERS A MATRUH.
The Greek warriors used to pad their helmets with sponge tissue, soaking this with water in height of the summer heat.

ROM CAIRO TO SIWA, ACROSS THE LIBYAN DESERT, WITH ARMOURED CARS.



A FANTASY OF THE NILE AND CAIRO.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*April*, 1933.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. Major Duez and Captain Defraiteur.

An account of operations carried out by the 1st/9th Regiment of the Line at Lombartzyde on the 20th, 22nd, and 23rd October, 1914.

2. *La mobilisation de la nation.* By Lieut.-General Giron.

On the outbreak of war, the army is suddenly transferred from a peace footing to a war footing; commerce and industry, as well as the public services, are almost automatically suspended. The feeding of the population becomes precarious.

Such was the situation in Belgium in 1914. The country, counting upon the sanctity of its treaties, had not thought seriously of war, and all arrangements had to be improvised on the spur of the moment. Before the regulations for mobilization could be fully put to the test, the country was in the hands of the enemy, and no experience could be gained as to their efficiency.

Belgium, as an industrial nation, is severely handicapped. It produces very little in the way of raw material; high-grade coal and most raw materials have to be imported. In France arrangements have been made by several of the leading manufactories in the north-east to have branch works somewhere west of the Loire. Should the country ever be invaded again, and all work in the north-east area suspended, the branches in the west will be able to carry on their activities. But, in the case of Belgium, the country is too small to permit of the transfer of its industries beyond the range of the enemy's interference.

The writer goes on to make a general study of national mobilization in Belgium, and of the work carried out by the permanent Mobilization Committee.

3. *Défensive de retraite et action retardatrice.*

An article by Lieut.-Colonel Renard, giving a concrete case illustrating the employment of artillery in a retirement.

4. *Quelques détails de l'instruction dans une compagnie de fusiliers.* By Captain Lescul.

Instructions for sentries and patrols, and practice in attack.

5. *Étude théorique de l'observation dans la marche d'approche.* By Lt.-Col. Nonnon.

(*May*, 1933.)—1. *Les transports de troupes par avions.* By Col. Desmet.

The author discusses a method of utilizing aeroplanes that has hitherto not been extensively used, viz., for the transport of troops. In America a battery of artillery has been carried successfully by air over a distance of 25 miles. The British have made use of aeroplanes for carrying a company of infantry from Egypt to Cyprus in October, 1931, and a whole battalion from Egypt to Irak in June, 1932.

The author quotes various writers who have made a study of this method of employing troops, and singles out for special mention a German writer, F. W. Borgmann. The latter proposes to organize the air force in divisions consisting of fifty fighting planes and two hundred carrying planes, each of the latter carrying seven or eight men and a machine-gun, or else a gun or a load of ammunition weighing a ton.

Colonel Desmet thinks there is considerable scope for dropping men carrying parachutes from aeroplanes: detachments so dropped could secure important focal points behind the enemy's lines. The defence of a small country like Belgium against this form of attack presents considerable difficulties.

2. *Le franchissement des cours d'eau.* A series of articles by Lieut. Thonnard.

In this first article the writer lays down some general principles regarding the crossing of rivers. Both from a strategical, as well as from a tactical point of view, a river retains, even under modern conditions, its value as an obstacle.

An army may be called upon to effect a crossing under various conditions. The crossing may be unopposed. If the bridges have been left intact, it is only a question of a contraction of the front; possibly extra bridges may be required. If the bridges have been destroyed, delay must ensue until the necessary repairs have been carried out. On the other hand, the enemy may oppose the crossing. In such a case, it may be possible to out-manœuvre him. Such an opportunity will seldom occur, and it will usually be necessary to force a crossing, one of the most difficult operations that can be carried out in war.

After a crossing has been effected, a river still remains an obstacle. The bridges in rear of an army are still liable to destruction by long-range gun fire or aircraft. To fight with a river behind one is a difficult operation and bad for the morale of the troops.

The writer points out how the amphibious Carden-Loyd tank has contributed to the solution of crossing water in the face of enemy fire. Such tanks would have been invaluable in the landing at Helles in 1915, or in the projected attack on the Belgian coast in 1917.

3. *Quelques détails de l'instruction dans une compagnie de fusiliers.* By Captain Leseul.

4. *Sebastien le Prestre de Vauban.* By Major Delvaux.

A sketch of the life of Vauban, Marshal of France, the tercentenary of whose birth was celebrated in May.

An orphan at the age of ten, he was brought up by the village curé, and, at the age of seventeen, enlisted under Condé, who was hostile to Mazarin and the King. Captured by the royalist army, and pardoned, he entered the service of the King. His life was devoted to his country. He took part in numerous sieges, amongst which Maestricht, Oudenarde, Valenciennes, Ypres, and Luxemburg are some of the most noteworthy. He marked out the French frontier with a network of fortifications, too numerous to mention in detail, but Ypres, Dunkirk, and Toulon are some of his greatest works.

Besides being pre-eminent as one of the greatest of military engineers, he was distinguished as a canal engineer, and many of the canals in the north-east of France owe their conception to him.

5. *La bataille de Galicie en août* 1914. By Captain Nannan. (From the Russian.)

This article is continued from the March number, and deals with the operations in Galicia between the 26th and 30th August.

On the 26th and 27th August was fought the battle of Tomasov, in which the 25th, 5th, and 17th Corps of the 5th Russian Army were engaged. The position of the opposing armies is shown on a sketch.

Another sketch shows the battles of Zloczov and the Gnila-Lipa, fought on the 27th, 28th and 29th August, between the 3rd and 8th Russian Armies and the 2nd and 3rd Austro-Hungarian Armies.

Points of interest in this portion of the campaign are that General Russki, commanding the 3rd Russian Army, disregarded the orders he had received and continued to march on Lemberg. On the 28th, the 4th and 5th Russian Armies were separated by an interval, very lightly masked, of 65 kilometres, whilst there was a fresh gap of 75 km. between the 5th and 3rd Armies. From that moment General Conrad's objective became the crushing of the 5th Army. It appears that up to that time he was unaware of the existence of the 8th Russian Army.

6. *Conférence pour la reduction et la limitation des armements. Le plan Mac Donald.*

A detail of the British plan for the reduction of armaments submitted to the Geneva Conference.

(*June*, 1933.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. An account, by Major-General Pierard, of work carried out by the fortress engineers of Antwerp from the 1st August to the 10th October, 1914. The lessons to be learnt from these operations are (1) that semi-permanent floating military bridges are too narrow: they should be wide enough to take wheeled and foot traffic in both directions, (2) that they should be protected against enemy aircraft, (3) the number of officers in engineer companies is insufficient.

2. *Étude de la rupture du contact par un regiment d'infanterie.* By Lieut.-Colonel Bouha.

A tactical scheme worked out with the aid of a map.

3. *Représentation de l'ennemi dans nos exercices.* By Colonel de Cae.

A brief study of the German regulations regarding tactical exercises.

4. *Le franchissement des cours d'eau.* By Lieut. Thonnard.

A description of the crossing of the Piave by the Franco-Italian Army between the 25th and 30th October, 1918.

The site selected for the crossing was not a good one; it was chosen because the river happened to be narrowest at that point; but it was commanded by the Austrian artillery. The operation was successful in spite of the great difficulties met. The force of the current was very strong, and caused delay, losses of boats, numerous breakages in the bridge, etc. The crossing was so fully exposed to the enemy's fire, that, in spite of every effort, it was not possible to build more than one bridge, and troops were only able to pass over it intermittently.

Success was due to the excellent arrangements and precise orders issued by the command, to surprise—the sound of the work being partly drowned by the noise of the river—and to the remarkable energy displayed by the assaulting regiment (the 107th) and by the bridging troops.

Some of the lessons learned from this manœuvre are that the number of boats and amount of equipment should not be calculated too finely: an ample reserve of material and personnel should be allowed for. The necessity was discovered for proper communication from bank to bank once the first troops had got across.

5. *La bataille en Galicie en août* 1914. By Capt. Nannan.

The writer describes the operations of the 29th, 30th, and 31st August, first from the Austrian, and then from the Russian point of view.

After the battle of Gnila-Lipa, on the 29th, General Russki, commander of the 3rd Russian Army, had a superiority over the enemy of two to one, which he could have taken advantage of by pressing on to the north of Lemberg. Instead of that, he persisted in attempting the capture of Lemberg.

On the 30th August, General Conrad launched his counter-offensive against the 3rd Russian Army, but it failed to attain its object. The front of the Austrian Army was penetrated at the junction between the IIIrd and IInd Armies, and a retirement was ordered. The Russians obtained a tactical victory on that day, but no important strategic result followed.

The 31st August marks the end of the first stage of the battle in Galicia. The mistakes in the Russian plan of campaign gave the Austro-Hungarians a superiority between the Bug and the Vistula, strategically the more important zone. In the second stage the superiority changed over to the other side in consequence of General Conrad's mistakes and the Russian counter-measures.

A.S.H.

RIVISTA DI ARTIGLERIA E GENIO.

(*March-April*, 1933.)—1. *Taratura di pezzi e omogeneità di batterie.* By Colonel Baldassare.

2. *Le onde cortissime e la loro importanza militare. Nuove realizzazioni di Guglielmo Marconi.* By F. G.

The scale of ultra-short waves lies between the lower limit of short waves (10 metres) and the upper limit of infra-red radiations (about 0·3 mm.). Out of these, waves of less than one metre length have recently been called micro-waves.

Marconi's recent investigations show the great value of these waves for military purposes. They can take the place of visual signalling over long distances; they are difficult to intercept; they will penetrate fog and are not affected by atmospherics.

3. *Tiro contra aerei ad alzo prestabilito.* By Brig.-General Faujas. A study of anti-aircraft gunnery.

4. *Nuove tendenze negli ordinamenti e negli studi militari al principio del* 1933. (S.R.)

The writer takes us over recent military developments in the armies of the great powers. It is only possible to pick out a few of the points mentioned.

Great Britain is referred to as the country that has made the biggest strides in the mechanization of its forces, but the writer aptly points out that conditions obtaining in the open ground of Salisbury Plain are not to be found everywhere.

In France there is a tendency to reconsider the conception of the offensive, and a good deal of attention is being paid to permanent fortification. It is recognized that under modern conditions the attacker is liable to a far heavier expenditure of men and munitions than the defender.

The problem of anti-aircraft gunnery is being studied both in Italy and abroad. Leaving out of account guns and machine-guns of heavy calibre, many of which are in an experimental stage, reference is made to Gerlich's experiments in Germany. With a projectile weighing only 8·15 grammes fired from a rifle of 7-mm. bore, Gerlich has succeeded in perforating a chrome-steel plate 15 mm. thick.

As regards establishing contact with the enemy, the writer reminds us that the Germans have in use a machine-gun with a direct fire range of 2,400 m. (3,500 m. indirect fire), and that the United States have a machine-gun with a range of 4,500 m.

5. *Varamento su gomene di acciaio del ponte metallico n.1.*

Lieut.-Colonel Adamo gives an interesting account of the construction of a steel girder bridge of standard type, with an overall span of 37·50 m., across a deep rocky gap with sheer vertical sides. To make the problem more difficult it was assumed that level spaces of six and eight metres only were available on the respective banks.

The method adopted was briefly as follows:—

A special intermediate support of wood and steel was erected about one-third of the way across. The girders were put together piece by piece. The shorter span was built out from the right bank as a cantilever, supported by means of counter-weights. The longer span was built out from the left bank on a support of two steel cables, stretched tightly across, the forward end of the girder being carried on a trolley with flanged wheels. As construction proceeded, the girder was pulled along the cables by means of a steel hauling rope. The dip of the cables was one metre, and care had to be taken that it was kept exactly equal in the two cables.

Six photographs and five figures make the method adopted clear. The construction is described in detail, and calculations are given.

6. *I cannoni moderni di corpo d'armata.*

A review of an article that appeared in the February number of the *Revue d'Artilleri* by General Challéat, on the modern guns of an army corps.

7. *Il servizio idrico nella grande guerra.* By Lieut.-Gen. Maglietta.

A general description of the water supplies provided during the Great War on the Italian front. Three separate areas are described: the Carsic zone, the Upper Plains zone, and the Piave front. It is interesting to note the extensive use, for pumping purposes, of hydro-electric power, which was installed to replace oil and petrol engines, owing to the scarcity of fuel.

A.S.H.

REVUE MILITAIRE SUISSE.

(*April*, 1933.)—1. *Réorganisation de notre armée.* By Lieut.-Colonel Wille.

The writer adds his own views, for which he disclaims any official character, to those expressed in a previous number by Colonel Sonderegger and also by other writers. He thinks there is room for improvement in the time spent and the methods employed in the instruction of the soldier. He gives his views on the reorganization of the battalion and larger units. One point he stresses is that in certain frontier regions the troops should be specially trained for work in their own region only.

2. *Quelques thèmes tactiques illustrés par des cas concrets.*—(*Continued.*) By Colonel Schibler.

3. *Méthode d'instruction; le contrôle individuel dans les cours de répétition.*

Lieut.-Colonel H. Frick gives his views on what he considers the best methods of instructing the soldier, so as not to make instruction tedious, by encouraging the more intelligent men, by avoiding waste of time and making work interesting.

4. *Notre instruction du tir; répond-elle aux besoins actuels.*

Lieut. Daniel considers that instruction in rifle shooting has deteriorated since the general introduction of machine-guns and other weapons. He quotes the Boer War and the Riff campaign of 1925 as instances that prove the great value of accurate rifle shooting. He suggests that men who are physically, or otherwise, incapable of firing correctly, should be transferred to units in which they will not have to handle a rifle, and that good rifle shots should be transferred from other units to the infantry.

(*May*, 1933.)—1. *La psychologie du "Poilu."* By Lieut.-Colonel Mayer.

An interesting study of the psychology of the French soldier, mostly taken from a recent work, *La psychologie du combat*, by Major Coste, and from an article, "Armée nationale ou armée de métier?" by General Debeney, published in the *Revue des deux mondes*.

The soldier's actions and feelings under fire, his loyalty to his superiors and comrades, his obedience of orders, are all discussed sympathetically and evidently with knowledge and experience.

2. *Les préliminaires du combat.* By Colonel Roques.

This is a study based on the organization of the French Army, in which the infantry division consists of three infantry regiments, a pioneer battalion, a reconnaissance group, two regiments of artillery, a proportion of aeroplanes and other services.

Attention is drawn to mistakes made during the Great War, when infantry, in column of route, was surprised by the enemy artillery, and disaster followed. These instances are held out as warnings.

A point that is insisted upon is the importance of collaboration between artillery and infantry in attack, and the methods to be adopted to ensure the necessary liaison.

3. *Quelques thèmes tactiques illustrés par des cas concrets.*—(*Continued.*) By Colonel Schibler.

(*June*, 1933.)—1. *Éléments de tactique.* By Colonel Léderrey.

Instructions for non-commissioned officers and recruits in the elements of tactics based on the infantry regulations of 1930, and drawn up as an *aide-mémoire* for work programmes and for training small units.

2. *Les tirs de l'artillerie.*

This is the first of a series of articles by Major de Montmollin, and is a contribution to the problem of liaison between infantry and artillery.

There was a great change in the duties of artillery prior to 1914, as compared with those required of it during the course of the Great War. Liaison between infantry and artillery did exist before the war, but it was unilateral and concerned the gunners only.

A comparison is made between the artillery of the French and German armies respectively. At the beginning of the war the Germans had a shell that was a marvel of mechanical ingenuity and combined the properties of shrapnel and common shell.

The French relied on the shattering properties of their melinite shells, which contained 650 grammes of explosive, as against 160 grammes in the German shells. The Germans were the first to realize the value of heavy artillery, and for a long time they outnumbered the allied artillery in heavy guns.

It is interesting to compare the casualties caused by rifle-fire and shells in the Franco-German War of 1870-1 with those caused during the Great War. In 1870-1 the French casualties were caused as follows: By bullets 70%, by shells 25%. In the Great War, between 1914 and 1917, 20% were caused by bullets and 75% by shells.

The writer quotes figures to show the enormous increase in the number of shells expended during the war as time went on, and the changing views as to the length of time to be expended in artillery preparation for an attack.

The demoralizing effect of artillery fire, and its psychological effect on the French soldier, are described at some length. It is interesting to find it recorded that, in open ground, the Frenchman is inclined to seek safety by moving from shell-hole to shell-hole: the Englishman and the German will remain in the same place. What is, perhaps, more demoralizing than anything else, is being subjected to fire from one's own artillery.

3. *Contribution à l'instruction du tir.* By Lieut. Daniel.

The writer considers that in the present method of instruction in rifle shooting too much attention is given to firing at range targets and not enough to field targets. He makes a number of suggestions for improving the soldier's shooting in the field.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*March-April*, 1933.)—1. *Considérations sur l'influence de la vitesse dans la guerre moderne.*

In the first chapter, Captain Fadeuilhe traces the history of the French Army from the earliest date of its formation to the introduction of conscription at the time of Napoleon, and the development of a nation in arms during the Great War of 1914-18. The second chapter gives a brief résumé of the strength and organization of some of the foreign armies. In the third chapter the writer deals with the evolution of speed. Since the first introduction of cavalry, in its simplest form, thousands of years ago, there has been no appreciable increase of speed on the field of battle until quite recent times. Even the introduction of the steam engine brought little increase of speed, except in the concentration of troops. It was not till the use of the petrol engine became general during the present century that any marked advance was made. The rest of the chapter is mainly devoted to the use of tanks, especially to the results of British experience during the last few years.

2. *Le domaine défensif.* A continuation of the previous article, by Lieut.-Colonel Thouenon, dealing with strategic roads and railways, coast defence works, and the fortified works in Alsace and Lorraine.

3. *Utilisation de vehicules "railroutes" par les sapeurs de chemin de fer*, by Captain Beauvais.

The writer describes the adaptation of a motor-car to enable it to be used on a railway-line, as well as on a road. In August, 1932, the Dunlop Company gave a demonstration of such a vehicle (known as a "railroute"), before the Minister of Public Works and other high officials. In this case a Hotchkiss car was used, and the American gauge of 1·44 metres had to be increased to 1·50 by lengthening the axles in a suitable manner.

To keep the wheels on the line, each wheel is supplied with a pair of adjustable flange wheels, bolted to the brake-drums, one in front and one behind each car wheel. These flange wheels have to carry a portion of the load, since the pneumatic tyres do not get their full bearing on the rails.

The general idea of the Dunlop Company is to work the cars in pairs, a tractor and

a trailer, each weighing six tons, when loaded. The method of working the cars, and convoys of cars, is described in detail, and four photographs give a good idea of the general arrangement.

4. *Remarques au sujet de la rupture des objets solides par explosion de charges superficielles concentrées d'explosif brisant.* By Chef de Bataillon Chambon.

The writer discusses the effect of firing high-explosive charges in contact with blocks of reinforced concrete, and compares the practical results obtained with the theoretical ones.

(*May-June*, 1933.)—1. *Le pH.* By Captain Cheoux Damas.

The writer explains the modern theory of the atom. He gives, as one definition of the symbol " pH " :—" The logarithm of the inverse of the concentration in ions of hydrogen of a solution." Towards the end of the chapter he points out the possible use of its meaning to engineer officers, in preventing the decomposition of mortar or concrete. If the symbol pH of any particular kind of water is = 7, the water is neutral in action. Should the value of pH, however, be less than 7, there will be an excessive amount of acidity in the water, tending to disintegrate concrete, and it will be advisable to use a special kind of cement in the mixture.

2. *Considérations sur l'influence de la vitesse dans la guerre moderne.* By Captain Fadeuilhe.

In the fourth chapter of this article, which is continued from the previous number, the writer quotes the opinion of various foreign authorities regarding warfare of the future. Extracts are quoted from articles by General Fuller, Generals von Metsch, von Seekt, and Réquin. He deduces from these that there are two schools of thought, one pressing for out-and-out mechanization, personified by General Fuller, and the other, more reasonable in his opinion, that considers that for various reasons (given in detail) mechanized units must be limited in number, to which must be added the fact that it is difficult to use them in mountainous country.

In the fifth chapter the writer speculates on the form that the next war will take. General Kabitsch is quoted as pointing out that mobilization will mean, not merely calling up reserves, completing effectives, and forming new contingents, but it will mean transforming the whole peace organization of industry into organization for war. In spite of the Kellogg Pact and that of the League of Nations, it is not likely that any nation will wait to issue a formal declaration of war. A sudden attack without warning is that most likely to succeed.

For France, a strong line of fortifications is essential, but that is not enough. The question is one of manœuvring power: mechanized units must be opposed by mechanized units, and these must be located at suitable spots in rear of the line of fortifications.

3. *Le domaine défensif.* By Lieut.-Colonel Thouenon.

The article is concluded in this number and deals mainly with traces of works and spaces to be kept clear round each one.

A.S.H.

WEHR UND WAFFEN.

(*April*, 1933.)—*Training of Artillery Field Survey personnel.* Lieut. Christ, of the Mountain Artillery, points out that much time can be saved in preliminary training of F.S. personnel by working at a scale of 1/100 on an open space, say 120 x 120 metres, in the neighbourhood of barracks. For such miniature survey the requirements are simple enough. Six points are chosen, four at the corners of a square and the remaining pair outside it on the produced diagonals. Six pickets, preferably painted red, are driven in nearly flush where they are unlikely to be disturbed by traffic, and six metal shapes of landscape objects (towers, chimneys, windmills, etc.), about 8" x 4", are provided, each having an open ring at the base for slipping on to a picket. Picket

and cock-shy are both marked so as to ensure that the latter is always put on facing the same way.

Work can now start by orienting and allotting co-ordinates to any fixed point desired.

A necessary warning is given that for such miniature work (when errors are multiplied by 100) it is the corresponding point on the plan, and not the centre of the plane-table, which has to be plumbed above the centre of the picket.

Anti-tank Defence (continued). Defence by artillery having been dealt with, this instalment considers in turn all the other means of active defence against tanks, the a.t. gun, the heavy machine-gun, the hand-grenade, the flame-thrower, gas, and low flying aeroplanes with bombs or m.g. fire. It further investigates the position as regards a.t. defence of the leading countries.

The development of the anti-tank gun has been on two distinct lines according to its war-time twofold origin, (1) from the field gun, *via* the infantry gun to a small-calibre a.t. gun, and (2) from the machine-gun to a larger calibre m.g. firing a projectile with bursting-charge. The final results of these two developments have a strong resemblance to each other. The task of the anti-tank gun proper, "far and away the tank's most dangerous opponent," is to engage the tank from the moment of its appearance at anything up to 1,000 metres. The super-heavy machine-gun, on the other hand, supports the anti-tank gun and supplements its fire, and engages the tanks at medium and close range. The two classes of weapon may be regarded as having somewhat the same relationship to each other as the heavy and light machine-guns of the infantry. Taking the machine-guns first, a typical representative is possessed by the British in the Oerlikon m.g., Model 9, which is widely known from photographs to be the armament of the Carden Lloyd tankette. It has a calibre of 20·1 mm. and fires an armoured projectile weighing five ounces at the rate of 100 rounds a minute, piercing 1" of modern armour at 200 metres. Other anti-tank machine-guns in this class are the French 20-mm. Hotchkiss, the Dutch H.I. en H.M., and the Danish Madsen, both also 20 mm., and the Italian 25·4-mm. Fiat.

In the other class Czecho-Slovakia (Skoda 3·7 cm.) and France (1916 model TR) have as anti-tank guns old infantry guns, which with their low muzzle-velocities are below modern requirements. The new French a.t. gun, not yet introduced and about which secrecy is strictly preserved, is a 40-mm. gun on split trail, with a muzzle-velocity of 840 metres a second. Good examples of a.t. guns are possessed by the United States (37-mm. infantry gun 1925 pattern) and by Poland (47-mm. Pocisk gun M 25); while Great Britain having under trial two patterns of the Beardmore 47-mm. gun, and having partially introduced the Vickers Armstrong gun L 20 of the same calibre, has not yet been able to decide upon a universal type. Two more definitely anti-tank guns exist in the Skoda L 22 and the Bofors L 23, both of which have undergone army trials, in Czecho-Slovakia and in Poland respectively, but without being adopted.

The article then deals shortly with the almost useless and highly unpopular 13-mm. tank-rifle and with all other means of defence used against tanks in the war. Outside the special anti-tank weapons the writer sees no promise of success except such as may be afforded by the ordinary rifle and the ordinary machine-gun using improved S.M.K. ammunition.—(*To be continued.*)

The best Shape and Size of the Gas-mask Filter. In this article Dr. Werner takes exception to several of the statements and conclusions arrived at by Dr. Meyer in a previous article with the same title (*vide R.E. Journal*, March, 1933, p. 182). In general he considers that it is too early to decide whether it is possible to improve the German form of gas-mask, with screw-in filter, by means of an additional filter for suspended matter, to such an extent as to drive from the field the box-container, in spite of the latter's acknowledged disadvantages.

The Automatic-call Telephone and the Army. Having described the principles of the telephone-system with automatic-call and given some idea of what it involves,

Lieut.-Colonel von Dufais decides reluctantly that its introduction as army equipment is unfeasible. The delicacy of adjustments to a fraction of a millimeter, and protection from the slightest vibration are antipodal to the robustness necessitated by field service conditions. Constant electrical conditions demanding perfect insulation cannot be looked for where the *sine qua non* of an instrument is that its performance may be less good, but must not cease, when lines grow faulty. Further, the fact that every telephone-station can be called up only by number constitutes a grave military objection to the automatic-call system, except as applied to standing camps and back areas. It is not possible at present to contemplate more than the connection of fixed military stations to the civil automatic-call telephone network.

The International Automobile and Motor-cycle Exhibition, Berlin, 1933. The chief points at this show in February, with which Dr. Stadie deals, are the swinging axle and front-wheel drive, which he considers in its present form as unsuitable for rough ground, *i.e.*, for military purposes, until such time as the adhesion-weight of the driven axle is sufficient for the gradients to be surmounted; the N.A.G.-Voran 6/30 h.p. with air cooling, front wheel drive, separate swinging wheels and self-supporting body; the Horch 8-cylinder 70-h.p. V-engine; two-point engine-suspension; air-cooled 4-cylinder engine, 1·5 litres, 30 h.p., so important for military purposes that its further development and use must be studied; also militarily important is an improvement of the D.R.W. two-cycle engine by which the burnt gas instead of being driven out of the cylinder by the upward movement of the piston is driven out by the fresh gases.—(*To be continued.*)

The French War Survey Department in N.E. France, 1914-18.—(*Continued.*) Dr. Meyer deals this month with the choice of projections which had to take place early in 1915. The choice lay between (1) Stereographic projection from a central point, (2) Gauss's cylindrical projection, and (3) Lambert's conic projection. The latter system, upon which the choice fell, partly because it is easily extendable east and west, is a true conal projection with straight meridians converging at the pole the parallels being concentric circles cutting the meridians at right angles. J. H. Lambert, an Alsatian, produced the system in 1772 in his "Contribution to the Use of Mathematics, and their Application." The decision was based upon considerations laid down by A. Courtier in an essay in the *Annales Hydrographiques*, 1912.

Dr. Meyer gives the formulæ for the distance apart of parallels and for the other elements of the system. There are also tables of calculated co-ordinates and of meridian-convergence, and an extract from a list of co-ordinates gives geographical and Lambert's co-ordinates of certain points near Verdun.—(*To be continued.*)

A Fighting Staff Car for a Cavalry Brigade. Consequent on the abandonment by the United States of the idea of independent mechanized forces, which followed on the trials with an experimental force at Camp Eustace, instructions were issued to all arms to develop their own mechanization along the lines of increased mobility, security and fighting power.

Under these instructions the 2nd Cavalry Brigade has produced, and tried out successfully on manœuvres, a cross-country car for Brigade Headquarters, carrying an anti-aircraft machine-gun, a wireless transmitter with generator, and a broadcasting receiver with loud-speaker. The car has an all-steel body on a Cadillac chassis and special small wheels with balloon tyres. It carries the Brigadier, two Staff officers, and two wireless operators. Two interesting and important claims are made for it from manœuvre experience, (1) That it increased the performances of the Cavalry Brigade, (2) That it greatly decreased the work of Divisional Signals.

Programme of the Tenth Introductory Course in Photogrammetry. This course will be held from the 18th to the 24th September, 1933, under the direction of Professor von Gruber and Professor Hugershoff. Those attending will assemble at the lecture hall of the Zeiss Works, 2 Abbestrasse, Jena, at 10 a.m. on the day first mentioned. All lectures will include demonstrations with the appropriate instruments. Accom-

modation will be arranged for by the Verkehrsverim, Markt 2, Jena. Fee for the course, 20 marks.

Liquefied Coal for the British Air-force. The British Air Ministry has ordered from Low Temperature Carbonization, Limited, whose works are in Yorkshire, enough spirit derived from the liquefication of coal to provide for one squadron of aircraft for one year. This commission followed upon a similar order from the Admiralty, and one can only deduce therefrom that the authorities concerned are determined upon giving liquefied coal a thorough trial. The supervision of the process is in the hands of the hydrogenization specialists, Carless, Capel & Leonard, of London. 4,000 tons of motor-fuel have already been obtained from coal and delivered; and an increase in size of the plant is intended. The residue, known as coalite, can be advantageously used for central heating.

(*May*, 1933.)—*Artillery Reconnaissance and Observation.* Without detracting from the possibilities of the artillery observation planes and of observers in kite-balloons, Major Schneider here puts in a plea for the greatest boldness on the part of F.O.O's, in order that the artillery, when the next war begins, may not find itself as powerless to assist the infantry as it did at the commencement of the last war. This failure on the part of the artillery, he considers, was one of the principal reasons that a quick decision was not gained.

Modern processes of Barrel-construction and the Manufacture of Ordnance, by Colonel Blümner. The changing of an inner tube, or the boring out of an inner tube and the insertion of a liner, were formerly matters only for ordnance works, and occupied perhaps weeks, including transport. Progress in the manufacture of high-grade special steels, containing chromium, nickel, molybdenum, etc., has produced a new style of gun-construction, viz., that of the loose inner tube, *i.e.*, an inner tube having a clearance of about ·1 mm., and prevented from turning or shifting by being bolted in or held in position by a muzzle-ring. This improvement has brought it about that anti-aircraft guns or field guns so constructed can have their worn inner-tubes hammered out and replaced by new ones without leaving their firing position. There is, however, a falling-off in performance as against barrels built up in the ordinary way; so that for guns with very high muzzle-velocities and very rapid rates of fire something else had to be sought. It appears to have been found in the loose or exchangeable liner, which has made extraordinary headway during the last few years. In this case *Brassey's Naval and Shipping Annual*, 1932, says that dispersion is the same as with ordinarily constructed barrels. In Italy and in the United States, where loose liners have been used in guns of various calibres, changes of liner have taken place during gun practice. The *Norsk Tidsskrift for Sjövesen* says that a 12-cm. gun on a destroyer had its liner removed in ten minutes on board ship. *Le Forze Armate* points to the further advantage that a simple exchange of liners makes possible not only certain changes of calibre, but also permits of guns being turned into howitzers. Regarding the effects of use on such liners the *Revue d'artillerie* claims that a Schneider-Creuzot self-shrunk liner has been removed without difficulty after 3,000 rounds had been fired.

The article then mentions shortly two processes from the United States. The first is self-shrinking, in which forgings, before they are finally bored out, are subjected to a very high internal pressure, so that the inner layers of metal are strained beyond their elastic limit without the external layers receiving a permanent set. As regards the pressure of the outer layers the effect is the same as if the mantle had been shrunk on, but it is claimed for light and medium artillery that the self-shrunk barrels are lighter, cheaper, and quicker to make. The second process has been described in a publication by Colonel Dickson, the Superintendent of Watertown Arsenal. A special high-grade steel, containing manganese, molybdenum and vanadium, is cast from a travelling high-frequency smelting-furnace into cast-iron moulds revolving between 500 and 1,500 r.p.m. about their vertical axes. The revolutions are gradually diminished and the steel is perfectly hard in from ten to

twenty minutes. The effect of the revolution while the steel is setting is a denser structure, the carbon and manganese tending towards the centre, therefore chiefly settling where the greatest strain comes on the barrel. The *Scientific American* also makes other claims.

Anti-tank Defence.—(Continued.) Logically, passive defence, with which this month's instalment deals, might have been considered before active defence, since, wherever passive defence against tanks plays a role, it determines the nature and application of the active defence. Passive defence is an exploitation of the tank's limitations, and is, therefore, based upon a knowledge of the tank's powers. As regards slopes, 35° may be regarded as a maximum, but 45° is said to have been reached. As regards the climbing of vertical heights, the late Major Heigl placed this at 1·7 metres, or say the height of a Grand National jump. As regards use on mountains, not height, but steepness and the nature of the going are the determining factors. Tanks have been used at over 6,000′ above sea-level.

A far more unpleasant obstacle to tanks is water, provided it is broader than they can stride over and deeper than they can wade through. This depth may vary from 70 to 150 cm. Such a stream may be regarded as tankproof. Even swimming tanks are subject to special conditions. Taking the water under their own drive and headway until the screw takes over propulsion is easy enough. For the same reason emergence at the other side is difficult, as the screw must drive the tank ashore with sufficient way for the tracks to bite. For want of pressure on the ground the tracks only burrow themselves in.

As regards trees these can be knocked over, according to the tank's weight-class, even up to three feet in diameter; but this applies only when they stand alone. Trees three yards apart and in any depth are a most formidable obstacle to tanks. As regards woods, much as the tank-leader seeks them for the approach-march and for assembly, he still strives to gain a decision in open country, and at any rate not to attack in predominantly wooded country. Young plantations hinder tanks but little, forests are generally traversed by clearings and glades. The detrimental effect of woods upon the action of tanks lies, therefore, less in their impenetrability than in the fact that the tank loses both field of fire and observation, its gun-fire becomes useless, its machine-gun fire largely ineffective among the tree-trunks. The defender of a wood against tanks will make his obstacles as effective as possible, and so that they serve his active defence. Tanks which penetrate the wood he will generally be able to put out of action by means of mines, flame-throwers, or even hand-grenades. One more serious obstacle to tanks is worthy of mention, and that although serious military writers have assured us it cannot recur, viz., the field of craters, called *paysage lunaire* with an appropriateness evident to all who have seen a photograph of the moon. Even these shellholes filled with mud and water were negotiated by British tanks, by means of inclined baulks or of fascines, the latter in the case of the Mark IV and Mark V tanks being laid by the tank itself. Since the pressure on the ground of the tank has been found to be little more than that of the ordinary man walking, as long as a sufficient number of fascines is available, the crossing of swampy ground presents the tank with no special difficulty. This circumstance points the teaching that an obstacle must lie under effective fire. To test swampy ground before a tank attempts it three or four men should be sent over it in Indian file. If the last man, treading in the footsteps of the others, does not sink more than ankle-deep, the tank will be able to follow. This test applied by the defence will show whether swampy ground can be relied upon as a tank-obstacle.—*(To be continued.)*

The French War Survey Department in N.E. France, 1914-18.—(Continued.) The final article of this series deals with miscellaneous matters—the preparation of the *plans directeurs*, the provision of optical instruments by Puteaux, and later by the Survey Department itself, and other statistics, such as, the number of officers and O.R. employed in the various branches, and the total output in maps.

A new English Tractor and Trailer for loads up to 100 tons. Describes with photo-

graphs and diagrams an interesting production by Scammell Lorries, Ltd., of a 6-wheeled (two pairs driven), 80 Brake H.P. tractor with a 40-foot trailer having seven axles in rear and a saddle-coupling in front.

The Question of Supplies, past and present. A classic example of catastrophe following a complete breakdown on the line of communication is the 1812 campaign. It would have been more than remarkable if Napoleon, who had shown himself to be a master organizer of supplies (as, for instance, in 1805 and in 1809) had failed in this respect in his great undertaking against Russia. It was not so. For this campaign, also, supplies were well thought out and arranged. Only the Emperor drove his masses of troops forward on Moscow at such a rate that in a country poor in roads horse-transport supplies could not keep up.

Another example of the rapid advance without respect for the supply column was the advance of von Kluck in Belgium and France in 1914. Here, as the troops lived to a great extent on the country, and as at first there was little fighting, the breakdown of supplies was hardly noticed, except in a shortage of bread, and later, when the first heavy fighting started, in a shortage of ammunition. The failure again was due to the inadequacy of horse-transport, and especially in this instance to its inability to cope with the voracity of the Q.F. gun.

In 1914 all armies took the field with horse-transport either entirely or to a very great extent in their supply columns. Since then a new element has arrived, so that now motor transport dominates. The superiority of motor transport over horse transport might at first appear to usher in a new era, but it has to be remembered that a new devourer has arisen in the horse's place, the machine. What is saved in oats and hay, is more than lost in petrol, spare parts, and in workshops. Existing regulations contemplate the retention of the horse forward of where motor transport ceases. It remains to be seen whether the void of the battlefield will permit of even this much use of horses, or whether supplies to the front line will not have to be delivered by tanks and by low-flying aeroplanes.

In pre-war armies the officer, whose work was not directly connected with these things, received little instruction about ammunition and supply columns. With the advent of mass-armies and the progress of technics, supply questions concern every officer. The enormously increased requirements of every sort have brought it about that the question of supplies in war directly affects the decision.

The Country's Defence the Country's Honour. Illustrated papers in Cologne and in Hamburg have brought out special numbers to make evident to Germans the "staggering disproportion" between the armed strength of Germany and that of its neighbours. One chapter bears the pertinent title, "*Who* needs security?"

(*June*, 1933.)—*Anti-tank Defence.*—(*Continued.*) After dealing with the natural objects of passive defence the writer comes to artificial obstacles. Among earthworks trenches can be made very troublesome to tanks or even impassable, but have the great drawback of requiring an immense amount of labour. For this reason they can really only be considered for position warfare. Trenches are hard to conceal, and when discovered can be easily improved for the passage of tanks by artillery or trench-mortar fire. They should only be used to fill a gap at a spot where the tanks are bound to come, and not where the tanks can go round them. The same applies to another form of earthwork, the pit or tank-trap. The only place for a tank-trap is a defile. The Germans put them one on either side of the huge craters they made when blowing up roads, with the result that the British tanks drove round the pit and crater with no more trouble than driving round the crater alone.

Iron and concrete obstacles, although, given time, they can be made effective enough, hardly belong to mobile warfare. If a railway is handy, rails may be buried close together to two-thirds of their lengths, or better, concreted in, pointing towards the enemy. The rule for obstacles being kept under fire applies, otherwise the tank may clear itself a passage. Concrete posts and pyramids must be too high for the tank to pass over, and thus bring it to a stop with one track in the air. Abattis can

be very useful, and were used with complete success by the Soviet troops in 1919-20 against White Russian tanks. In this case it worked best to fell the trees inwards, *i.e.*, away from the attacker.

Provided the transport question can be solved, the ideal tank obstacle for mobile warfare is the mine.—(*To be continued.*)

Infantry and Artillery Liaison. Colonel Blümner's article about artillery shelling their own infantry (*vide R.E. Journal*, June, 1933, p. 366) has produced some reminiscences of what happened when Kemmel was taken from the French in April, 1918. From the moment when a French preparatory bombardment drove the Germans forward into the front line, so that they were able to overwhelm the French attack when it came, to the moment when the German barrage descended on their own reserves, the whole battle on both sides was a vivid example of what can happen with faulty liaison between artillery and infantry, and also of how good infantry, even after long years of fighting, can fail to realize artillery possibilities.

The Boulengé Chronograph. Major Pappas, of the Greek Artillery, explains a new method, tried at Athens, for which he claims that it makes it possible both to exclude systematic errors, and to estimate probable errors. He uses, in fact, two chronographs, the electro-magnets of which are so connected that each screen is common to two circuits. Interruption being simultaneous, any difference in the reading of the time-measures must be due to the instruments.

The International Automobile Exhibition, Berlin, 1933.—(*Continued.*) As regards the lorries, in their variety and in their significant development they gave a gratifying picture. From the military standpoint, however, the variety was still too great. Without its hands being in any way tied in its development and in its inventive and creative joy, the automobile industry should make it a point of honour to see that the satisfaction of the requirements of trade is made with full regard being paid to the demands of the army. Only the simplest supply conditions, as regards spare parts, tyres and spirit, guarantee the faultless performances which the army requires. Of militarily important specialities may be mentioned: (1) The Diesel engine. This, in all its forms, has made essential progress since the last exhibition, in simplified construction, in performance and in reliability. The Diesel lorry of to-day is a good performer technically, and economically, provided it is in the hands of a skilled and experienced driver; but in time of need such people are rare. In all qualities necessary for military purposes the ignition engine is still so far ahead that the Diesel engine's second military drawback of requiring double the supply of oil need not be considered. Until large M.T. formations can be universally equipped with high-speed and noiseless Diesel engines the extra load cannot be justified, and from a driving point of view the introduction of small numbers of Diesel lorries is impossible. (2) The air-cooled engine. Together with its lightness this has the militarily great advantage of permitting almost complete armouring. Horizontal cylinders make it very compact. Improvements may be expected in noise-reduction. (3) The wood-gas generator. Although in France trials with these generators have been going on for some years, they are still not reliable enough either for the army or for civilian traffic. They are urgently required in the home country and on the lines of communication to set free oil, heavy and light, for the front.—(*To be continued.*)

F.A.I.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*April* 1933.)—*The Exploitation of Railways in War by the Austro-Hungarian Army.* The new editor, Major-General Ratzenhofer, leads off with one of his interesting historical studies, fortified by all official dates and figures. The period covered is the first six months of 1916, and therefore includes, in addition to satisfying the requirements of all ordinary war-traffic—reinforcements, rations, forage, ammunition, supplies, hospital-trains, leave personnel—the troop movements necessitated by three distinct

sets of operations. The fronts concerned were as widely separated as Cattaro, in the extreme southern tip of Dalmatia; the Bukovina, east of the Carpathians; and the South Tyrol. It so happened that all three theatres were badly served by railways: Cattaro, reached only by a single railway through the mountain wilds of Bosnia and Herzegovina; the Bukovina, lacking broad-gauge communication with Siebenburgen, because trade jealousy between Austria and Hungary had wrecked all War Office railway projects; S. Tyrol, possessing only a single railway from Franzensfeste down the gorge of the Eisack to Bozen. This railway dearth makes the writer's plain tale a record of problems solved and difficulties overcome.

War—never again? By Colonel Wessely. The writer's argument runs on the following lines:—Eternal peace is the highest of aims. There is only one way to the true peace, and that is through the Christian spirit of brotherly love and justice. Without this there can be no true and permanent peace. But before this can be realized we shall all need a complete change of spirit. This change of spirit must not only be in ourselves, but in all nations. Failing this spirit, defencelessness only puts the idealist at the mercy of his evil-intentioned neighbours. It is our sacred duty to work with all our power for the peace-idea, to make, at any rate, amongst civilized peoples the cry of "War never again" true. But we have equally the duty of caring for our own safety. If our ideals are not to perish—including our peace-ideal—we must be prepared to defend them. A nation without the will to defence is on the road to decay. For the highest that we know we must be prepared to give our lives. Through military service, properly administered, the noblest qualities of man are called forth. The spirit of discipline, the will to obedience, the awakening of the spirit of self-sacrifice, the putting up with hardships of every sort, devotion to the public service, working in common for the good of all, the cultivation of comradeship, are all virtues which lift men out of the low levels of selfish struggling in the daily effort to gain their livelihood, and will serve them as guides for life.

The article may be regarded as a pointer to the change which is expected from Austria's present small professional army to what all Austrians, broken to arms, will regard with satisfaction, universal service if only in a militia.

Modern Defence Organization. In considering what must be the defence organization in peace and war of the modern Great Power, now that we have the nation in arms to reckon with, Major-General Wiktorin starts very nearly where the writer of the foregoing article left off, with the nation's will to defence. As this is the first and most important foundation of the nation's defence organization, one of the most important tasks of every statesman conscious of his responsibility is the awakening of this will. "Where the correct feeling towards national defence is present, the duty of defence is not looked upon as an unpleasant duty, but as the right of the citizen, and the idea is far from being remote of making the granting of political rights dependent upon previous service to the State in some form or other." Here some hints as to how this most desirable feeling is to be awakened and stimulated would be welcome, but the writer unfortunately breaks off. He then treats of: geography as a decisive factor; the nature of future wars; land, sea, and air forces to be under one commander-in-chief in war, and in peace, when each has its own minister, a chief of the General Staff for all three branches will advise the Prime Minister.; that land, sea and air forces must be under one commander-in-chief in war is taken as self-evident; air forces can still be used independently.

On the nature of the future army Major-General Wiktorin says there must be an army of operations, and a mass army, more or less of the nature of militia. Many reasons contribute to this decision, of which perhaps the chief is that a mass army could not rise to the high standard of training and technical skill which modern warfare demands. The small highly-trained professional army has been forced upon us as a result of the great size of modern national armies, and prohibitive cost. The line of separation was foreshadowed in the Great War, not so much in name as in fact, when certain formations used to be sent wherever there was most fighting,

while others were preferably kept on quiet fronts. This cleavage is shown now in France, with its *armée de couverture*, and behind it the *nation armée*, in Italy with its field army and its Fascist militia, in Russia with its rifle-divisions and its territorial formations. Sweden, the Baltic States, Poland and Czecho-Slovakia have also adopted this principle, and so too have to a great extent two Great Powers, although they are without conscription, Great Britain and the United States.

Certain points about these two armies are worth laying down:—

(1) A continual effort must be made to keep the army of operations as large as possible, and to keep the difference between it and the mass-army in training and equipment as small as possible.

(2) A sufficient proportion of the army of operations must be kept always more or less on a war footing, so as to be able to take the field in a few days; in the case of special troops in a few hours.

(3) There must be one organization for the whole of the land forces, so that any single formation, or body of formations, can pass at any time without difficulty from the mass-army to the army of operations.

The writer then considers compositions, mechanized and motorized formations, and special troops. He cuts out the Corps, his peace-time armies consisting of divisions. On the nature of service he says that only universal service can be considered, but that in its widest term. Not even every man of military age will serve in the mass-army, let alone in the army of operations; but serve he must in some capacity, and be ready to be called upon when required. His training should start with training as a youth, and when called up, it would last from two to three years in the army of operations, or alternatively, six to twelve months in the mass-army.

For the army of operations voluntary enlistment must be used as widely as possible. To encourage this certain privileges in their later civil life must be reserved for ex-soldiers of this army.

As regards the continued education of those who have completed their service, the system at force in Switzerland of ex-soldier unions, charged with this responsibility, might well be studied.

Of equal importance with the personnel question is the question of material. In general this is a question of the most extensive utilization, regulated by law and well prepared, of all the resources of national defence. It includes what is called economic mobilization, rationalization, and the fullest assistance to the conduct of war that technics can afford. The writer here inserts a note of warning that the guiding principle must be "man *and* the machine" with man always in the first place.

Economically must be arranged and striven for: the country's greatest possible independence as regards indispensable foodstuffs and raw materials, accumulation of stocks of raw materials obtainable only abroad, manufacture of substitute materials, security of the people's food-supply. Technical points are: the widest possible standardization of the most important articles, like motor transport; no provision of great stocks of articles which are quickly out of date (*e.g.*, aeroplanes, tanks, armoured cars), but an unremitting following up of every improvement, combined with arrangements for mass production of the latest type in case of war.

Finally the finance question. In order to be truly economical the budget for defence must take a long view. "What is saved in peace in money has in war to be paid for two and three times over in blood."

(*May*, 1933.)—*The Continuous Line in Mountain-Defence.* Colonel von Pfersmann tells the story of how the continuous line came to be adopted for the defence of the Tyrol. The whole of the South Tyrol from the Brenner Pass downwards, and including *Italia irredenta, i.e.*, the portion inhabited predominantly by Italians, formed a sharp salient into Italy. Field-Marshal Conrad, as appears from his Memoirs, cherished between 1906 and 1911 the plan of defeating Italy by a powerful thrust from this

S. Tyrolese salient in the direction of Venice. In order to be able to assemble an army of three to four hundred thousand men in the S. Tyrol for this blow, it was decided that the salient should be surrounded by a chain of works and fortresses. By the fortification school of the period this system of group-fortification was accepted as dogma, while the old system of line-fortification was regarded as quite out-of-date. The fire power of the defender, infantry as well as artillery, had to be collected in single points, the "works." What lay between them was "interval." Roads of approach were to be closed by means of stone or concrete forts. The country between these forts was labelled either impassable or, at least, impracticable. Its defence (if any) would be left to mobile forces.

The outbreak of the Great War found accordingly that the most important inlets into this mountainous country had been closed by more or less modern works, interspersed with older stone forts. An assessment of the defence value of all the works was made in September, 1914, by a Major-General of Engineers, an extract from whose report is given. The two fortresses of Riva and Trient, and twelve other barrier-groups, with garrisons from one battalion upwards, were considered to be capable of holding out for periods varying from a few days upwards. It was estimated that the whole would require 60 battalions to man.

When the war came Austro-Hungary soon had its hands full with war on two fronts, Russian and Serbian. The defence of the Tyrol in the event of Italy entering the war was at first left to that province itself. Having been drained of troops, it was no mean achievement when the Tyrol produced 14 battalions for that purpose, seven of Landsturm (the last line) and seven Labour-battalions. This number was so far short of the estimated requirement, that G.H.Q. was asked whether reinforcements could be expected to occupy the works. The answer given was that none such must be reckoned with.

The Commandant of the Tyrolese Defence Forces, Lieut.-Fieldmarshal von Koennen-Horak meanwhile was busy enough. He first reconnoitred the perimeter from end to end, came to a profound disbelief in the group-system, being convinced that the works could all be avoided and outflanked by parties of troops working their way over the mountains, and then against stout opposition carried out his idea of a continuous line of defence. There were plenty of difficulties also in the choice of this line. Eventually, with the aid of thirty more battalions combed out of the Tyrol, the line of resistance ran 350 km. long from Switzerland to Carinthia. One barrier-group, S. of Rovereto, was left outside this line and abandoned to the enemy as indefensible owing to shortage of troops. With this exception the whole of the groups remained in Austrian hands from start to finish.

The Fighting for the Bainsizza Plateau, 12th-30th May, 1917. After the slight but hard-won gains of the first five battles on the Isonzo, the Italians first made considerable progress by capturing Gorizia and the Doberdo plateau in the 6th battle. After the slight advances resulting from the 7th and 8th battles, the 9th battle brought them as far forward as Kostanjevica, 11 km. south of Gorizia and 10 km. beyond the river. Cadorna, who was always ready to fight, now wished to strike decisively in the direction of Laibach, if the Entente would assist with troops. The French and British were unable to do this owing to their own offensives planned for the spring, but they sent heavy artillery. Cadorna then decided to attack in co-operation with the offensive on the Aisne, putting in 12 divisions N. of Gorizia and 16 divisions S. of Gorizia in the direction of Mt. Hermada.

The fighting here described in detail by General von Fabini is what occurred on the northern portion of this 10th battle of the Isonzo. It is clear that the Austrians regard their resistance as a victory, but the Italians crossed the river and captured important heights along a front of 9 km., whence they were able to take the Bainsizza plateau at their next attempt.

Switzerland and its Army, by Colonel von Wittich. This sketch gives a good picture of the Swiss militia system, its peculiarities, its strength and its weaknesses.

The most questionable feature of this system is the short period of service—five to six and a half months only. It is true that Sweden, Norway, and, as far as infantry is concerned, Holland, have no longer period of service, but in all other European countries having conscription, the active time with the colours still varies between twelve and eighteen months, so that one year's service may be taken as the average, just as before the war two years' service was the average. Generally, previous military training and an increase in size of the army are accompaniments of this diminished period.

However the Swiss militia may compare with the soldiers of other nations, it appears from this article that there are not lacking opinions of Swiss officers, like General Wille and Colonel Bircher, which, if they err, err on the modest side. And that is all to Switzerland's good.

Reconnaissance. Lieut.-Colonel Rendulic writes his considerations upon Part III of the Austrian *F.S. Regulations*, which he finds treat this subject more exhaustively than the regulations of any other country, in that they not only formulate numerous principles, but also break much new ground.

The main difference appears to be that Reconnaissance is sub-divided into three activities which are treated separately, viz. :—(1) Reconnaissance proper, concerned only with the enemy, sub-divided into air and land reconnaissance, and working by observation and by other means for eliciting information. (2) Survey, concerned not with the enemy, but with the terrain ; and (3) Observation, which is one of the means of reconnaissance, but has many duties outside that service, reporting enemy aircraft, locating our own troops, correcting artillery fire, providing security on the march, etc.

What is common to these three activities is that they have to establish facts which furnish a basis for the conduct of the fight. The Austrian regulations distinguish between them according to their differing objects. This is done for the sake of clarity and defining the tasks of the personnel concerned.

The Danish Defence Act of 1932. Owing to the passing of this Act the military policy of Denmark has completely changed. The Defence Act of 1922, which has just been superseded, allotted to the Army the task of defending the new southern frontier in Schleswig, while the Navy was charged with defending, closing if necessary, the three straits connecting the Baltic with the North Sea. This Act, which was introduced at a time when there was much talk of disarmament, and when Denmark had passed with unviolated neutrality through the Great War, made inadequate provision for guarding Denmark's neutrality should that be seriously threatened by a Great Power landing on either of the chief islands, Zealand or Funen.

The new Act puts the whole responsibility of defence on the Army, and provides it for the purpose with modern infantry equipment, armoured-cars, eight 4-gun A.A. motor batteries and new American searchlights. The Engineers are organised into three battalions, two of pioneers of three companies each, and one of telegraphs of five companies. Three reconnaissance squadrons of 10 aeroplanes each are added to the Air Force, and two squadrons of fighters of 15 aeroplanes each. Altogether a great accession of strength, besides the improved organization.

From Professional Army to an Army of Millions. Major-General Wiktorin here reviews the work of Lieut.-Col. Kortzfleisch which bears this title, and describes the vast development undergone during the Great War by the armies of the two Anglo-Saxon powers. The understanding shown by this Austrian reviewer, and his sympathetic references to Great Britain, are the more appreciated as contrasting sharply with the tone adopted in recent German reviews. From the reviews on Czech-Fochberg's *Those Responsible in the World War*, and P. Kluke's *England's Military Policy and the Building-up of her Army from the Boer War to the Great War*, there breathes a spirit to make glad the hearts of armament-makers, a whiff of the old *Gott Strafe England !* For this relief, much thanks.

(*June*, 1933.)—The number starts with a portrait of the Minister for the Army, Carl Vaugoin, opposite an announcement in large type to the effect that the President of the Austrian Federation has in acknowledgment of his eminent merit conferred upon the Minister for the Army, tax-free, the title of General of Infantry.

There follow a letter of greeting from the new general to his comrades, and an editorial to explain the honour.

Conrad von Hötzendorf and the Question of his War Guilt. No better person could be found to repel the accusations against Field-marshal Conrad of having been a partisan of war than the officer who was head of his Intelligence Branch from 1909 to 1914, the writer of these notes, Lieut.-Fieldmarshal Urbanski. Conrad has been accused of having wanted war, and of having worked to bring war about. Quotations are made from his writings and sayings as evidence against him. His present defender has little difficulty in disposing of these attacks. The simple explanation of warlike utterances by Conrad was that he was a believer in preventive war, *i.e.*, in fighting at a time favourable to yourself instead of waiting for the time favourable to your opponent. For that, of course, one must be certain that war is inevitable. Here Conrad proved himself to be a far-seeing statesman. He saw that war with Serbia was inevitable from the day that Austria proclaimed her annexation of Bosnia and Herzegovina, he foresaw that Italy would not only desert the Triple Alliance but would fight against it, he foresaw that Rumania, in 1910 Austria's natural ally against Russia, would in war be found on the side of Austria's enemies.

The Line of Defence of the Tyrol. The first article having shown how it came about that a continuous line of resistance more or less following the Austro-Italian frontier for 350 km. was chosen instead of the existing system of barrier-groups, there follows now a list of the new works constructed and some account of the work. The tracing of the new line in the mountains could be done on no map: it had to be left to the commanders of sectors to do on the ground. These officers and their Staffs climbed about the snowy mountains for months. As the tracing was completed the works started, just as the winter arrived, with a snowfall unfortunately above the average. There followed months of work both unpleasant and dangerous, the difficulties of which may possibly be appreciated by comparison with those of a glacier-expedition, though the latter is undertaken in midsummer, when routes are marked, mountain-huts are staffed and stocked, and trusty guides are available. The working parties had to find shelter at great heights. Their tools, wire and food had to be dragged up after them. They had to work in places where later no officer or man was allowed to move about without paying out of his pocket a red string to give him a chance of being saved after being carried away by an avalanche. To the difficulties of the task generally came the additional labour consequent upon the discovery that many of the works were mere shell-traps. The guns had then to be transferred outside to new positions, and the works were evacuated, remaining only to be fired at.

Except for portions of the line above 6,000′ the work was complete by the end of April, 1915, and all paths leading to it from the enemy were systematically destroyed.

On the 4th November, 1918, Italian motorized forces on the valley-roads passed through the line unbroken through three and a half years of war.

The Russo-Polish War of 1919-20. Colonel von Wittich leads off with three lists of writers, whose publications have dealt with this campaign, not only Russian and Polish, but also French, both in original works and in translations. In Germany and Austria, on the other hand, the number of publications on the subject is strikingly small, pointing to an unfortunate lack of interest in what is in many respects well worthy of attention. The characteristics differentiating this war from the Great War immediately preceding it may be summed up as follows:—The armies were less well trained, armed, equipped and led, thus approximating more to the armies of civil war. A lack of organization and a lower state of technics made the whole

proceedings more primitive. There was all through a deficiency in the application of strategical principles, until in the final chapter of the Vistula battle there appeared a large and bold design on the Polish-French side. But most remarkable of all was that two years after the end of the Great War, in which cavalry had receded into the background, an unexpected resurrection of cavalry took place, which stultified the idea that the last cavalry battle in history had taken place, and showed that Eastern Europe contains cavalry possibilities still.

Events are divided into three distinct phases :—(1) Up to May, 1920, Poland's star in the ascendant : the occupation of Kiev marking the zenith. (2) The Russian masses driving the Poles back to the gates of Warsaw. (3) The Vistula battle, which completely changed the aspect of things : the flooding back of the Russians behind the Niemen and with that also the end of the war.

In this number Colonel von Wittich deals only with the first of these phases. His criticisms incline towards the view that the advance on Kiev brought only an apparent success, and may not unrightly be labelled as an adventure.

Considerations about the Pacific Problem. General Wiesinger's introduction to these considerations consists of some notes on Jehol, and a narrative of the recent operations in that province, a juxtaposition for which the justification lies in the concluding lines of the same writer's *The Fight for Manchuria* (*vide R.E. Journal*, June, 1933, p. 373). Jehol has a bearing on the problem of the Pacific, because its conquest by Japan strengthens the Japanese hold on Manchuria, and thus menaces both the United States and Great Britain.

The other great event during the last six months of special significance to the Pacific problem is Japan's withdrawal from the League of Nations. Japan thus obtains a free hand, like the U.S.A. and Soviet Russia, a state of affairs affecting the relationship of these three competitors to one another, as well as Japan's relations with the other powers having interests in the Pacific.

Japan's fight for space, for life, for the future of her uncannily increasing population, has expressed itself during the last forty years in a policy of expansion, which has set firm foot on the Asiatic mainland, cut off from the open sea wide stretches of Asiatic coast-line, and planted its outposts deep in the Russian spheres of interest. Its aim, like that of the United States, is to possess the Chinese market, so as to ensure the sale of the products of its own highly developed industries, and work for its own workpeople.

According to General Wiesinger, Japan's great plan is two-fold, the first part of which is the securing of her position on the continental or land-front, to be followed by securing her front towards the Pacific. He thinks that the United States and Japan will play the chief roles in the fight for supremacy in the Far East and in the Pacific, that these two will have to settle by fighting the question of whether white or yellow is to be the ruling race.

Incidentally, figures are quoted as to Australia's capacity for human beings. The N. and N.E. of Australia are supposed to have room for about 30 millions : the whole of Australia for between 100 and 150 millions. The present population is about 10 millions.

The writer, whose judgment of Far Eastern affairs has proved to be very sound, looks upon the eight-day campaign which added Jehol to Manchuria as only a stepping-stone to Mongolia, at present nominally Chinese but actually by peaceful penetration Russian.

Camouflage. Lieut.-Colonel Rendulic discusses here Part IV of the Austrian F.u.G. (*Field Service Regulations*). What is chiefly of interest in these regulations is that they attempt to distinguish between concealment, as hitherto understood, principally of a passive kind, and a more active form of concealment which for want of a better word we must be content to call blinding or blanketing. The definition given, viz., " Camouflage embraces measures which are intended to make it more

difficult for the opponent to make correct observations at the right time," paves the way to a distinction between camouflage proper, or simple concealment, and active measures undertaken either to mislead or to prevent the enemy from obtaining information. The underlying idea in this distinction has educational value, since it aims at teaching the soldier that his action must always be in accordance with the dictates of camouflage. It emphasizes the active object of concealment so as to increase the fighting value of the troops.

An Example of Road-making in War. Colonel Waldmann tells the story of one of the last of many technical achievements of the Austro-Hungarian Army during the Great War. Time, the winter of 1917-18, after the great successful break-through, known to the Italians as Caporetto, and to the Austrians as the 12th battle of the Isonzo. Situation, the Austrians on their right wing had reached the Monte Grappa and been held there. The supply question to this new front in difficult country was acute, and it was decided to build a road to decrease the distance between Feltre in the Upper Piave valley and Vittorio in the Soligo valley, by going over the mountain ridge, running S.W. from Col Vicentin, 5,730' high to Monte Cesan, 5,100' high. The new road 15 km. long from Tovena to Trichiana would shorten the distance from railhead, Vittorio, to Feltre for vehicles by 30 km.

Work started on Feb. 1st, 1918, with 500 men of road-making companies. The number employed had increased to 7,000 at the completion of the work five months later. They included engineer, pioneer and infantry companies, boring sections, hand and pneumatic, lighting detachments, road-metal machine and steam-roller personnel, M.T. and pack-animal columns, Italian, Russian and Serbian prisoners of war, and civilian employees of a Viennese firm of contractors, Bosnians by nationality and by profession tunnellers.

The main difficulty with the road occurred where there were almost perpendicular heights rising some 300 feet. The site chosen for surmounting this obstacle was a gorge 50 yards broad with perpendicular sides and a bottom consisting of moraine, sloping at 30° to 45°. Up this gorge zigzagged a bridle-path. The task was to make the gorge practicable for heavy guns, *i.e.*, it must have a road 5·5 metres broad, with a maximum rise of 10%, except for short distances of 15%, and a minimum curve of 10 metres radius. The new road had to rise 260 feet, must therefore be at least 2,600 feet long, of which at most 1,000' could be traced in the gorge itself. Five of the six serpentines had therefore to be made in tunnels, each tunnel rising from 15' to 18'.

As regards the work itself the rock was found to be firm enough for the tunnels to be left unlined, and later stone for causeways was obtained by increasing their width. Owing to the simultaneous commencement of all tunnels, and of taking out the foundations for the causeways between the tunnels, there was at first the greatest difficulty in getting rid of the spoil, work being brought almost to a standstill, until sufficient outlets and shoots had been provided.

Lighting for the night-shifts was at first by acetylene torches, which, on account of unsteady flame and deep shadows, were replaced later by ordinary electric bulbs. The latter were in their turn replaced by the best system of lighting, a number of 35-cm. searchlights, distributed round the top of the gorge.

Explosions were carried out with No. 1 dynamite, with a very powerful bursting gelatine, captured from the Italians, and occasionally with liquid air, but the latter is unsuitable if a charge has to wait any time before being fired.

Cement for the bridges arrived at the end of February, but owing to lack of water for concrete the bridges were all made of wood, fortunately enough as it turned out, for it facilitated their destruction when the Austrians retreated in October.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1933.)—Général Brossé begins *La marche d'approche* in this number. In war throughout history the approach march has usually had more effect on the enemy than any other operation. Frederick the Great realized that his troops could move quicker than his adversaries, and he beat them accordingly. Napoleon, using conscripts with little training, defeated nearly all his enemies. In 1870, the French held very fine positions, but the Prussians were superior in their approach marches and were consequently successful. In 1914, the French advanced into the Ardennes in columns, where they were met by the Germans deployed and so were defeated. Each war provides a more complicated problem than the one before it, and now with many different rates of movement, from armoured cars at 20-30 miles an hour to infantry at 2½ miles an hour, approach marching is more important and more difficult than ever. Général Brossé explains in considerable detail how a division moves nowadays, first in columns, then partially and finally fully deployed, and how its covering troops must provide the protection without retarding the pace. Immediately one wonders what will happen if the enemy use tanks in their advance guard; how can they be stopped? The writer suggests some form of armoured machine-gun carrier with A.P. bullets in the battalion, as he quite rightly points out that the use of tanks at first may mean that they will not be available later on when battle is joined all along the front. The article is worth reading if only to see the various different factors affecting the approach march nowadays.

Lieutenant-Colonel Larcher finishes *Données statistiques concernant la guerre* 1914-18, with certain general graphs giving the losses of the Allies and Central Powers throughout the war and also the effect of the submarine campaign. As the writer says, one can take too much notice of tables and not enough of the human element, but at the same time the production of these figures does give an idea as to how far a nation can go without breaking up, whatever its nationality. The German losses were mainly in killed, wounded and prisoners; the Turkish largely in sickness and desertions, but the net result is very much the same for each nation.

Capitaine Mousset continues *De la bataille de la Marne à la course à la Mer* in this number. Throughout this instalment Von Falkenhayn is trying to bring off a decisive success on the western front while the army commanders are unable to comply with his wishes. He has already ordered the 6th Army to attack on the German right; he now feels that it will only attack in driblets and he orders the remaining armies to attack frontally; and they point out how difficult it is to do so after the setback on the Marne. When eventually the 6th Army really gets under way towards Amiens it finds a French army there before it, and a deadlock occurs. The only real success is east of Verdun, where the Germans reach St. Mihiel on the Meuse owing to a surprise attack, and this success provides Von Falkenhayn with something to "write home about." Actually, it now appears that the armies on both sides needed a certain interval before being plunged into violent battles again. It was later on in Flanders, at the first battle of Ypres, that both sides fought themselves to a standstill.

Georges Gay has a short article describing *Le 15 août 1914 sur la Meuse : Combat de Dinant*. The French 1st Corps, under Franchet d'Aspérey, had the task of preventing the Germans crossing at Dinant, and well did they carry it out. The article only describes this particular action, and is of more interest to Frenchmen who were there than to Englishmen. It is, however, a comfort to read of an Allied success at this period of the war, when the Germans were generally succeeding all along the line.

A further long instalment by Colonel Blaison, of *Un passage de vive force du Rhin français in* 1848 appears in this number. Reading this many years after one cannot help feeling that there was a great deal of talk with very little action as far as Germany was concerned. When the German Legion from Paris reached Strasbourg, Herwegh, the local patriot, gave vent to a tremendous document about the Legion, how it was ready to advance and so on. This was unfortunately crushed by a decree from

Paris, which pointed out that France was at peace with the German states and that numbers of men with arms could not possibly pour into those states from France. The decree therefore dissolved the collection of Germans in the eastern states, and ordered their arms to be collected. Although this collection was not carried out quite according to the decree, it certainly damped down the zeal of that particular German Legion. In the meantime another Legion was being formed in Switzerland, but it was fated never to cross the Rhine at all. Colonel Blaison gives a very full description of the various incidents; it is an article requiring careful reading, as so many people appear in it that to read it lightly leaves one with a mass of names and no detail as to what they all did.

(*May*, 1933.)—Général Brossé finishes *La marche d'approche* in this number. One feels after reading it through that there are many ways of carrying out an approach march and yet none of them really "fills the bill." There are reasons for advancing on a wide front; on the other hand, not more than a third of the infantry can act as advanced guards; this means that although 6,000 yards can be covered by a division, it is only capable of fighting on 3,000 yards; this is too narrow for an advance. The problem, then, is which of these rules is to be given up, or are tanks to be produced to help, or shall the modern divisions again be defeated when advancing as the French were in the Ardennes in 1914. What Général Brossé suggests is that during the advance each infantry regiment should have an artillery brigade, engineer company, etc., under its orders, and so be ready to strike hard without waiting for the divisional commander. This is, of course, on the same lines as the British use of infantry brigades with artillery brigades in support of or even under their orders. It still does not really solve the complete problem of how an advance is to be carried out sufficiently quickly yet without running undue risks. For anyone who is interested in this very important problem, Général Brossé's article is of very good value.

"1815-1914," by Lieutenant-Colonel Pugens, starts in this number. The writer begins by showing that between the two Napoleons the French army had a wonderful series of successes; she then fell, and great was her fall. He then goes on to explain how the various generals were apt to be jealous, how preparations were not always made for the various campaigns, and how it was the great efforts of the French troops themselves which brought off their undoubted successes. No doubt these successes were of considerable extent; wars such as the Crimea and against the Austrians in Northern Italy apart from other campaigns in Africa were sufficient to raise the morale of the French nation. There was, however, one thing lacking, namely, the opposition of another nation with equally good troops and better organization. This did not occur before the Franco-German War, and the result was immediate. The French were defeated, and to the Englishman it seems that the general lack of organization was enough to produce the defeat of the French as soon as they came up against a nation like the Germans.

Colonel Blaison continues *Un passage de vive force du Rhin français en* 1848 in this number. The whole story is too complicated for even a short review; there are so many people and so many places concerned. In this instalment part of the Legion is successful in crossing the Rhine and moves slowly forward, conferences are held every evening, and no one knows what is likely to happen or where the Legion will proceed the next day. At any rate, it is easy to see how a force should not act if it proposes to go to war.

In the third instalment of *De la bataille de la Marne à la course à la Mer*, Capitaine Mousset describes how Falkenhayn and Joffre each moved gradually towards the race to the sea. Neither of them were suddenly seized with the idea of a race of this kind, but each found it impossible to attack with any degree of success where the front was stabilized, and therefore tended more and more to outflank the enemy. The German army commanders were not anxious to continue their attacks in the centre of the front and Falkenhayn therefore became more and more reconciled to a wide outflanking movement. At the same time, the French efforts in the neighbourhood of

the Meuse had little result and Joffre, in just the same way, thought also of a wide outflanking movement. The instalment ends with the commander on each side preparing to attack farther north.

General Inostrantzeff has an interesting article entitled *La première poussée allemande sur Varsovie* in this number.

In spite of the Russian defeats at Tannenberg and the Masurian Lakes, her armies had been successful against the Austrians in Galicia. According to the Russian plan of operation, once the Austrians had been defeated the Russians proposed to turn against the Germans in the country round Warsaw. The Germans, on the other hand, were faced with a more difficult problem. They still had to leave as many troops as possible in France, yet they felt that they must relieve the Austrians, who had been decisively defeated. Fortunately for the Germans, Hindenburg and Ludendorff knew far more of the Russian plans, partly owing to the capture of an officer who carried the plans on him, than did Nicholas, the Russian commander-in-chief, know of the German plans. Therefore the Germans were able to act more vigorously than the Russians. Although they failed to capture Warsaw and were forced to retreat, they inflicted severe losses on the Russians and the Austrians were relieved to a considerable extent. On the whole, however, the Russians may be regarded as having been able to impose their wills on the Germans during the first campaign against Warsaw in 1914, although they suffered to a great extent.

(*June*, 1933.)—Général Loizeau begins *La manœuvre défensive* in this number. It is well known now how the French never even thought of the defence before the war, and how disastrous were the results in 1914. Général Loizeau begins by considering the defence in the time of Frederick the Great and Napoleon, and he shows immediately how these great commanders were only able to attack on the whole of their front when the enemy adopted a system of purely passive defence. Many of Napoleon's campaigns illustrate most clearly the system of offensive-defensive, and the writer's object in this article is to show how Foch, who could never be accused of having a defensive mind, used defence to facilitate offence. From reading Foch's orders during the war it will be seen that tactically his orders were to defend to the very last ounce, while strategically he was often prepared to refuse battle for a considerable time. We must not forget that the Marne, in 1914, was the result of Joffre being prepared to continue his retreat until the Allies were ready to strike. As long, therefore, as we realize that Foch's principles in defence do not include sitting still, but entail particularly the formation of defensive reserves, the defence will appear to us a necessary combination to be used with the offence, and that it is normally by the use of both that the greatest victories will be won.

Lieutenant-Colonel Pugens finishes " 1815-1914 " with a short description of the effects of the war of 1870-1 on the Great War of 1914-18. It is interesting to see how some of what was not done in 1870-1 was remembered later, while other mistakes were made in 1870-1 and again to a higher degree in 1914-18. Before the outbreak of the 1870-1 war, Napoleon III had spoken airily of alliances, particularly with Italy; when he was heavily defeated the King of Italy was only too thankful that he was not involved. As a result France made quite certain of allies before 1914, and entered the Great War with Russia as a definite ally and a good understanding with Great Britain. Where the lessons of 1870-1 were not taken to heart is shown by the way the German generals acted on their own in 1914. The elder Moltke had already had trouble of this kind, but nothing compared to what the younger suffered. The result was that the younger Moltke lived so far back that he really exercised little control, and at the same time the Staff began to have a separate control of their own, culminating in the action of Lieut.-Colonel Hentsch. This is an article well worth reading.

In the fourth instalment of *De la bataille de la Marne à la course à la Mer* Capitaine Mousset describes first the German attempt to break through at St. Mihiel and then a further inconclusive French attack followed by a repulse in the neighbourhood of

Péronne and Albert. At St. Mihiel the French troops had failed in intelligence concerning the Germans and in consequence had to send forward a division in a great hurry; as a result the Germans nearly broke through the French line and the St. Mihiel "pocket" was formed and was not removed till the autumn of 1918. This did not, however, prevent Joffre from preparing to attack the German right with an army under Castelman on Manoury's left. Owing to lack of information by the French, however, this attack never reached any distance, the Germans captured Péronne, and the line eventually was stabilized just east of Albert. The whole of this period, towards the end of September, 1914, consisted of attacks by either side with insufficient information followed by a stabilization of the front farther and farther north.

Colonel Blaison finishes *Un passage de vive force du Rhin français en* 1848 with a description of the defeat and capture of that portion of the Legion which managed to cross the Rhine, followed by a final epilogue on the whole course of operations. The different insurgent leaders attempted to continue the movement against the German states, and eventually they were successful for a short space until more regular forces came from Prussia and crushed the revolutionaries again. The whole article is long and requires a good deal of attention if it is to be followed throughout by anyone who is neither a Frenchman nor belongs to the country near the Rhine, where all the action at the end of the article took place.

Colonel Bernis begins *Essai sur le renseignement à la guerre* in this number. He starts with three operations, each of which show how the action of the enemy must be considered from the start. These are the orders to the 40th French division on 22nd August, 1914, the German attack on 15th July, 1918, and the famous (or infamous) Plan XVII of the French. The 40th division were ordered to advance practically without intelligence of the enemy, and as a result the division found itself in difficulty throughout the day. On 15th July, 1918, Ludendorff tried to repeat an attack carried out at Riga without considering the action of the French; when the attack came off the Germans found it to be a blow in the air. Finally we most of us know how the French never considered the Germans advancing well north of the Meuse at the outbreak of war, and how the French plan broke down from the start as a result. Colonel Bernis gives these examples to show how essential intelligence is, and points out how Napoleon may have been overwhelmed by numbers but was never surprised.

H.A.J.P.

CORRESPONDENCE.

Headquarters, Northern Command,
York.
30*th July*, 1933.

THE CORPS BADGE.

The Editor, *The R.E. Journal.*

DEAR SIR,

Since the custom is arising in the Corps of using the badge of the Royal Arms, I would suggest that consideration is given to the way in which the coat is drawn. I understand that at the present time it follows the style laid down in *Dress Regulations* of 1911, but there are two comments to be made on an adherence to that design. Firstly, the official style of heraldic drawing has changed since 1911, and a reversal has been made to the original character of mediæval times, which is very desirable as it represents heraldry as it was when a living art and used on coat armour in the field; the drawing of the Royal Arms on current numbers of the *London Gazette* is a good example of this character; the shaded background, however, is quite unnecessary. Secondly, there is really no such thing as an "official" pattern in good heraldry; the blazonry of the coat is certainly official, but the way in which the blazonry is depicted varies according to the space that it is required to fill—for instance, the design intended for a round button is not suitable for a rectangular space.

I would suggest, therefore, that the character of the representation of the Royal Arms on the cover of *The R.E. Journal*, Christmas cards, etc., be reconsidered; and that a type of drawing be introduced which follows the original mediæval character, very much on the lines of the Arms at the head of the *London Gazette*, with a few differences, such as the omission of the background, and the substitution of the letters R.E. for G.R. A plethora of mottoes is not needed; the two "Ubique" and "Quo fas et gloria ducunt" are an intrinsic part of the badge granted to the Corps, but the motto "Dieu et mon droit" is not in any way an essential part of the Royal Arms, and so I would suggest that only the first two be used.

I suggest also that the detail in the colouring be given careful attention.

I am, Sir,
Yours faithfully,
J. G. O. WHITEHEAD,
Major, R.E.

ECONOMICS.

[It is not proposed to open the columns of *The R.E. Journal* to a discussion on *Economics*, but the following letter is published in view of the general interest aroused by the theories of Major C. H. Douglas, and the mention of his books which appeared on page 718 of *The R.E. Journal*, December, 1932.—Editor, *R.E.J.*]

16, Farquhar Road, Upper Norwood,
July 13th, 1933.

The Editor, *R.E. Journal*.

Dear Sir,

A recent review of the works of C. H. Douglas in *The R.E. Journal* was so alarming that I hastened to enquire for the books. His early books are out of print, and the publisher has ceased business, but a new publisher has brought out his latest work about 18 months ago, and from it I was able to get some idea of the author's story.

His fundamental idea appears to be that (p. 17) bankers when they lend money, create money. This misunderstanding of the methods of banking rather destroys the value of his arguments, for bankers create credit, not money. They allow the borrower to use the bank's cash, which they know from experience will otherwise lie idle in the till. The author confuses cash with deposits. The bank cash does not increase when a customer receives a credit account, that would be too simple a way of getting rich quickly.

Money is one of those vague terms which even trained economists are apt to use without due care, and the amateur may be excused for mistakes in its use. Mill on the value of money, and Adam Smith on the exchange value of commodities, have, I believe, left little to be said on those questions.

The author says (p. 26) that one unit of human labour produces to-day at least 40 times as much as 100 years ago. He bases this conclusion (*inter alia*) on the output of motors per man, which in recent years has increased 210 per cent. There is clearly some fallacy in this approach to the subject, for, in fact, the productive capacity of human labour in that particular industry has increased infinitely since about 1895, when the first motor-car was built. The truth is, I believe, that the output of human labour has improved perhaps 25 per cent. in the nineteenth century, and perhaps another 25 per cent. in recent years, owing to one or two fortunate discoveries and inventions. But even this is doubtful.

Later on the author gives a diagram in which he shows that, since Mr. Montague Collet Norman (the name is printed in full under the diagram) became Governor of the Bank of England, the suicide and

bankruptcy rate has increased by some large percentage. This gives the author an opportunity to bring in that blessed word deflationary, which he applies to Mr. Norman's policy, and which he appears to believe is one of the causes of our troubles. If that has really been Mr. Norman's policy, it has been singularly unsuccessful, and the truth is that banks have very little real influence in such economic changes, if they confine their activities to legitimate methods.

The author claims to prove his theory by showing that bank deposits in England did not increase between 1920 and 1928, when at the same time they increased in America by 32%. Variations in bank deposits prove little, they are influenced by many factors which have little to do with inflation or deflation, and it is common knowledge that deposits may increase in times of depression. Moreover, the figures he quotes appear to include both deposit and current accounts. It is at least certain that no-one borrows money from a bank in order to leave it at the bank on deposit.

But for other reasons the figures of bank deposits prove nothing. If American bank deposits increased 32% between 1920 and 1928, it was a poor showing, for they increased 80% between 1900 and 1908. As to English banks, the League of Nations bulletin shows that deposits at English joint stock banks increased £117,000,000, or about 1⅛% per annum between 1922 and 1928, and from the *Economist*, 1910, p. 1,123, I find that bank deposits increased in England from £790,000,000 to £890,000,000 between 1900 and 1910, about 1¼% per annum. There is, therefore, no support in the bank deposit figures for the author's condemnation of Mr. Norman.

Most of the war inflation of sterling still exists. The ratio of cash to loans in British banks is now 33%, compared with 50% before the war. The National City Bank of New York shows a ratio of over 50% in their last return. Our currency shows an inflation to-day of 150%, having fallen from 200% since 1920 owing to the fall in prices. This fall is temporary and will disappear with a recovery in prices, which cannot fail to come (it has arrived)—gold prices, I mean. In the U.S.A. there was an inflation of currency of 50% at the peak of prices in 1920, but this had disappeared by the end of 1932. A 50% inflation is no more than a variation from normal which must occur from time to time, and, in fact, there was no inflation in the U.S.A. more than may often occur in boom times. These figures show that the author has been misled in supposing there has been any deflation in England.

On page 14 he quotes a definition of money attributed to Professor Walker, which says that money is "any medium" which "no one will refuse to exchange for his goods," a good enough definition for a Stone Age school of economics. But for 3,000 years or more the

users of money have decided to accept only gold or silver as the medium (for many good reasons), and it is a waste of time to reopen the question.

The author follows the definition with a sentence of eighty words, from which one may extract the words "creating money." He is again confusing money with credit, or the acknowledgment of debt. No one can create money. It can be produced by an expenditure of labour, just as you may produce a steel rail, and its value depends on the cost of production (J. S. Mill, *Pol. Econ.*, Bk. 3, ch. 7, s. 3.) Notes are not money, they are I.O.U's, verbal promises or acknowledgments of debt. The value of an I.O.U. is fixed by the buyer, and the names of all the bankers and prime ministers in Europe on the back of a note cannot take from the buyer his power to give in return for the note only what he thinks it is worth. This has been proved hundreds of times, and finally by the case of the £ note, which is legal tender for one sovereign, but is, in fact, worth about half that amount of gold, or in other words of labour of that value, as anyone who thinks back 20 years cannot fail to realize.

Mr. Reginald McKenna is quoted (p. 15) as saying that "every bank loan creates a deposit, and the withdrawal of every bank loan destroys a deposit," a statement which needs so much qualification, that it might be flatly contradicted in this context. The author puts the statement into mathematical symbols—a proof, he says—and in doing so unwittingly exposes its error. The assumption that cash remains constant is impossible. New money must be deposited, if there is to be an increase of loans beyond a certain limit known to experience. The author's mistake is in supposing that loans can be increased (legitimately) without cash, beyond that limit. If loans were increased beyond that limit, a time would come when the bank is denuded of cash, while customers' accounts are still in credit. The bank will then have to close its doors, cease business, unless it can rapidly call in its loans.

In chapter 4 the author gets into difficulties over production, wages, and prices, and develops an A + B theorem, for the notice of students. A page is devoted to a diagram which shows that if a certain sum A + B is spent every month for five months on wages and materials, then the resulting product will have cost 5 A + B. I do not perceive any virtue in the diagram which is not found in two lines of print, in fact, it took me some time to gather the meaning, which two lines of print would have conveyed at a glance. A lump sum called profit is added at the end, in order to arrive at the price. Might not a rectangular figure be added each month for this also?

Assuming the diagram to represent the world's work of five months, the author's difficulty appears to be that if the wage earners

spend their wages each month, how are they to buy what they produce at the end of the period? It is difficult to take this seriously, one may suggest that what the author calls "wages" required to pay the world's wages for January, is contained in his item B "from a previous cycle," and the produce at the end of May becomes the item B of the next period, from which "wages" are paid. There is no mention of increasing population or "the surplus" and the omission leaves the whole argument incomplete.

The author's real grievance appears to be that bankers since the war have acquired too much power. In that we may sympathize with him. The bankers, led by the advice of irresponsible economists, have needlessly assumed functions and powers which the human machine is incapable of carrying out. But the remedy is to revert to pre-war practice, and "let gold do it." The banker's functions then become automatic or mechanical, leaving him no room for discretion or latitude. The return to the use of gold money, and the enjoyment of peace and prosperity, which will go with it, cannot now be far off.

Yours truly,

L. E. HOPKINS, *Lieut.-Colonel.*

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