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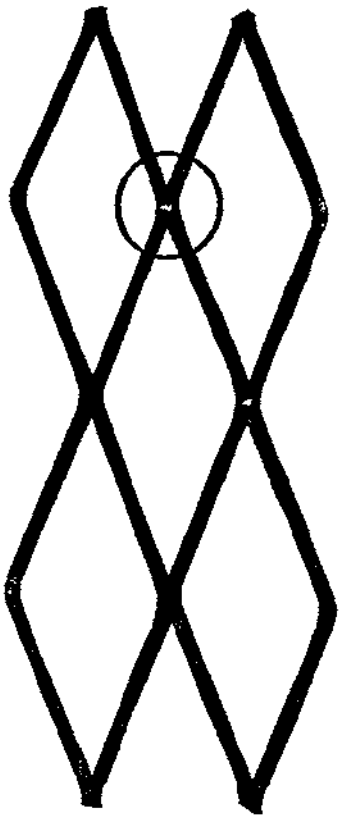

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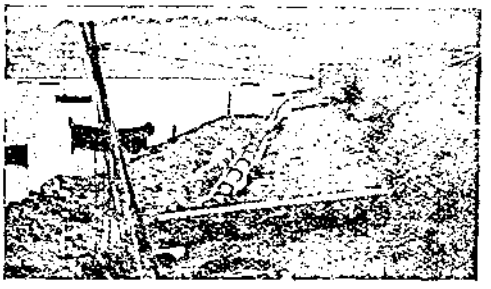

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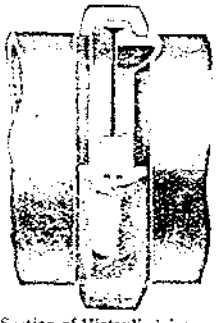

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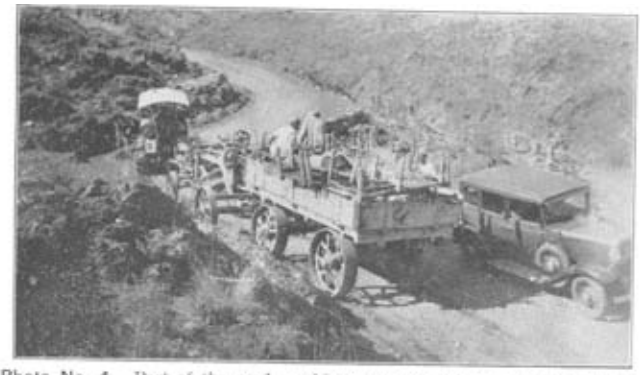

Photo No. 4.—Part of the road machinery convoy going up to Ghalanai on August 29th.

Photo No. 5.—The machine-made road, Ghalanai Camp in the distance.

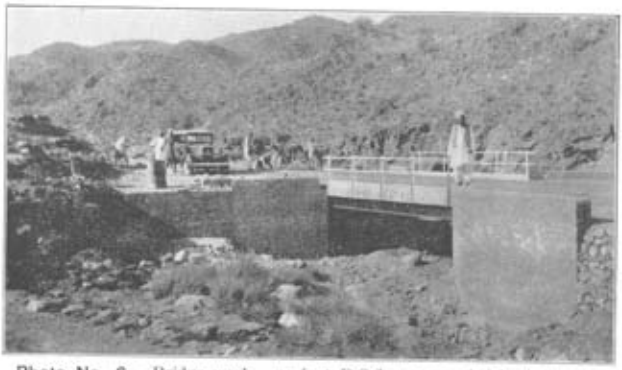

Photo No. 6.—Bridge work. 21-foot R.S.J. span on brick abutments.

ROAD RECONNAISSANCE.

It should be realized that practically no soldier in Peshawar had ever been in Mohmand country. It was a closed book to us. The last expedition was in 1908. In 1915 there were operations against the Mohmands, but these consisted chiefly in repelling an attack upon the administered territory. At that time a line of blockhouses was built along the frontier, and this line had practically been our boundary ever since.

When, therefore, the Lower Mohmands asked us to come to their assistance, we found that we knew little of their country, except what we could get from reports of the 1908 operations and from route books. This was no fault of those responsible for collecting information, because it had been quite impossible to visit the country except by means of a reconnaissance in force. We knew that the terrain was mountainous and that there were some open valleys. We had made reconnaissances as far as Dand, just beyond our administered border, and we knew that beyond Dand the country would be excessively difficult. Some of us had been over it by air, so we knew what to expect.

This was the situation on 26th July, 1933, when the writer was informed that operations would probably be undertaken against the Upper Mohmands and that a motor road from Pir Kala to Ghalanai would probably be required. An air reconnaissance was therefore carried out by the writer on that day.

It is believed that this is the first occasion on which the whole R.E. plan for an operation was based on an air reconnaissance without any ground reconnaissance. The reconnaissance turned out to be extremely difficult owing to the nature of the country (see Fig. 2). The three ruling points for the road having been given, viz., Pir Kala, Dand and Ghalanai, and a ground reconnaissance between Pir Kala and Dand having been done, the object of the air reconnaissance was to settle the alignment between Dand and Ghalanai. The existing track was about two feet wide with a grade of 1 in 4 in many places. The track was marked on the map, but on the ground it was scarcely discernible and disappeared in rocks and *nullahs* on numerous occasions (see Photo 1).

However, an alignment had to be selected and an estimate and plan had to be made for a motor road, and there was nothing else to do but to make out these from the air reconnaissance. The procedure adopted was to fly over the whole area with the object of deciding the best general alignment for a motor road and then to tackle each short section in greater detail. It was decided that the best general alignment was to keep to the original track, such as it was, and to get the grade necessary for a motor road by taking advantage of the numerous spurs that existed. Previous to going

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THE GANDAB ROAD.

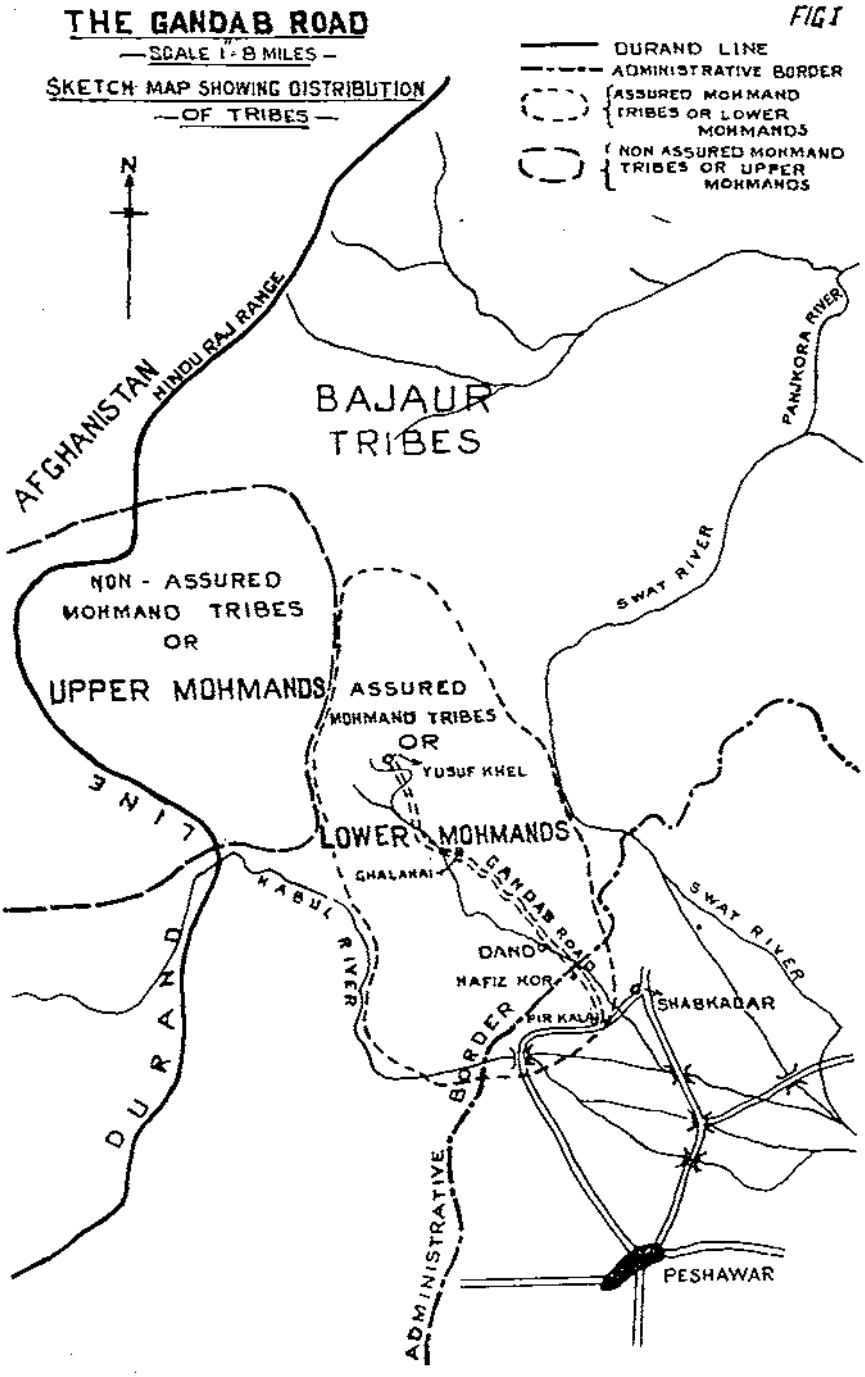
By LIEUT.-COLONEL A. V. T. WAKELY, D.S.O., M.C., *p.s.c.*, R.E.

CAUSE OF THE MOHMAND OPERATIONS, 1933.

THE north-western portion of the tribal territory of the Peshawar District between the administrative border and the Durand Line is occupied by the Mohmand tribes. These tribes had on frequent occasions in previous years raided into the administered territory, and numerous expeditions had had to be sent against them.

They are divided roughly into two categories, the assured tribes and the remainder. The assured tribes consist chiefly of the Lower Mohmands; their habitat is the area adjacent to the administrative border, and they receive allowances from us. The remainder consist of Upper Mohmands who receive no allowances from us, and over whom we have practically no control. They reside in the mountain fastnesses of the Hindu Raj range along which the Durand Line runs (see Fig. 1).

In recent years there had been intense tribal jealousy between the Upper and the Lower Mohmands. In 1932 this was accentuated by an incident typical of the many small occurrences which are liable to cause a flare up on the frontier. An old muzzle-loading gun was sold by the Afridis to a section of the Upper Mohmand tribes, and in its journey to the tribe it had to pass through Lower Mohmand territory. This was too good an opportunity to miss and the Lower Mohmands seized the gun. Subsequent inter-tribal fights culminated in 1933 in an unprovoked attack by the Upper Mohmands upon our assured tribes, and several villages were burnt. The Lower Mohmands then asked Government for assistance and it was decided to send an expedition into Mohmand country.


THE GANDAB ROAD
—SCALE 1"-8 MILES—
SKETCH MAP SHOWING DISTRIBUTION
—OF TRIBES—
FIG I
DURAND LINE
ADMINISTRATIVE BORDER
ASSURED MOHMAND TRIBES OR LOWER MOHMANDS
NON ASSURED MOHMAND TRIBES OR UPPER MOHMANDS
N
AFGHANISTAN
HINDU RAJ RANGE
BAJAUR TRIBES
PANJKORA RIVER
SWAT RIVER
NON - ASSURED MOHMAND TRIBES OR UPPER MOHMANDS
ASSURED MOHMAND TRIBES OR
YUSUF KHEL
LOWER MOHMANDS
GHALANAI
GANDAB ROAD
KABUL RIVER
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SWAT RIVER
DURAND
BORDER
ADMINISTRATIVE
PESHAWAR

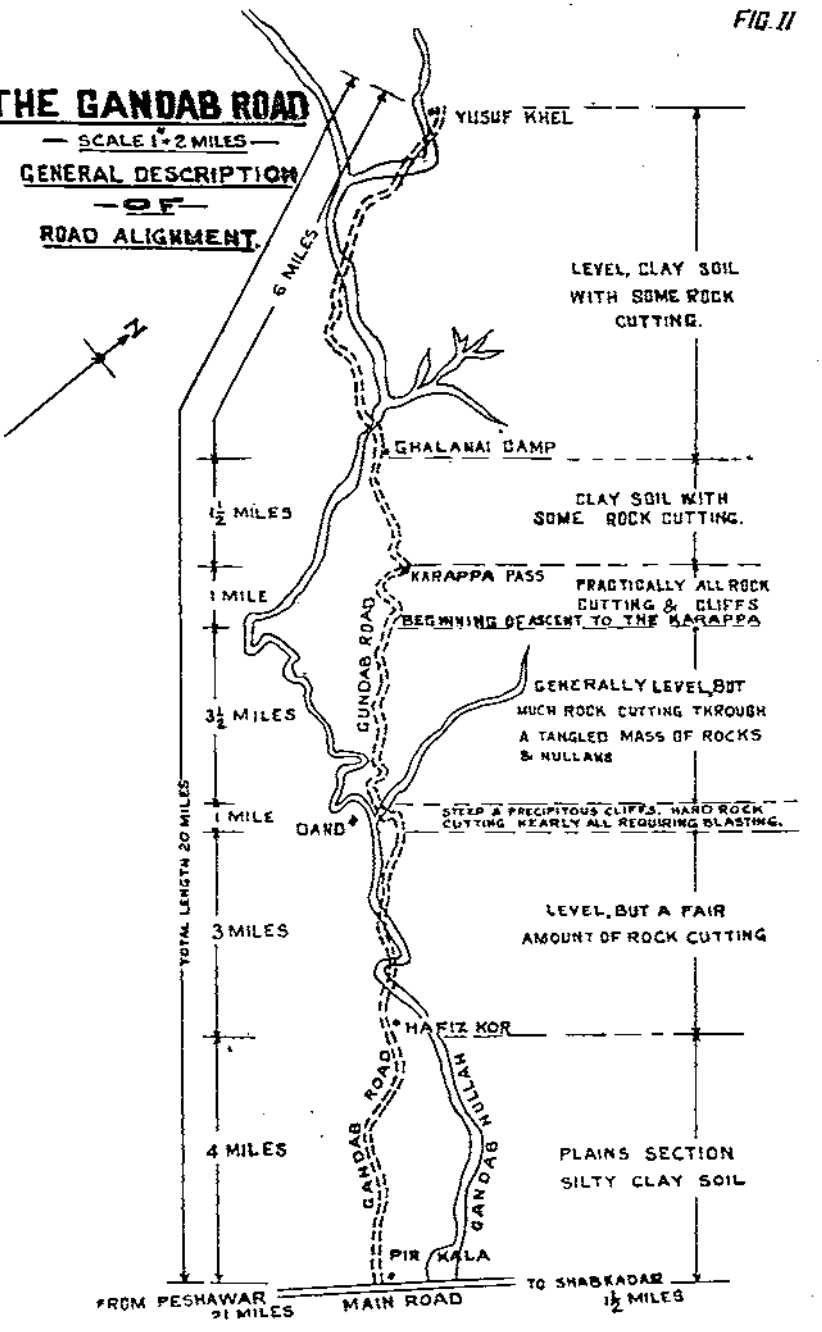
up in the air a very close study was made of the map, and the country was divided into sections and marked on the map taken up. The pilot was then asked to fly over each section in turn about ten times at a low height, and sketches were made of the probable alignment that the motor road would take. On return to Peshawar an estimate was made out of the time and labour required for the road. The time given was eight weeks, which was exactly what was eventually taken, but the labour required was under-estimated. It is quite possible to make an estimate from the air of such a road, but it does require previous practice and training. The writer had had opportunities for this training, and to this must be ascribed the success of these air reconnaissances. The procedure during training is first to fly over the proposed road and make an estimate. Then walk over it on the ground and see where mistakes were made, then fly over it again and find out why the mistakes were made.

The general alignment selected from the air was subsequently adopted, with one notable exception in Miles 9 and 10. Construction was pushed on so rapidly that the surveyors laying out the actual line were only just in front of the working parties, and the Field Engineer's detailed reconnaissance was only just in advance of the surveyors. On one occasion we were trying to find the best way down a steep *nullah* when we saw on a hill above us an old wall. This was an unusual sight, because no one in their senses would build a wall in such a country without some cause. The whole area was a tangled mass of rocky hills with no house or habitation of any sort within miles. We decided to investigate the wall, and after much hill climbing on a very hot day we found an old road alignment. Subsequent enquiries proved this to be an old Buddhist trade route. It must have been built about 2,000 years ago, and it was in use up to about 100 years ago. We traced it for 2½ miles and eventually adopted it for our new motor road, at a great saving in time (see Photo 2). The question immediately arose as to why the writer had not seen this from the air, and he went up in the air again to find out. The old alignment, even when one knew exactly where it was, was quite imperceptible even from a low height. It had become so overgrown and so merged into the surrounding country through a century of disuse that it was quite impossible to see it, except from the *nullah* below, from where the old pieces of retaining wall were visible.

ROAD CONSTRUCTION—FIRST STAGE.

To resume the chronological order of events, although no orders had been received that the operations would take place, it was clear that they were imminent, and the night of 26th and the whole day of 27th were spent in making a plan, and arranging for such further

FIG. II


THE GANDAB ROAD
— SCALE 1 = 2 MILES —
GENERAL DESCRIPTION
— OF —
ROAD ALIGNMENT.
N
6 MILES
YUSUF KHEL
LEVEL, CLAY SOIL
WITH SOME ROCK
CUTTING.
GHALANAI CAMP
½ MILES
CLAY SOIL WITH
SOME ROCK CUTTING.
KARAPPA PASS
1 MILE
PRACTICALLY ALL ROCK
CUTTING & CLIFFS
BEGINNING OF ASCENT TO THE KARAPPA
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3½ MILES
MUCH ROCK CUTTING THROUGH
A TANGLED MASS OF ROCKS
& NULLAHS
1 MILE
OAND
STEEP & PRECIPITOUS CLIFFS, HARD ROCK
CUTTING NEARLY ALL REQUIRING BLASTING.
TOTAL LENGTH 20 MILES
LEVEL, BUT A FAIR
3 MILES
AMOUNT OF ROCK CUTTING
HAFIZ KOR
GANDAB ROAD
GANDAB NULLAH
4 MILES
PLAINS SECTION
SILTY CLAY SOIL
PIR KALA
FROM PESHAWAR
21 MILES
MAIN ROAD
TO SHABKADAR
1½ MILES

reconnaissances as appeared necessary or were possible. On the evening of 27th July orders were received that the operation was to be carried out. These orders fixed 27th July as Z day, which in the programme had been fixed for making arrangements to commence work. We lost an important day here, because we had agreed to complete the first four miles, which were easy, by Z+2. At dawn on July 28th a C.R.E.'s reconnaissance was made up to Dand on horseback. It was a hot day, and several officers elected to ride in shorts, a proceeding which they afterwards regretted. It took eight hours to ride the seven miles to Dand and back, owing to the stony nature of the existing track. During this reconnaissance a complete plan was made out for road construction up to Dand, where motor road-head had to be established by Z+6.

It was imperative that work should start that evening if possible, or at latest next morning at dawn, if this programme was to be carried out. Fortunately, owing to extensive road construction work in Peshawar District, which had been in progress for eighteen months, we possessed a number of road-making machines. At the first whisper of operations these had been secretly concentrated near Shabkadr, so they were readily available. They were ordered to commence work forthwith and by the evening of 28th nearly two miles of road had actually been constructed.

This was a good start, and it had a great moral effect on everyone as we had generally been depressed by the apparent impossibility of our task. It was clear, however, that the machines could only do the plains section of the road and that they were incapable of doing the equivalent of hard pick work in rocks and stones. We therefore made arrangements for 1,500 local labourers and 300 donkeys to arrive at dawn on 29th and to be put on the work. Tools for them were rushed up from Peshawar by lorry during the night. The scene on the road on the morning of 29th baffles description, but gradually order emerged out of complete chaos. All these men were employed as daily labour, because it was impossible in the time to arrange for contractors, or for the contractors to get any labour. The payment of this labour was a matter of extreme difficulty because

(i) They would not work unless they were paid daily.
(ii) They would not accept notes, but must have rupees.

The result was that Coxwell-Rogers, the Field Engineer, had to carry heavy bags of rupees about with him, which greatly reduced his mobility. He had a really good day and by the evening of 30th July had actually constructed a further two miles of road up to Hafiz Kor.

No. 2 Field Company, K.G.O. Bengal S. and M., under Pim, had

arrived on the evening of 28th and was available for work on 29th. There were thus three agencies employed on the road at this period.

(1) No. 2 Field Coy. on the most difficult rock-cutting portions up to Dand.
(2) Daily labour all along the section between Hafiz Kor and Dand where the machines could not work.
(3) Road graders on the plains section.

The general organization was under the C.R.E. Peshawar District, who was in command of the Field Units, S. and M. and the Military Engineer Services of the district. Work proceeded on these lines on 31st July, when motor road-head was established at Dand, seven miles from Pir Kala. We were thus ahead of our programme in terms of Z in spite of having lost a day at the beginning.

The Peshawar Brigade passed through us and proceeded up to Ghalanai, and the Nowshera Brigade camped at Dand. There were then two brigades with attached troops taking part in the operations.

The first stage of the road construction was thus completed, and consisted merely in getting some sort of a motor track through to Dand. The real difficulties of the road were still to come.

Road Construction—Second Stage.

The second stage of the road construction was to open the road for another seven miles as far as Ghalanai. We could now, on 1st August, proceed on horseback, though with considerable difficulty (see Photo 1), as far as Ghalanai, and we were able to see what we had to do. We were all greatly depressed by the sight. To begin with, at Dand, there was a series of formidable-looking cliffs and steep slopes composed entirely of rock, up which the motor road would have to go. This sort of country extended for a mile. Then there followed four miles of tangled rocky hills and *nullahs*, culminating in a high pass known as the Karappa. Fortunately the country was in general, except for the Karappa, at more or less the same level, and the Karappa could obviously be crossed only at one spot. Beyond the Karappa there was an open valley where the going was easy.

The writer had given eight weeks as the time for construction, so it was obvious that the Brigade at Ghalanai would have to be maintained on a pack basis until road-head reached Ghalanai. For this purpose some 2,000 camels and mules had been collected at Dand. They added in no small degree to the difficulties of the road work, since throughout working hours long convoys were continually passing, interfering with the work and preventing the firing of charges for the rock blasting (Photo No. 9).

The organization of the whole road construction work was changed

on 1st August from a daily labour basis to a contract basis. Although this did delay work on the Pir Kala–Dand section owing to the change over, it had to be done, as it would have been quite hopeless to attempt to control the amount of daily labour required for the Dand-Ghalanai section. A combination of the two methods under M.E.S. control would have meant hopeless confusion. It was possible, on account of the additional supervision available, to allot daily labour to the field companies, and this was done.

It was realized that there were two portions of this section which would take longer to complete than the rest, viz., the ascent from Dand in Mile 8 and the ascent of the Karappa in Mile 13. These difficult sections were given to the field companies, No. 3 Field Coy. K.G.O. Bengal S. and M., under Davidson, having been sent up from Roorkee for the operations.

The organization then decided upon was (see Fig. 3) :—

Mile 8	..	No. 3 Field Coy. assisted by 600 Tarakzai labourers.
Miles 9, 10		Contractor Mir Aslam Khan with about 2,500 men.
Mile 11	..	Contractor Abdul Manuf with 1,500 men.
Mile 12	..	Contractor Arbab Ataullah Khan with 1,000 men.
Mile 13	..	No. 2 Field Coy. assisted by 500 Halimzai labourers.

Work was started on these lines, but it was soon clear that the field companies would be unable to do the sections allotted to them in reasonable time. Assuming the actual working strength of a field company at about 250 men, they would only have 850 men in the one case and 750 in the other actually on the work, whereas each contractor had between 1,200 and 1,500 men per mile on easier miles.

Owing to political considerations daily labour had to be drawn from the local tribe and no more men were available. The only alternative, therefore, was to reduce the distances allotted to the field companies. That given to No. 3 Field Coy. was reduced to half a mile and No. 2 Field Coy. was given a quarter of a mile on the Karappa. The contractors were at the same time ordered to increase their labour.

These latter men were drawn from all over Peshawar District, notably the Khattak area and the Khyber. From long experience these tribesmen were expert in rock-cutting and blasting and they were hardy and good workers. They turned out to be invaluable. They are organized in village gangs of 25 men, each with their own mate and each man is allotted his own proper task. Certain men always do the jumper work for making holes for blasting, others do

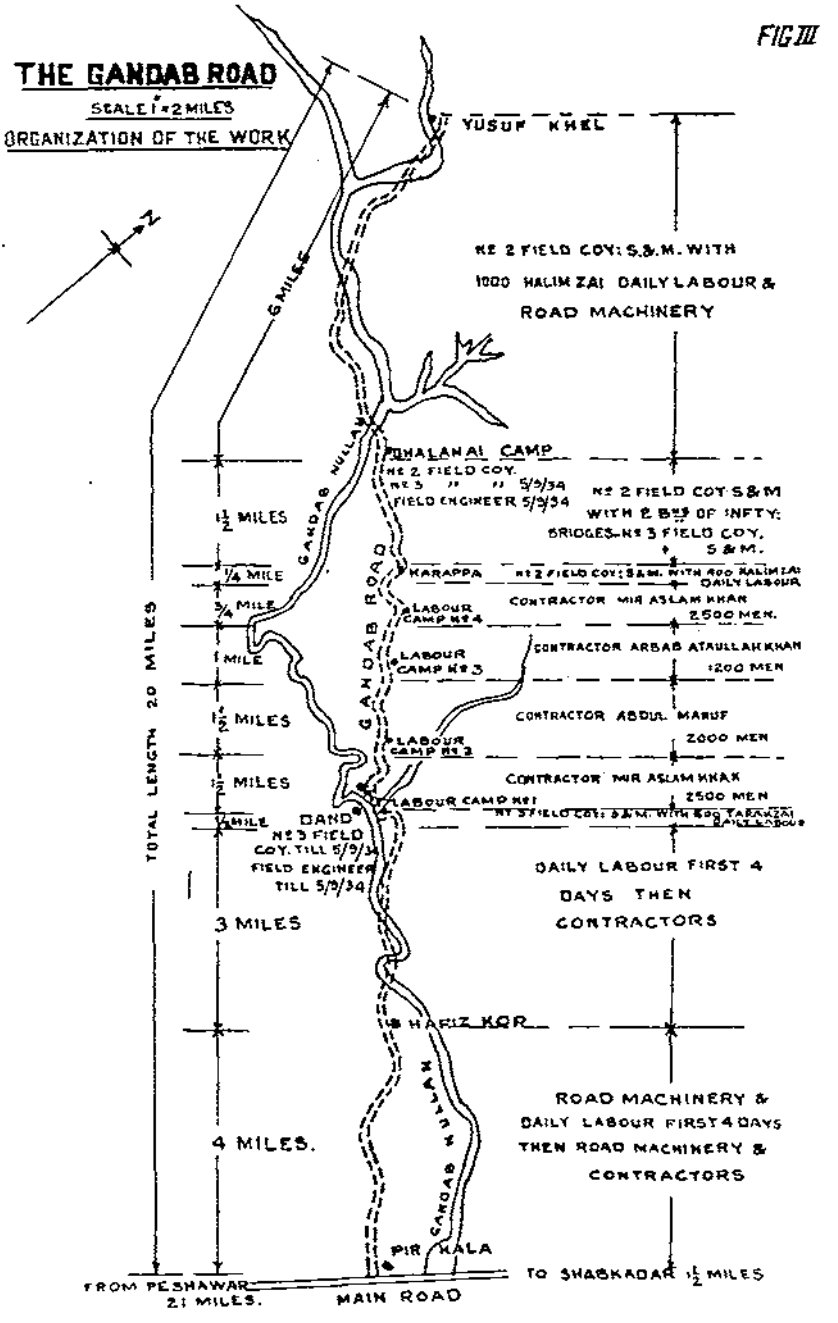


FIG III
THE GANDAB ROAD
SCALE 1"=2 MILES
ORGANIZATION OF THE WORK
N
6 MILES
YUSUF KHEL
NE 2 FIELD COY: S.&M. WITH
1000 HALIM ZAI DAILY LABOUR &
ROAD MACHINERY
GANDAB NULLAH
SHALAMAI CAMP
NE 2 FIELD COY.
NE 3 " " 5/9/34
FIELD ENGINEER 5/9/34
NE 2 FIELD COY S&M
WITH 2 Bdes OF INFTY:
BRIGGES-NE 3 FIELD COY.
S & M.
1½ MILES
¼ MILE
KARAPPA
NE 2 FIELD COY: S&M. WITH 400 HALIM ZAI
DAILY LABOUR
¾ MILE
CONTRACTOR MIR ASLAM KHAN
2500 MEN.
LABOUR CAMP NE 4
1 MILE
LABOUR CAMP NE 3
CONTRACTOR ARBAB ATAULLAH KHAN
1200 MEN
GANDAB ROAD
1½ MILES
CONTRACTOR ABDUL MARUF
2000 MEN
LABOUR CAMP NE 2
½ MILE
CONTRACTOR MIR ASLAM KHAK
2500 MEN
LABOUR CAMP NE 1
NE 3 FIELD COY: S&M. WITH 500 TARAKZAI
DAILY LABOUR
¼ MILE
BAND
NE 3 FIELD
COY. TILL 5/9/34
FIELD ENGINEER
TILL 5/9/34
DAILY LABOUR FIRST 4
DAYS THEN
CONTRACTORS
TOTAL LENGTH 20 MILES
3 MILES
HARIZ KOR
ROAD MACHINERY &
DAILY LABOUR FIRST 4 DAYS
THEN ROAD MACHINERY &
CONTRACTORS
4 MILES.
GANDAB NULLAH
PIR KALA
FROM PESHAWAR
21 MILES.
MAIN ROAD
TO SHABKADAR 1½ MILES

nothing but pick work, and others, usually the older men, do earth moving. Each gang has its own tool sharpener or blacksmith with the well-known equipment. The blacksmith keeps his fire in position with his feet and the bellows are tucked under his arms. It must be terrible work on a hot day. These gangs were extremely efficient, and in spite of shouting and yelling and much apparent confusion the work proceeded rapidly and without check.

It would have been quite hopeless to attempt such work at such speed with untrained gangs, though it is possible to train new gangs in it if the men are amenable to discipline. The Tarakzais and the Halimzais, local Lower Mohmand tribes who were assisting the field companies, had never been under any discipline, and their conduct added greatly to the difficulties experienced by the companies. It would probably have been better and cheaper to have taken the field companies off this work entirely and put them on bridging and to have employed nothing but outside contractors on the road formation.

At the time this solution was not obvious and it could not have been done. There was no other way of supervising the tribesmen, and if they had not been employed they would have attacked us, in spite of the fact that we were there to help them. Indeed, in one instance, the writer had occasion to complain of one Halimzai gang whom he saw taking a rest. The spokesman of the gang explained quite frankly that working all day and sniping all night was very hard work and he was very tired.

Actually, sniping into Dand Camp was continuous throughout the stay of the Nowshera Brigade there, and there is no doubt that most of it was done by our supposed friends just for amusement.

Labour camps were formed for the contractors' men at various points on the road. There were in all five labour camps. These were the target for snipers at night, and at the beginning numbers of men ran away. We solved the problem of the security of the labour camps by making two tribal headmen and a number of local tribesmen live in each camp, and by wiring the camps. The latter was more with the object of preventing the egress of the occupants than the entrance of the enemy. It took a considerable time to arrange for the local tribesmen to go into the camps, but when it was done the sniping ceased.

Arrangements had to be made for water supply to these labour camps, since their location had to be selected with respect to the work on the road and there was no water within miles. This was done by lorry or by donkey from the nearest camp supply. The sanitary arrangements for the camps were placed in the hands of a medical officer, with a sub-assistant surgeon for each camp.

While the work on the Dand–Ghalanai section was going on well, we were soon in trouble on the lower section between Pir Kala and

Dand, which was now carrying heavy motor traffic. The first difficulty was that the contractors, who had been nominated by the political authorities and were not regular M.E.S. contractors, were unable to produce sufficient men and donkeys to do the work at a fast enough pace. We broke them immediately, measured up their work and paid them off. We had this clause in all contracts, verbal or otherwise, because it would have been impossible to give the usual notice in the case of an unsatisfactory contractor. The delay to the work would have had serious consequences in holding up the operations.

Our next trouble on this section arose from the nature of the ground between Pir Kala and Hafiz Kor. The soil was a mixture of silt and clay and was very bad. The road machines in the opening stage had made a 30 ft. wide road straight across the open. With the intensive lorry traffic this speedily became impassable and there was about two feet of dust on it. The really bad stretch was about two miles long. We devised two methods of temporarily surmounting this difficulty. We had two sets of road machinery, and we kept them employed in making new tracks parallel to the first one. Finally, road width became 300 yards, the best track for the moment being marked with white stones. It was found that, carrying about 300 lorries per day, each track lasted five hours. Before any track, however, became a hopeless dust heap the machines had had time to construct a new one. There was an obvious limit to the possibilities of this scheme, and it would not do for the permanent road. Our second plan was to lay the Army Track wire netting in a double width of 24 feet. This stood up fairly well and lasted about three days. The ground underneath it was so bad that it rapidly broke up into deep pot-holes, which rendered it impassable, and it had to be moved. With the labour at our disposal it was not possible to keep the pot-holes repaired at a sufficiently rapid rate.

In the meantime we had concentrated on our first alignment and had decided to try and make a permanent road of it. Fortunately, we had plenty of good gravel available within a mile and there was water within a reasonable distance. We therefore decided to stabilize the soil with the gravel. The construction of a *pakka*-metalled road was quite out of the question. It would have taken weeks to do, and in the meantime the maintenance convoys would have been held up. The procedure was to water the soil thoroughly and grade it to a proper formation with the machines (Photo No. 3). We then spread two inches of gravel and after further watering we allowed the traffic on it. Numerous donkeys were put on to collect more gravel and stack it beside the road. We soon had sufficient gravel to give immediate treatment to any bad places that developed. The maximum thickness of gravel was about four inches, and it was found that stabilization occurred with an average covering of three

inches. Subsequently this stabilized road carried 500 vehicles a day for a period of two months during the operations, and to-day, a year after construction, the surface is as smooth as when the road was made. Cars can travel at 40 to 50 m.p.h. on it with ease. The gravel that was used was screened to remove all large stones over ¾-inch in size. It was very good natural gravel varying in size from ¾-inch to dust, and was such that it combined with the clay in the soil to form a hard crust which stood up excellently to traffic. It was selected after a careful analysis of the original soil had been made, and the success of this stretch of road was a remarkable example of the correct use of local materials in the proper proportion.

The original specification for the road was a two-way motor road, unmetalled, but fully bridged, with a clear width of 22 feet and a ruling gradient of 1 in 15 (see Fig. 4). The maximum gradient was not to exceed 1 in 10. It was evident that this would take some doing on the second stage between Dand and Ghalanai, so we concentrated first on getting a one-way road through and then widening afterwards.

On 13th August work had been in progress from Dand to the top of the Karappa Pass for 12 days and very good progress had been made, but we had almost reached the end of our resources both in labour and in stores. The last 1½ miles into Ghalanai camp had not been started. This was ideal work for the road machinery, but it was quite out of the question to get it there. Fortunately there was at this period a lull in the operations, so three battalions of infantry became available for road work. These were put in Pim's charge with No. 2 Field Coy. S. and M. An excellent organization for the work was made out, and within four days these units had completed the mile and a half into the camp.

At an early date we saw that compressors for rock drilling would be invaluable. Four of these were obtained and they were given to No. 3 Field Coy. on the ascent from Dand Camp. It would have added greatly to the speed of construction if these machines had been capable of being transported on pack animals. They could then have been sent to the Karappa to No. 2 Field Coy. Also we could have used 20 of them, but only four were available. However, those that we had did excellent work.

As an example of the type of labour that No. 3 Field Coy. had to deal with, it is of interest to note that the Tarakzai coolies ran away when they saw the first compressor starting work. They said it was an infernal machine. Most of these men had never even seen a motor-car.

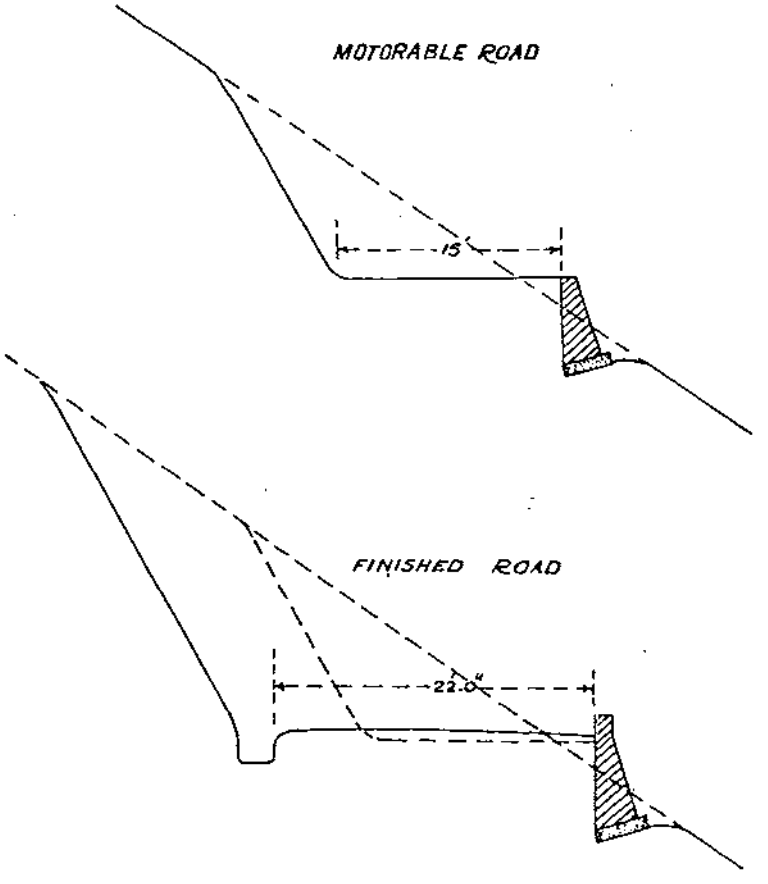
On the 28th August the motor road to Ghalanai was opened by the writer. The opening ceremony was an impressive one. A large *shamiana* had been erected at No. 1 Labour Camp and the whole

place was bedecked with flags and ribbons across the road. The writer had to make a speech in Pushtu eulogizing the staff, the

FIG. IV

GANDAB ROAD

SECTION OF ROAD



contractors and the workmen on the good work that they had done. About twelve bottles of champagne were then consumed, and we all proceeded as best we could on the then narrow road to Ghalanai. Owing to excessive zeal in blasting, a large rock weighing 20 tons fell across the road half-way up the Karappa just before the cars

arrived there. The block was cleared in the record time of 45 minutes. It gave us an opportunity of witnessing the skill of the Khattak men in moving really heavy weights by a skilful use of levers and crowbars.

At the Karappa, the entrance to the Peshawar Brigade area, we were received by a pipe band and more flags and ribbons across the road. The whole Brigade had turned out and lined the route into Ghalanai Camp. They cheered the cars as we proceeded to the camp. At Brigade Headquarters more champagne was consumed.

Everyone present must have realized the importance of the occasion. It was the first time a motor-car had ever been driven up to Ghalanai. The real significance of the opening of the road was that we had proved once and for all that the mountain fastnesses of the Mohmands were not impregnable. In four weeks from starting we had constructed 14 miles of motor road, most of it through rocky hills and deep *nullahs*. We had crossed two passes and we could now move troops into the heart of the Mohmand country in four hours from Peshawar, whereas previously it had taken as many days.

So ended the second and hardest stage of the road construction. During this period the M.E.S. staff, headed by Coxwell-Rogers, the Field Engineer, had done excellent work, and they were most ably supported by the two field companies under Pim and Davidson respectively. No men could have worked harder or better under every possible kind of difficulty, not the least being the intense heat both by day and night.

ROAD CONSTRUCTION—THIRD STAGE.

In the second stage of the road construction we had overcome enormous natural difficulties imposed by the country. In the third stage our difficulties were of an artificial nature, though none the less hard to surmount on that account.

In the second stage we had made a motorable road to Ghalanai, thereby enabling the two brigades to be maintained by motor convoy instead of by pack transport. The Nowshera Brigade, as soon as the motor road was open, evacuated the unpleasant camp at Dand and moved to Ghalanai. The third stage consisted in extending the motor road seven miles beyond Ghalanai to Yusuf Khel, and in completing the whole road from Pir Kala to the full specification, including bridges.

The country beyond Ghalanai was an open plain with very good soil and easy going. It was eminently suitable for work with the machines. For strategical reasons it was important to get a road to Yusuf Khel quickly, so once again we were faced with heavy road

construction against time. We were asked to do the six miles by 1st September, *i.e.*, in three days.

The first thing was to get the road machinery on the work. A convoy was therefore formed on 29th August, consisting of about 20 units of road machinery, and the motor road was closed to all traffic, except M.E.S. cars and lorries, until the machinery had got through. We had numerous delays in collecting the machines, and the concentration of the convoy was not a particularly good example of M.E.S. staff work. It stretched over 20 miles of road (Photos Nos. 4 and 8). However, by midday on 30th August, it was all concentrated in Ghalanai and some of it had already started work. The composition of the convoy is of interest. It contained :—

2 Tractors.
2 Road graders towed by tractors.
1 Auto-patrol.
1 Road roller towed by tractor.
1 Planer.
1 Scarifier.
1 Scooper.
2 Road scrapers.
4 Broom drags.
2 Compressors.
10 Water lorries.

The actual road construction of the six miles was done with this machinery in three days. The writer had previously settled the alignment by air reconnaissance, and little alteration had to be made in the route.

It was thought advisable to stabilize the surface at once with gravel, of which plenty was available. The organization of the work was in Pim's charge, and No. 2 Field Coy. S. and M. was put on the most difficult rock-cutting, of which fortunately there was very little. The machines were given the road formation to make, and three battalions of infantry were put on gravel collection. Thus, with about 1,500 men available for work, none at all were on the road formation except for the rock-cutting by S. and M. With this amount of labour a good deal of gravel was collected at a rapid rate. It was spread chiefly by the auto-patrol. This six miles was, therefore, an entirely machine-made road, done at a rate of two miles per day (Photo No. 5).

No. 2 Field Coy. then started on the bridging work north of Ghalanai, and No. 3 Coy. on the bridging between the Karappa and Ghalanai. It was on the section north of Ghalanai that Henniker did such good work. He had about 800 Halimzai local labourers. It may be noted that these men were working ahead of the protective troops. They were fired at by the enemy, but they did not run away

on account of that, considering it as quite a normal occurrence. Nevertheless they had to be withdrawn from the forward area, as it was certain that several would have been hit sooner or later. These men, when they were working on the Karappa, had shown that they were very jealous of their territorial rights. They demanded the right to do all the road work within their own tribal limits. One of the contractors one day foolishly brought a party of Tarakzais to work in close proximity to the Halimzais. This started a fight at once, the latter armed with picks, shovels and stones, making a determined attack upon the Tarakzais. The fight was only stopped by Henniker interposing himself between the contending parties. He would have fared badly but for his plentiful supply of Pushtu oaths, which had the desired effect in a very short time.

In the meantime, work on the lower sections between Pir Kala and Ghalanai was proceeding fairly well. This work consisted in widening the road to the required specification of 22 feet, the provision of drainage, stabilizing the surface with 2 inches of gravel, and the construction of bridges. All this work was under contract. It was not done without considerable trouble. The local *maliks* (headmen), having been too busy and hurried previously, now found time to raise an agitation against the M.E.S. road staff. The S.D.O., Mukand Lal, was the special target of their machinations. They alleged that he was working against their interests, and demanded his instant removal from the road, otherwise, they said, his stay in this world would be definitely limited. The writer naturally refused to move the S.D.O., as his departure at that juncture would have been a disaster of the first magnitude. The S.D.O. himself said that he would only be removed dead. The squabble was settled by the political authorities putting the offending *maliks* in gaol in Shabkadr, where they remained until the operations were over. The agitation, however, had meant a complete stoppage of work for three days.

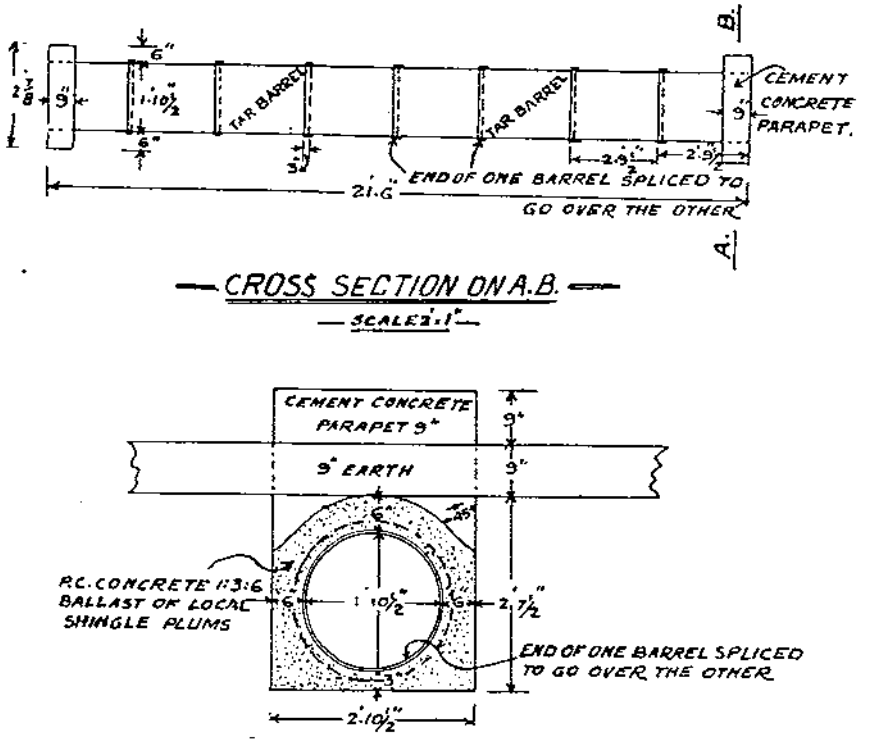
Another instance of tribal jealousy interfering with the work was in connection with the supply of gravel. The nearest gravel for Miles 8 to 13 was in Halimzai territory, the miles on which it was to be spread being in the Tarakzai area. The Halimzais would not allow the Tarakzais to come and collect it, and the Tarakzais would not allow the Halimzais to enter their territory to deliver it. The trouble was eventually overcome, but such occurrences increased the cost of the road and delayed the work.

The bridging work was not particularly difficult but it required good organization to get it done in time. There were 100 culverts, 20 bridges (Photo No. 6), 8 scuppers and 4 large causeways. There were no special points about the design except that of the culverts and causeways. The general type of culvert was what is known as the tar-barrel culvert (see Fig. 5). The tar-barrels act as centering for a 3-inch ring of concrete reinforced with wire. These are

extremely rapidly erected and are a permanent job. The use of the barrels (with ends removed) as centering allows the road to be opened at once to traffic as the centering is not taken away. Rapid-hardening cement was used for all concrete work. We opened the

FIG V

TAR BARREL CULVERT



bridges 24 hours after pouring the concrete. It was trying the latter fairly high, but we had no cases of failure.

Drainage problems on the road forced themselves upon us at an early stage. In Peshawar District we get the edge of the monsoon, and cloudbursts during August are of fairly frequent occurrence, especially in the hills. We therefore had numerous floods down the

Gandab *nullah*. Our ultimate plan for the permanent crossings was the construction of barrel causeways. The general design is shown in Fig. 6. The downstream drop wall was carried down to rock in all cases. We calculated these causeways for a 12-foot flood, the highest we got in 1933. In 1934, however, a 15-foot flood came down. Actually this did no damage to the causeways, but cut the road on either side of them. An extension of the causeways is now being put in. The lesson is that the length of the causeway in the first instance should be made such that the whole *nullah* in full flood is crossed.

We had many delays at these crossings before the causeways were built. We found that the tractor and scooper were invaluable for constructing temporary crossings. In Photograph No. 7 the scooper is seen delivering a load of stones from the hillside into the middle of the stream. The *nullah* bed both above and below all four crossings was overgrown with reeds, which held up the water. When the spate had gone down the water remained stagnant at a depth of 3 feet for hours, thus completely holding up traffic. The tractor and scooper made a crossing in about half an hour, whereas with men it would have taken several hours.

Drainage on the plains section offered no difficulties, as the graders had constructed wide drains on either side of the road. The value of these drains was exemplified on 12th September, when a heavy spate covered the whole country with water, except the road surface. Catch-water drains were made as far as possible in the hill sections and were very useful. Where a large roadside drain entails costly rock-cutting, it is often possible to make a catch-water drain higher up the hillside. This drain need not be straight and rocks can often be avoided.

The completion of the bridges and drainage saw the end on 29th September of the road construction. It was, allowing for stoppages of work, almost exactly eight weeks since work started. The time-table was as below :—

(*a*) *Construction of a Motorable Road.*

1st Section.	(i) Pir Kala to Hafiz Kor, 4 miles in 2 days	7 miles	3 days
,, ,,	(ii) Hafiz Kor to Dand		
2nd Section.	Dand to Ghalanai (chiefly rock-cutting)	7 miles	—28 days
3rd Section.	Ghalanai to Yusuf Khel	6 miles	— 3 days

Total :—20 miles in 34 days.

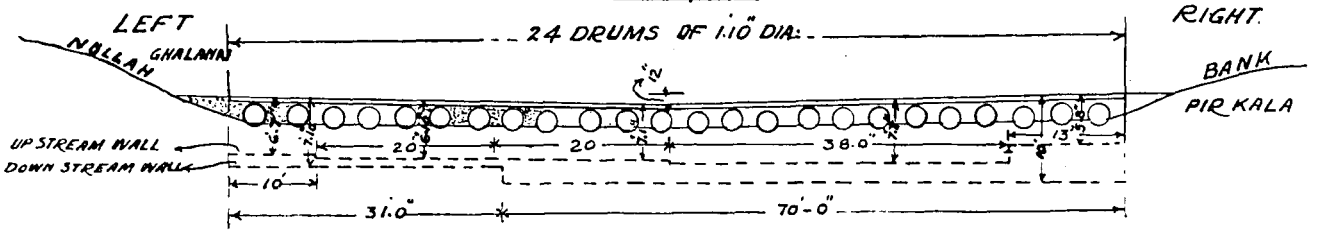
(*b*) *Completed Road 22 feet width, bridged, drained and stabilized.*
Pir Kala to Yusuf Khel—20 miles in 64 days in all.

FIG VI

THE GANDAB ROAD

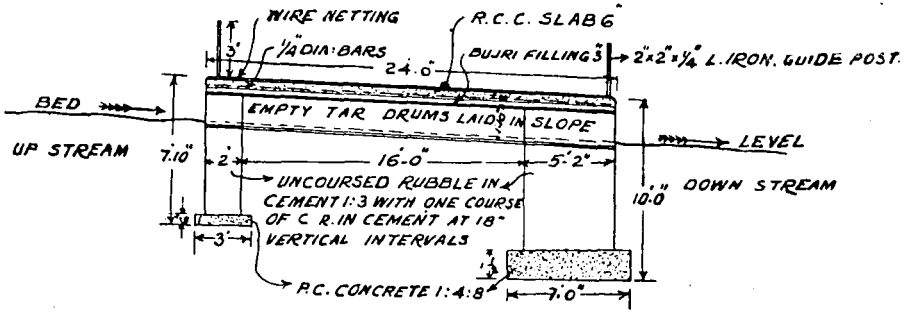
PLAN OF CAUSEWAY 101' LONG CONTAINING 24 TAR DRUMS OF 1.10" DIA:

— SCALE 1/16 = 1" —



CROSS SECTION

— SCALE 8:1" —



It is believed that the construction of this road is the first instance in the history of the North-West Frontier of India where an all-weather, two-way motor road has been constructed under the protection of an expedition. Although the construction of a road of this type on the frontier should be a deliberate operation, yet the speed at which the work was carried out and the success of the whole undertaking leads one to suppose that this is not the last attempt that will be made to drive a road through independent territory under cover of troops. It may, therefore, be of advantage to study the main lessons derived from the operation.

VALUE OF AIR RECONNAISSANCE.

When it is not possible to do a ground reconnaissance, the value of a detailed air reconnaissance is very great. As an instance, the writer reported from air reconnaissance that the original track from Dand to Ghalanai was definitely unfit for camels. The earlier convoys were, in consequence of this report, composed of mules, but some people said that camels would be able to travel. The experiment was tried and a camel convoy started from Dand. They proceeded half a mile in two hours, killing one camel and injuring two others in the process. They then returned to Dand, and were not used until a good camel track had been made. This latter work, incidentally, was done by infantry with great rapidity and efficiency.

It is important that the officer who does an air reconnaissance of this nature should be experienced in it. It follows that all R.E. officers on the frontier should include practice in air reconnaissance as part of their training. It is positively dangerous to send an inexperienced officer on air reconnaissance.

SUPPLY OF STORES.

Owing to the limited time at our disposal to arrange for the supply of stores, we were unable to make full use of our normal stores organization, and we were unable from the nature of the work to make the normal forecast of requirements.

We had in some cases to resort to local purchase. The disadvantage of purchasing locally in a great hurry is that prices at once go up and the quality is bad. Sometimes we got orders from the Field Engineer and field units in the evening for stores required urgently next morning. While most of these urgent stores could be supplied from our normal stocks, some had to be purchased in Peshawar in the middle of the night, and in some cases the articles were actually manufactured in Peshawar City during the night.

For the transport of the stores and for watering the road and general construction work, we had 80 lorries employed almost con-

tinuously. This was a complete transport organization in itself. While we obtained a large number of lorries from military sources allotted by the "Q" Staff, sufficient numbers could not be spared from maintenance work, and we had to hire locally.

On numerous occasions the stores situation gave rise to the greatest anxiety on the part of those responsible for the road construction. Gunpowder was manufactured locally by a contractor in Peshawar City. Our first indent on this man was for 5 tons. He sent us 5 lb., with a note to say that he presumed we had made a mistake and we meant lb. and not tons. We had to compete with this sort of attitude right through. Actually this contractor did us very well, in spite of the fact that, if it rained, he could not dry the gunpowder he had manufactured.

About the middle of August we found we were running out of local stocks of explosives and we had to order from Karachi. It was then discovered that Government of India sanction was required to move explosives by rail across the Sind desert during the hot weather. This sanction was eventually obtained. It was fortunate that the consequent delay did not coincide with the stoppage of our gunpowder supply while it rained.

On 25th August we found that we had practically exhausted all the stocks of detonators in India, and there was danger of having to wait for fresh supplies from England. Reserve stocks in arsenals were issued to us, which saved the situation.

Such occurrences as these cannot well be avoided in a rush job, but a forecast of probable requirements would greatly assist matters. It is not always easy to make an accurate one.

Road Machinery.

At the beginning of the operations we had three tractors and graders and one auto-patrol.

It was very fortunate that when the M.E.S. handed over the main roads in the district to the P.W.D. early in 1933, we retained temporarily those roads still under construction on which we were using this machinery. It meant that we had all the road machinery under our own control and that we had the staff to work it. Of the 20 miles of the Gandab road, 10 miles were done almost completely by machinery, and without the machinery we could not have got the road through at the pace we did. Each tractor and grader is equivalent to about 300 men and does the work better than hand labour. It is essential that road machinery such as this should be kept available on the frontier for work of this description.

As a result of our experience on the Gandab road we have now purchased two road-builders. These machines have Diesel engines with a heavy cutting blade in front. They will cut through anything

but solid rock. They have already done excellent work in Peshawar District, and if we had had to continue the Gandab road they would have been invaluable.

The need for compressors has already been mentioned, and it would be advantageous if each Field Company S. and M. could be equipped with two of these machines.

Water carts will always be required for road work. We had none at the commencement of the operations and had to hire from the Peshawar Cantonment and Peshawar Municipality. We also had to fit up many 30-cwt. lorries with 400-gallon water tanks and sprayers.

Motor water carts can be purchased for about Rs. 8,000 each, but we have little work for them in peace time. There are many of these machines in cantonments in India and it might be possible for a census of them to be taken and agreements made with the cantonment authorities concerned for their use in operations when required.

The maintenance of the road surface of the Gandab road in smooth condition under a traffic of 500 vehicles a day was ensured by the use of the auto-patrol, drag scrapers and broom drags. The auto-patrol (Photo No. 3) is a self-contained maintenance machine, and now has a Diesel engine. It is able to bring the worst surface into good condition at a rate of about ten miles a day. Drag scrapers and broom drags are locally-made articles drawn by lorries. They were found extremely useful on the Gandab road as they maintained a good surface the whole time. They cannot, like the auto-patrol, bring fresh earth or gravel and spread it on the road, but they can smooth the road, so that pot-holes are not allowed to form.

LANGUAGES.

A serious difficulty experienced during the road construction was that very few new officers from down-country could speak Pushtu, and we were handicapped by the lack of Pushtu-speaking N.C.O's in the field companies. Pushtu is the language of the tribes on the North-West Frontier of India and it is almost vital for anyone in charge of labour on work to be able to speak it. On many occasions the writer had to do an assistant Field Engineer's work. If the majority of the officers on the work cannot speak to a single mate and only to a few contractors, the work is delayed and mistakes are made. It also throws a great additional burden on those officers who can speak Pushtu. Often, also, it was pathetic to see the complete inability of N.C.O's and men of the field companies to give a single order to the coolies. Work Munshies, who spoke Pushtu, had to be detailed for duty with field companies. This is an unsatisfactory expedient, as these men have little in common with Sapper and Miner units, and their presence is often resented by the N.C.O's and men.

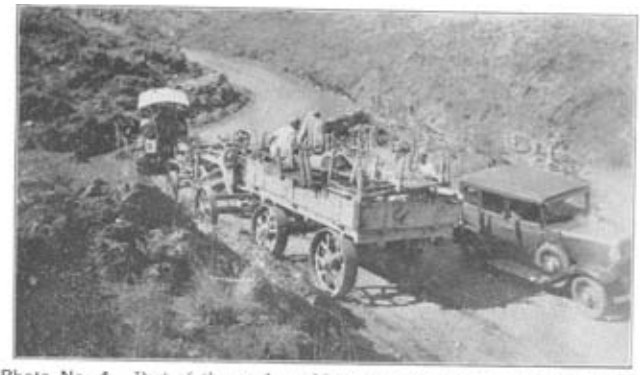


Photo No. 4.—Part of the road machinery convoy going up to Ghalanai on August 29th.

Photo No. 5.—The machine-made road, Ghalanai Camp in the distance.

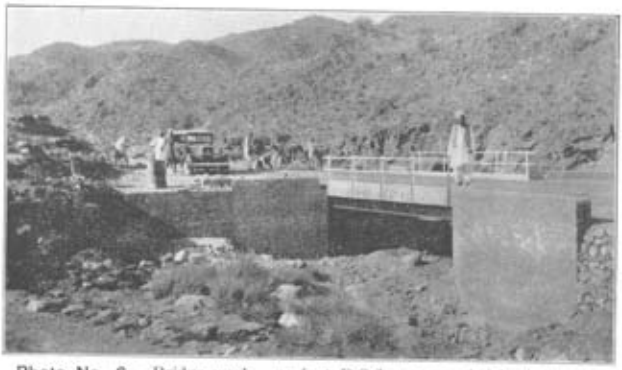


Photo No. 6.—Bridge work. 21-foot R.S.J. span on brick abutments.

Since the Mohmand operations many field companies on the frontier have started Pushtu classes for their N.C.O's and men. This is an excellent idea and cannot but produce the best results. A very few words and simple sentences only are required, and a knowledge of the technical terms of road work.

Those officers who could speak Pushtu were invaluable. The outstanding example was Henniker. He used to go to the local villages and collect his own daily labour. The men would do anything or go anywhere for him, and incidentally he saved Government a large sum of money because we did not pay any political charges for men so obtained.

The writer considers that no R.E. officer is really efficient on the frontier unless he can speak the language.

The New Field Company Organization.

These operations were the first occasion on which the new field company organization was tried out, but when the operations began the units had not had time fully to complete their new organization and they were not trained as new units.

To those who have not recently served in India it may be explained that in 1931–32 the 10 Pioneer Battalions of the Indian Army were disbanded for reasons of economy and among other changes the strength of each Field Company S. and M. was increased from 235 to 330. This was done by the addition of another section to each company.

The new organization of the field companies was found to be satisfactory and no difficulty was experienced during the operations in controlling the larger number of men, even when they were distributed on bridge construction over a considerable length of road. It is important that they should be kept to their proper technical work and that their strength should not be frittered away on unskilled work.

The effect of the increased strength of these units is to create a tendency towards dispersion and employment on unskilled work, whereas if they are kept concentrated on technical work, such as bridging, they pull their weight to greater effect.

The new units used in this way were a great success, in spite of their lack of training.

During these operations we were asked to construct a permanent motor road. This was a job which had never before been undertaken, and the companies were naturally not trained for it. The technical work involved was quite different from the usual work done by field companies. Previously these units had been trained in field works, demolitions, girder bridging and field bridging, or to put it shortly, field engineering generally. It is the writer's opinion that

if they are to undertake the work that is likely to be demanded of them in the future on the frontier, they must also be trained in permanent road construction. The technical work involved is :—

(1) The use of compressors, rock drills and concrete-breakers.

(2) The building of masonry bridges, reinforced-concrete bridges and causeways and reinforced-concrete culverts and scuppers.

(3) The use of road machinery, including driving tractors, graders, auto-patrols and road-builders.

(4) The control of large numbers of unskilled labourers.

At the beginning of the operations the units under the writer's command were not very good at these things, but they rapidly adapted themselves to the changed conditions, and in the end they were extremely good. It is of importance that the training of field units should now include these items. The writer does not suggest that this training should take the place of other training done by field companies. It should be in addition to that training, and a period of six weeks per annum in it is quite sufficient for each unit. Since the close of the operations some six units of the K.G.O. Bengal Sappers and Miners have been trained in permanent bridging work in the Peshawar District. They have erected many concrete bridges in the District, and are capable of undertaking any work of this nature on service.

The question may also be asked whether or not we missed the pioneers. The answer is in the negative. When we required unskilled labour we had contractors' men and in many cases infantry battalions. It has to be realized that the disappearance of the pioneers means that infantry battalions must undertake the unskilled part of road work in order to get the numbers required for the work, or alternatively, civil or enlisted labour must be provided.

On the Gandab road it may be noted that, in order to get the numbers of men required, we would have had to concentrate every pioneer battalion in India, an obviously impossible proposition. Whether a pioneer battalion or two had been there or not, we should still have required large numbers of civil labourers, and on most road construction works this will usually be the case.

AN ANTI-TANK EXERCISE.

(*Southern Command Exercise*, 1934.)

By LIEUT.-COLONEL N. T. FITZPATRICK, D.S.O., M.C., R.E.

DURING the course of the last Southern Command Exercise on Salisbury Plain, September 19th to 21st, 1934, doubts were expressed as to whether the Eastland Engineers could have accomplished all the jobs they undertook in the way of mine-laying, cratering, etc. Indeed, at the final conference, the C.R.E. was likened unto the female daddy-long-legs for his rapid "egg-laying," the insect—according to the G.O.C.-in-C., Southern Command—being credited with a million a day.

As a matter of fact, however, the mechanization of Field Coys. has increased the effectiveness of these units to a surprising extent. A complete mechanized Divisional Engineers—three Field Coys. and a Field Park Coy.—is now capable in certain circumstances of undertaking a very considerable amount of additional work owing to their new plant and power tools. Additional mobility opens up many new possibilities as to tactical employment, and the writer hopes that the following account of the R.E. work on the exercise will convince readers of *The R.E. Journal* that the results claimed were not incredible.

It is proposed to give a brief general account of the exercise, and then to examine in some detail how one of the R.E. units concerned, for example, the 12th Field Coy. at War Establishment, could have carried out its tasks.

The plot of the exercise in general terms was as follows :—G.O.C. Eastland—1st Division, 2nd Cavalry Brigade, two Armoured Car Squadrons, Air, and buses for one Infantry Brigade—was set the task of stopping a Westland armoured mobile force of a Tank Brigade and the 7th (Experimental) Infantry Brigade from raiding the dumps, aerodromes and H.Q. on Salisbury Plain marked in shaded areas on Sketch I.

Eastland was based on Southampton, whilst the Westland communications extended back into Wales.

The main battle front was some way off to the west—near Bath.

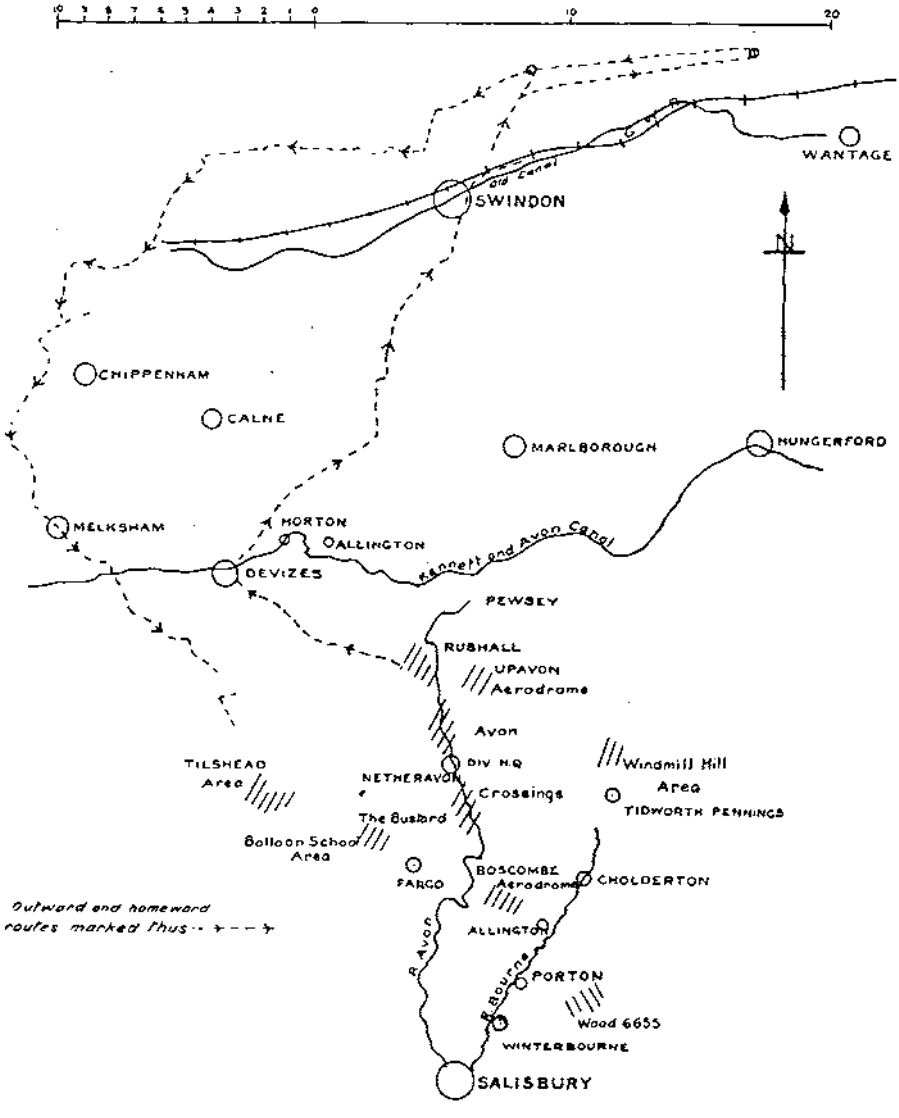
The Westland Commander had to carry out the raid between 19th and 21st September, and in the arrangements to prevent this happening, the Eastland Commander was instructed to use the maximum

SKETCH I

MAP I.

AREA OF OPERATIONS.

(FRONTIER: R. SEVERN — CHELTENHAM — COVENTRY.)



number of "devices" and the minimum of infantry, so as to keep the 1st Division fresh for use as a reinforcement any time after 2359 hours on the 21st.

Phase I.—Local Protection during the Night 19th/20th September.

G.O.C. Eastland was not allowed to move any troops on the 19th before 2359 hours, up to which time we remained in brigade groups at Windmill Hill (1st Guards Brigade), The Bustard (2nd Infantry Brigade), and Fargo (3rd Infantry Brigade).

An opening divisional conference took place at 1000 hours on the 19th, when the G.O.C. gave his outline plan, which took up primarily for the local protection of the shaded areas, and at the same time placed the Eastland Force in a position of readiness.

2nd Infantry Brigade was to concentrate on the protection of the Avon areas, and have detachments for the local protection of the Tilshead dump and the Balloon School.

1st Guards Brigade was to remain concentrated at Windmill Hill, placing out detachments for the local protection of Boscombe Aerodrome and the dump at Wood 6655.

3rd Infantry Brigade was to concentrate at Rushall, and also be responsible for the local protection of the Rushall road junction and the Upavon Aerodrome.

2nd Cavalry Brigade to concentrate at Pewsey.

Armoured cars and R.A.F. reconnaissance out to the northwards and north-east.

As regards R.E., definite instructions were issued by superior authority that, to avoid impeding the future mobility of 1st Division in any direction, no bridges were on any account to be destroyed. This stringent order held good throughout the exercise.

Subsequent to the opening conference, the remainder of the 19th up to 1800 hours was left for reconnaissance of the outline plan. This had to be done quickly, and as regards R.E. it was obviously a case for the Field Coys. working under brigades.

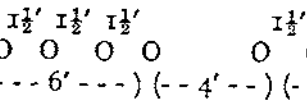
The opening conference had been attended by brigade staffs only and it was 1200 hours before the Field Coys. were in the picture, but by 1800 hours complete schemes with demands for A.T. mines, wire, etc., had been made by all brigades.

The total number of A.T. mines available was 3,300, *i.e.*, twice the normal resources of a division. Demands came to 2,800, and this number was allotted at the next divisional conference which took place at 1800 hours, when it was also arranged that Field Coys. should remain under brigade control for the night's work on 19th/20th September.

Before the exercise started we had guessed that there might be a

good deal of A.T. mine-laying ahead, and in case the supply of mines should prove inadequate, three natures of minefields, with varying quantities of mines, had been decided on for trial :—

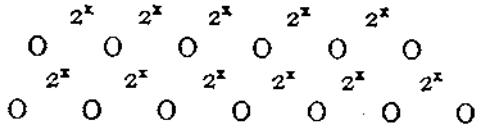
Layout No. 1. " 100% protection."



1,500 A.T. mines per 1,000 yds.

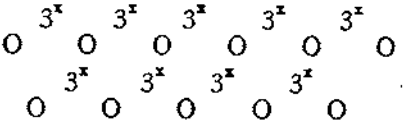
A distance of 4' can be left between groups of mines, as a tank cannot pass through a gap of that size without striking a mine on one side or the other.

Layout No. 2. " 80% protection."



1,000 A.T. mines per 1,000 yds.

Layout No. 3. " 50% protection."



700 A.T. mines per 1,000 yds.

Our previous experience of this sort of work was limited, but we felt sure that provision should be made for doing such work quickly and economically. These " cock-shy " layouts proved very useful for reconnaissance, estimates, and minefield laying.

From what the writer saw of places he visited, there was no doubt that a considerable measure of local protection could have been hastily provided by mines suitably sited in defiles, on reverse slopes, and along the edges of woods which tanks are apt to hug. Field Coy. commanders reported to the same effect.

Units reached the areas shortly after 2359 hours on the 19th, and by daybreak on the 20th the preliminary measures for local protection had been completed.

The A.T. defences thus made were never tested. But, as the Director subsequently suggested, had the armoured force been launched during the early part of the exercise in columns suitably composed to deal with specified objectives, local protection would have been of supreme importance. In consequence it is submitted

that the allotment and use of mines as carried out on 19th/20th was reasonable, whilst the withholding of large reserves could hardly have been justified.

Phase II.—River Bourne A.T. Belt.

By 1100 hours on the 20th, Eastland had obtained fairly accurate information that a large proportion of enemy tanks was in the neighbourhood of Hungerford, and Divisional H.Q. were apprehensive about our open south-east flank, *i.e.*, along the River Bourne from Cholderton to the Winterbournes.

At 1130 hours it was decided that this area should be reconnoitred forthwith and as rapidly as possible under C.R.E.'s arrangements for demolitions, etc., to form an anti-tank defensive flank.

From the map a decision was made as to the area most likely to produce the best demolition zone. This was divided up into Field Coy. sectors for reconnaissance, and it was hoped from the combined reports to arrange an effective and continuous demolition line—a " primary belt " which could subsequently be extended in depth.

The 23rd and 26th Field Coys. were near at hand, and on " message form " orders reconnaissances started at once. Subalterns acted on orders received in the absence of company commanders and the reconnaissance officers were called into Divisional H.Q. *en route* for preliminary co-ordination. With the 12th Field Coy. things were different, as this unit was away in the blue. In consequence orders in their case had to go by signals and there was no chance of preliminary co-ordination.

Everything, however, went well. Preliminary reports which were ordered to be in Divisional H.Q. by 1500 hours were all received by that hour, and one was able to arrange a continuous " primary belt " along the whole flank.

Meanwhile, companies had come under C.R.E. control ; 23rd Field Coy. was out on site at 1600 hours and both the others by 1800 hours. Company H.Q. were established at Cholderton, Allington and Porton ; progress reports came in at two-hourly intervals, and the demolition belt was completed by midnight. Sketch VI shows what was done.

As regards tactical protection during the work. A cavalry escort was at one time arranged, but had subsequently to be diverted. Each Field Coy. was in consequence responsible for its own local protection. There were, however, no signs of the enemy throughout the night.

All companies " rendezvoused " again at " C " crossing at 0530 hours on the 21st—and so ended the night's work on Phase II.

It is difficult to ascertain the effect of this belt of flank protection, but one gathers that this flank was the avenue the enemy had

intended to use and that their plan was foiled by the obstacles. According to an authoritative opinion, the work was a good example of what could be done, but a comment was made on the majority of the mines having been previously used for local protection during Phase I. A justification of the aforementioned allotment of A.T. mines has already been made and had we been unable to obtain more mines for Phase II, it is claimed that we could have " devastated " the communications through the River Bourne area effectively, even without mines, in one night's work, to prevent any onrush of A.F.V's. A detailed examination of the work entailed is given at the end of this article.

PHASE III.—CRATERING OF WESTLAND COMMUNICATIONS.

By the morning of the 21st the Divisional Commander was of the opinion that the anticipated deep raid was not materializing, and that he had an unexpected chance of assuming the offensive. The G.O.C. commenced hatching a plot for cutting the tanks' L.-of-C.

It was considered that the question of time no longer admitted of the enemy carrying out a deep raid by a wide flank move. If the enemy were now to attempt a limited raid north of Netheravon, the G.O.C. thought their line of withdrawal northwards would have to be *via* the east of Devizes, and if he could check the armoured force on the Kennet Canal, our Air might do considerable damage. If, on the other hand, the enemy gave up any attempt to raid, the line of withdrawal was then expected to be due north from Hungerford, and again the G.O.C. wanted the retiring forces checked and bombed.

The Kennet Canal was easy. We knew the locality and the obstacle afforded by the canal. A half-company in Devizes and a half-company east of the town could quickly block communications, bridge blowing or no bridge blowing. " Camouflet " craters and felled trees, etc., on both banks could undoubtedly be carried out by one mechanized company in six hours.

A line north of Hungerford was not so easy. It was useless attempting anything too near the enemy front, and one obviously could not venture too far northwards for this purpose. From a hurried examination of the map, " G " concurred that the line of railway and canal from Wantage to Swindon appeared to offer good prospects.

Hasty demolitions of the Wantage–Swindon line required two Field Coys. and although such operations would lie well within Eastland territory, yet in the circumstances the move was bound to be hazardous. The prize, however—an armoured force—was a big one and justified risks.

The question of an escort for these companies was immediately considered. The only available armoured cars amounted to three.

TheG.O.C.'s plan for this operation also took up for the simultaneous dispatch of the 2nd Cavalry Brigade round the enemy's west flank to the north of Hungerford, and thus it was expected that our cavalry would be in between the Sappers on the Wantage–Swindon line and the enemy south of Hungerford. The G.O.C. came to the conclusion that the three armoured cars would be more generally effective if allotted to the cavalry, and the risk in detaching the Sapper companies was accepted. It was expected that the local inhabitants would certainly do all they could to help their Eastland R.E. units, and the Field Coys. were ordered to pay particular attention to their own local protection. As a matter of fact, the G.O.C. hoped all the enemy would prove to be south of the cavalry sweep. They were.

The 2nd Cavalry Brigade moved forward from Pewsey at 1400 hours, and the attached R.E. operation order shows how our various moves were arranged.

Again there was no enemy interference of any kind. 23rd Field Coy. completed their task (Sketch II) at 1830 hours, 12th Field Coy. and 26th Field Coy. completed their work (Sketches V and III) at 2200 hours.

The Kennet Canal demolitions were never tested as the enemy retired northwards from Hungerford, but, again from what one can gather, the Wantage–Swindon demolition belt was a surprise and a success.

Detailed Examination of Tasks undertaken by the 12th Field Coy. R.E.

Phase I.—Local Protection.

At 1200 hours on the 19th the Commander, 1st Guards Brigade, held a brigade conference on the formation of the brigade laager at Tidworth Pennings and also as to the defence of Boscombe Down Aerodrome and the dump at Wood 6655.

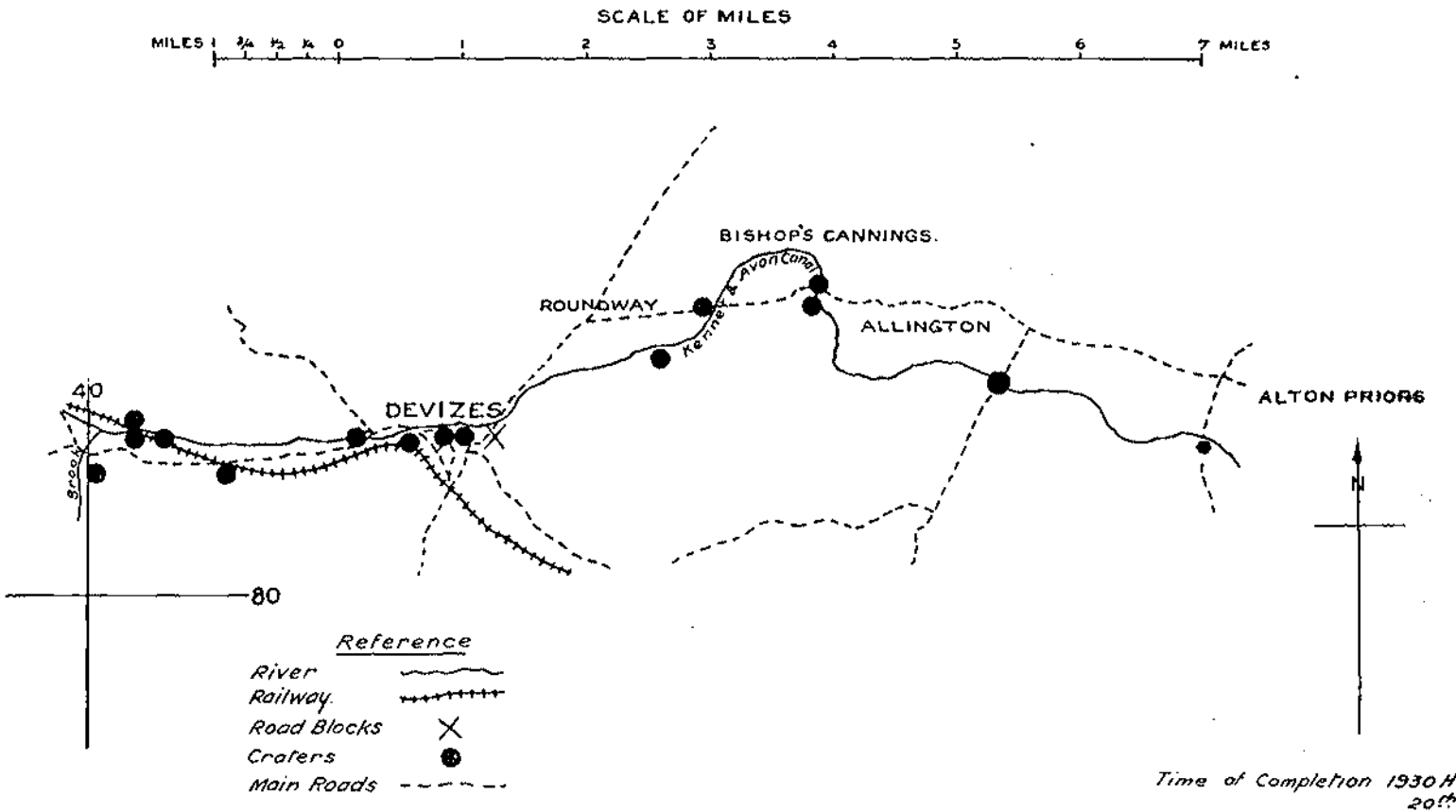
By 1500 hours O.C. 12th Field Coy. and one of his subalterns, using their company cars, had reconnoitred both the aerodrome and the dump. The proposals put forward involved a combination of mines and A.T. guns protected by small infantry detachments. Two hundred and forty mines were required for a layout co-ordinated with arcs of fire of the guns. Mines were placed in ground the guns could not cover, in road blocks, and also in potential tank forming-up areas to break up their attack or deflect the tanks into the gun zones.

A sample of the dispositions is given in Sketch IV.

At 1600 hours O.C. 12th Field Coy. discussed with O.C. Brigade A.T. Coy. (eight A.A. guns) the R.E. work required for the brigade laager. Again, mines and guns were co-ordinated, and in this

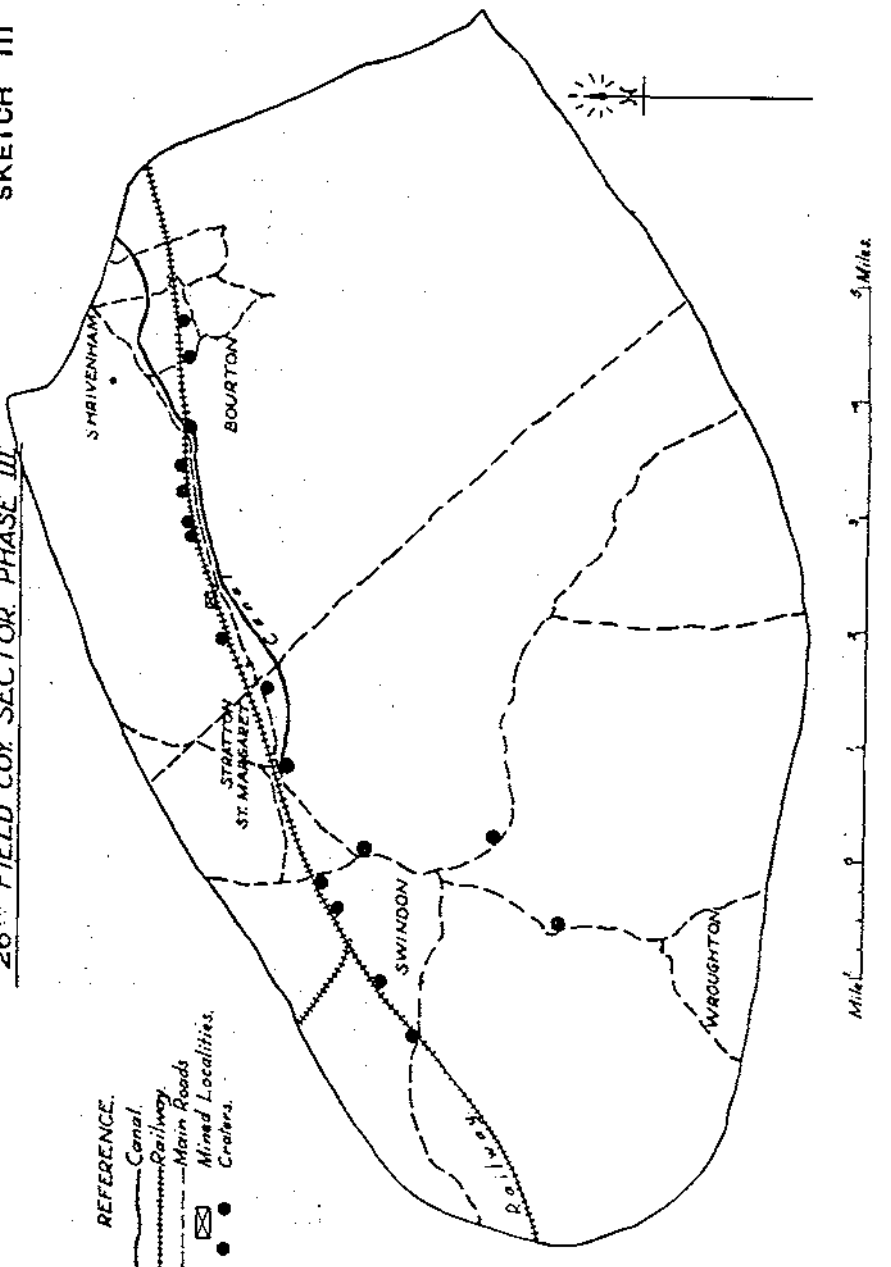
23rd. Fd Coy. SECTOR. PHASE III.

SKETCH II



Time of Completion 1930 Hours 20th

SKETCH III


26TH FIELD COY. SECTOR. PHASE III.
SHRIVENHAM
BOURTON
STRATTON ST. MARGARET
SWINDON
WROUGHTON
R. Ivel
Railway
REFERENCE.
Canal.
Railway.
Main Roads
Mined Localities.
Craters.
Miles
5 Miles

instance nine mine road blocks (Layout No. 1) and six armoured-car wire road blocks were sited; the former required 110 mines.

The number of Sappers available at war establishment was 160, and the number of A.T. mines allotted the Field Coy. was 700 mines and 700 dummies. As regards transport, pool lorries would have been equally distributed at this juncture, and the 12th Field Coy. quota would have provided for 70 men. This M.T., reinforced if necessary with one or two 3-ton lorries and trailers from B group of the Field Park Coy. (bridging equipment dumped *pro tem.*), would have transported all the men O.C. 12th Field Coy. wanted to send out of camp.

With reconnaissances completed in daylight, and ample time being available for preliminary store arrangements, this unit could have completed their Phase I tasks by 0600 hours on the 20th September.

Phase II.—River Bourne Demolition Belt.

The task given the 12th Field Coy. was the sector which was nearest to this unit, *i.e.*, the northern sector in Sketch VI.

Orders for the reconnaissance reached 12th Field Coy. at 1230 hours. The reconnoitring officer brought in his preliminary reconnaissance personally to Divisional H.Q. at 1500 hours, and with this information the 12th Field Coy. belt was co-ordinated with that of the other companies.

The Coy. received orders to move at 1630 hours and arrived at a central rendezvous in their sector at 1800 hours.

12th Field Coy. still had 350 A.T. mines, and in addition to the normal company explosives the unit had drawn a ton of ammonal under C.R.E. arrangements.

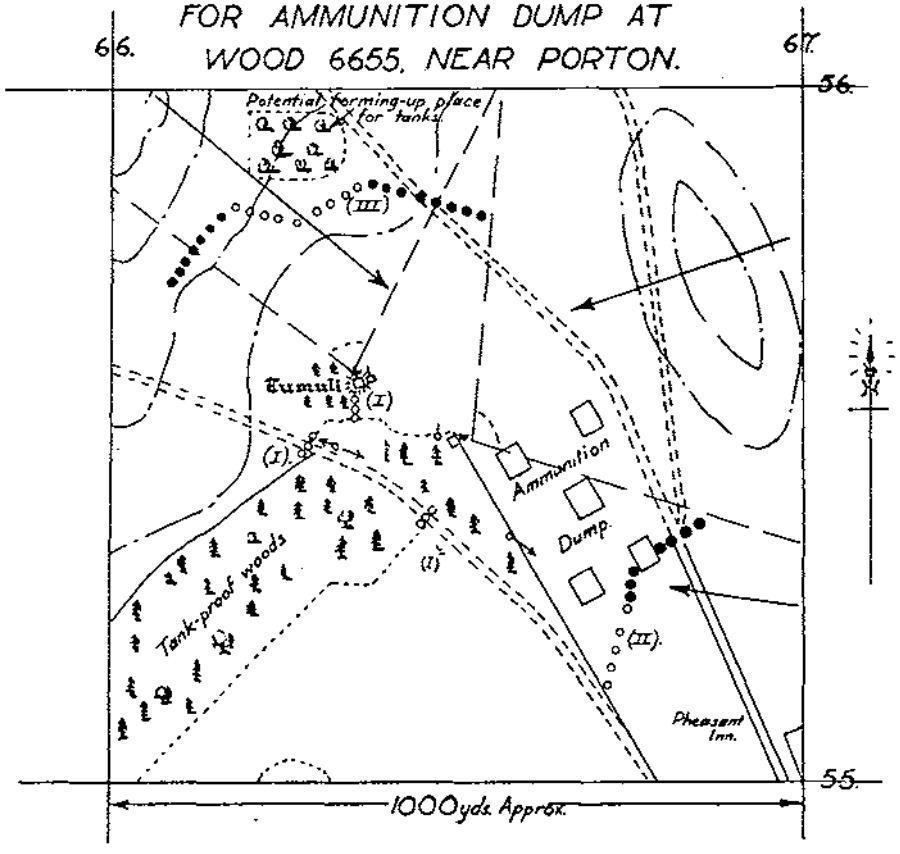
Sketch VI shows how admirably the sector lent itself to the construction of an A.T. belt—and at first sight the sector might be considered exceptionally accommodating. It should be borne in mind, however, that the belt as a whole had been selected for A.T. defence, and an examination of the other sectors shows the latter also to be good in this respect. The writer suggests that in similar circumstances and country, the exception might be for one not to be able to select a fairly good A.T. belt.

The only gap in the 12th Field Coy. sector which could not be economically and quickly blocked lay in the area north of the Thruxton Road. Consultation with R.A. at Divisional H.Q. showed, however, that a number of our guns happened to be so sited that they could deal most effectively with any tank formation attempting to pass through the area in question. R.E. were in consequence relieved of this particular responsibility and the Field Coy. treated the gap with dummy mines as shown in the sketch.

Over the remainder of the sector there seems no doubt that the proposed obstacles would have held up an onrush of A.F.V's. It

SKETCH IV

DIAGRAM ILLUSTRATING A.T. DEFENCES FOR AMMUNITION DUMP AT WOOD 6655, NEAR PORTON.



Note:
Garrison,
1 Platoon Infantry
1 A.T. gun detachment

KEY.

- ....Most likely line of Tank attack.
- ....Mine field. (Layouts I, II or III, vide explanation in article).
- ....A.T. gun detachment.
- ....Central zone of A.T. gun fire.
- ....Rifle sec.
- ....L.G. gun sec.
- ....Dummy mine field laid badly camouflaged.

has been suggested that the A.T. mines could have been seen and removed, but the writer thinks it doubtful whether these small mines hidden in long grass would be observed before taking effect, specially in half-light or darkness.

The work in this sector amounted to :—

A. Seven 60-lb. road craters.
B. Six road blocks made chiefly by tree felling.
C. Laying 350 A.T. mines in the gaps and thin parts of the natural A.T. wood belt obstacle.

Estimated times (allowing for night work) :—

Detailed reconnaissance	1 hour
Distribution of tools, men, explosives and 2 compressors on to jobs	1 hour
Job A	50 men, 2 hours
(Craters made by camouflet method as demonstrated at Aldershot R.E. Demonstration, 1934, 6 men in 1 hour make a tank-proof crater.)	
Job B	50 men, 3 hours
Job C	60 men, 3 hours

On the above showing, it is held that 12th Field Coy. would have had no difficulty in completing their Phase II tasks within the available time.

Phase III.—Wantage–Swindon.

Routes, Sketch I.
12th Field Coy. area, Sketch V.
Orders for this move, Appendix I.

At 1000 hours on 21st, arrangements were made to issue extra supplies of petrol, the companies were placed under a 10 minutes' notice to move, and company commanders were called in to Divisional H.Q. to hear the proposed plans.

12th Field Coy. resources in A.T. mines were brought up to 200, 1½ tons of ammonal were issued, and each Field Coy. was wholly motorized (*vide* para. 7 of the Operation Order).

12th Field Coy. left " C " crossing at 1115 hours and reached the Devizes rendezvous at 1400 hours.

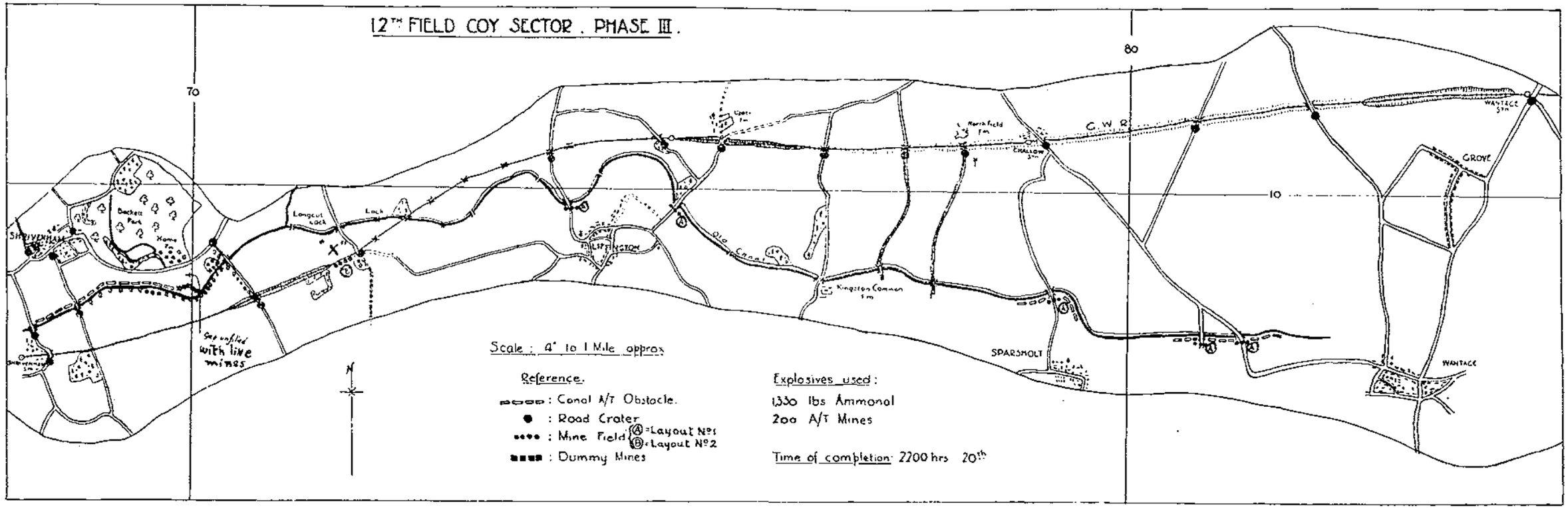
Whilst halted, the Company Commander heard that enemy A.F.V's had been seen in that vicinity. Consequently, on departure from Devizes at 1500 hours, 12th Field Coy. made a big detour to the west of Swindon, reaching their destination at 1800 hours.

No enemy were encountered.

Company H.Q. went under cover, and sections proceeded immediately to previously appointed rendezvous.

SKETCH V

12TH FIELD COY SECTOR . PHASE III.



Scale : 4" to 1 Mile approx

Reference.

- : Canal A/T Obstacle.
- : Road Crater
- : Mine Field (A=Layout No1, B=Layout No2)
- : Dummy Mines

Explosives used :

1330 lbs Ammonal
200 A/T Mines

Time of completion 2200 hrs 20th

The work in this case comprised :—

A. Nineteen 70-lb. road craters.
B. Five Layout No. 1 road blocks, using total 80 A.T. mines laid in the roads and covered. Trees also were to be felled and included in the block wherever possible.
C. Layout No. 2 mine-field at Longcot crossing (*vide* " x " on Sketch V) and in certain gaps in canal bank hedge.

Estimated times (allowing for night work) :—

Preliminary reconnaissance, distribution of men, stores and 3 compressors	1½ hours
Job A	114 men, 2½ hours
Job B	40 men, 4 hours
Job C	16 men, 4 hours

Work should have been completed in 5½ hours. Six hours were allowed.

The canal was more or less dry and turned out to be of minor use as an obstacle. The main natural line of obstacles lay in the railway cuttings and embankments.

This zone should not have been 100% proof, but it is thought it would probably have had considerable effect on a retreating force. One of the Westland columns made straight for the centre of this sector.

Lessons.

(1) A.T. mine-laying. Approved patterns of contact and electro-pneumatic mines have now been brought out. Their handling requires a fair amount of elementary training.

(2) Other A.T. obstacles. Rapid tree-felling, road cratering by the camouflet method, and other means of hastily checking tanks and A.F.V's also appear worth investigating.

(3) Mine-fields. It is suggested that there is much to be gone into as regards " layouts." This work might with advantage be reduced to a " drill " like that for a barbed-wire obstacle. It should be practised by night as well as by day.

To make the best use of our limited resources in A.T. mines they should be distributed and laid on a co-ordinated plan.

(4) Anti-tank areas. Provided preliminary reconnaissances are carried out in daylight, surprisingly large areas of normal country can be taken on by a single mechanized Field Coy. and quickly made proof against sweeping moves of tank formations.

(5) This type of work may often have to be rapidly carried out ; reconnaissance, supplies, siting, record, recovery, all require training.

(6) Tactical training in Field Coys. is as important as ever. Training in giving verbal appreciations and orders is required for technical as well as tactical work.

(7) The new *War Establishments* for mechanized Divisional Engineers appear excellent. They are all that one could wish for in present circumstances, and pending the introduction of complete mechanization, the C.R.E.'s M.T. pool should give Divisional Engineers something approaching the mobility required to co-operate in the new duties of protection.

APPENDIX I.

Secret.
Copy No. 1.
20th Sept., '34.

OPERATION ORDER NO. 1.

1 *Div. R.E.*

Ref. Maps: 1" to 1 mile Southern Command Manœuvre Area.
¼" to 1 mile England Sheet II.

INFORMATION.

1.—*Enemy.* Reported reliably one Tank Bn., Savernake Forest; three Tank Bns. and Mech. Inf., area Hungerford. No enemy forces located West of Marlborough.

2.—*Own Troops.* 2 Cav. Bde. in Pewsey area is being sent to general line east and west through Aldbourne as a screen between Hungerford and Fd. Coys. in area Wantage–Swindon, 5905.

INTENTION.

3.—To stop withdrawal of enemy A.F.V's by road blocks as follows:—
(*a*) Line of railway and Old Canal incl. Wantage, 8207–Swindon.
(*b*) Line of Kennet–Avon Canal between incl. Alton Barnes, 5482—Br. 418819.

METHOD.

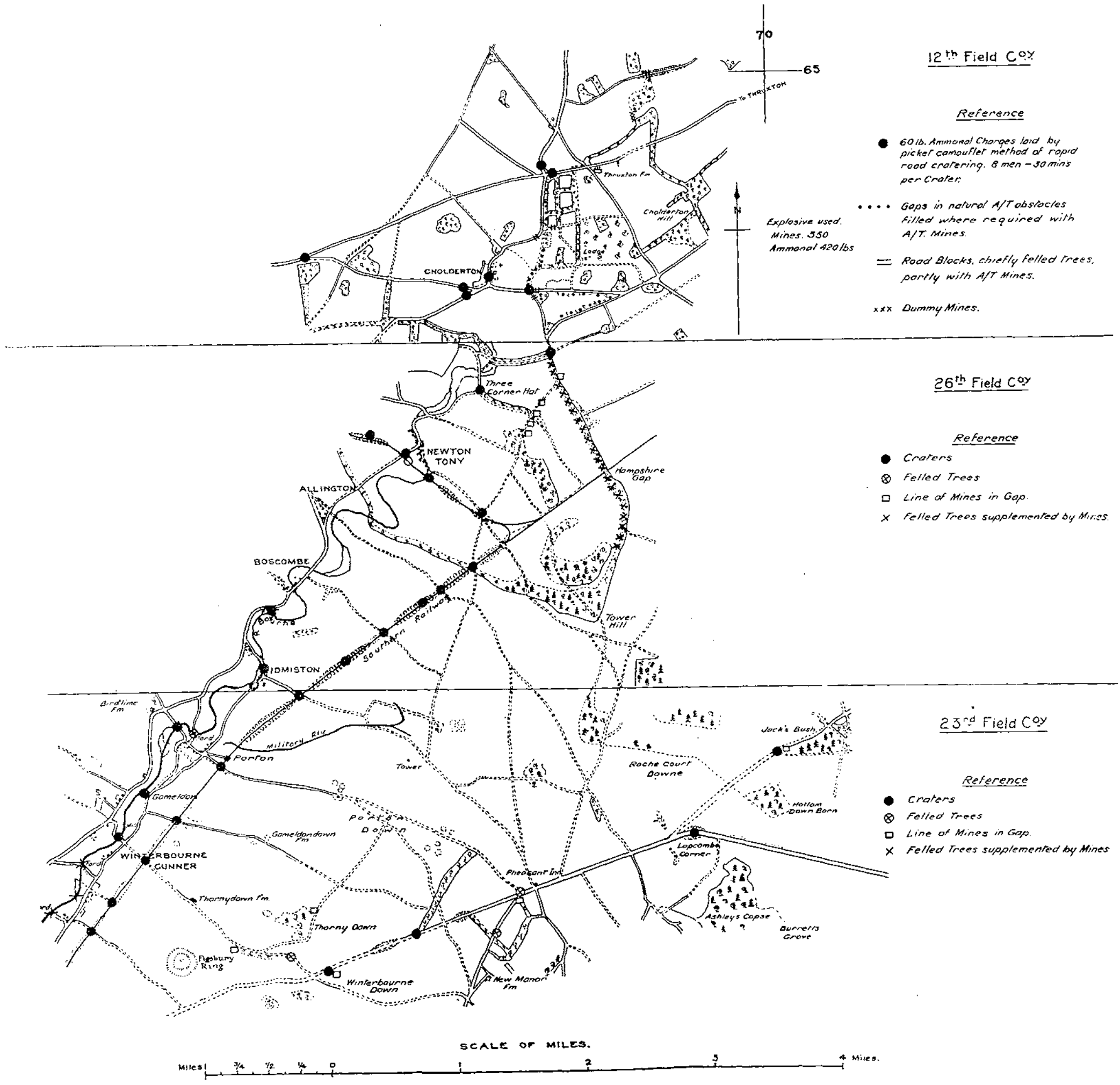
4.—*Areas.* 12 Fd. Coy. incl. Wantage–Shrivenham, 6709.
23 Fd. Coy., Kennet–Avon Canal.
26 Fd. Coy. excl. Shrivenham, incl. Swindon.
Priority main road crossings. No Brs. to be blown. Blocks to consist of felled trees or craters.

5.—Fd. Coys. responsible for own protection.

6.—*Compressors.* Compressors Fd. Pk. Coy. allotted, one to 12 Fd. Coy., one to 26 Fd. Coy.

SKETCH VI

DEMOLITION AREA IN PHASE II.



12th Field Coy

Reference

- ● 60 lb. Ammonal Charges laid by picket camouflet method of rapid road cratering. 8 men – 30 mins per Crater.
- • • • • Gaps in natural A/T obstacles filled where required with A/T. Mines.
- ═══ Road Blocks, chiefly felled trees, partly with A/T Mines.
- xxx Dummy Mines.

26th Field Coy

Reference

- ● Craters
- ⊗ Felled Trees
- □ Line of Mines in Gap.
- × Felled Trees supplemented by Mines.

23rd Field Coy

Reference

- ● Craters
- ⊗ Felled Trees
- □ Line of Mines in Gap.
- × Felled Trees supplemented by Mines

7.—*Transport.* Pool transport divided equally between Coys. Remainder Coys. will be embussed in transport provided by 1 Div. arriving Crossing C, 1030 hrs.

8.—*Explosives.* All Coys. to load 1½ tons of ammonal from dump, Crossing C.

9.—*Timing.* 12 and 26 Fd. Coys to leave Crossing C 1115 hrs. and R.V. Devizes Bks. until 1500 hrs., when they will move forward to demolition areas. 23 Fd. Coy. to leave Crossing C for demolition area 1045 hrs. Estimated time to complete work all Coys. 6 hours.

ADMINISTRATIVE.

10.—Refill petrol arrives Crossing C 1030 hrs. Baggage lorries remain with units. M.P. supplies will be notified 1800 hrs.

INTERCOMMUNICATION.

11.—Report centres will be established as follows:—12 Fd. Coy. and 26 Fd. Coy., Devizes Bks. until 1500 hrs., and on arrival demolition areas, 12 Fd. Coy., Fernham, 7312; 26 Fd. Coy., Stratham St. Margarets, 6107; 23 Fd. Coy., Devizes Bks.

12.—Communication by civil 'phone to Netheravon 56.

13.—*Routes.* (*a*) *Forward.* 12 and 26 Fd. Coys., Rushall–Devizes–Beckhampton, 5389; Wroughton, 5800. 23 Fd. Coy., Rushall–Stert, 4680.

(*b*) *Withdrawal.* 12 and 26 Fd. Coys. north of Swindon–Wootton Bassett, 5103; Calne, 4491; Martinslade, 3982; Seend, 3881; West Lavington, 4573. 23 Fd. Coy., West Lavington–Tilshead.

R.V. for all Coys. on withdrawal, Crossing C.

(*Sd.*) A. MURRAY, *Captain, R.E.,*
Adjutant, R.E., 1 Div.

Issued by D.R. 1030 hrs.

DISTRIBUTION.

Copy No.: 1. 12 Fd. Coy.
2. 23 Fd. Coy.
3. 26 Fd. Coy.
4. 1 Div.
5. Umpires, Eastland.
6. File and War Diary.

AIR SURVEY.

By LIEUTENANT J. S. A. SALT, *late* R.E.

TOPOGRAPHIC MAPS FOR MILITARY PURPOSES.

THERE are two ways of providing maps to assist the conduct of a war :—

(1) By predicting the areas in which a campaign is likely, and preparing beforehand a series of maps in suitable styles and on the required scales.
(2) By actual survey work during a campaign, using rapid methods.

The former is not always possible, partly owing to the uncertainty of the future, and partly to the nature of interesting areas, which may for political reasons be inaccessible. That the state of the existing mapping of the world is not yet very advanced a glance at Fig. 1 will show. The development of modern instruments of war, however, increases rather than diminishes the need of accurate topographic maps on the larger scales, and the contribution to the latter method made by the introduction of air photography lends particular interest to the subject of air survey. A considerable amount of research work has been done in various parts of the world, and most of the methods and instruments developed have been tried out on actual surveys. Thus the theory of the subject has been exhaustively examined and sufficient practical experience has been obtained to judge fairly accurately the virtues and limitations of the various methods. In the following article, a description of the method which has been developed for use by the Royal Air Force and Field Survey Companies, Royal Engineers, is prefaced by a very brief description of the general theory, in order to place it in its proper perspective. The method has been extensively used in such varying country as India, all parts of the Middle East, Central Africa and Canada, as well as in Europe. Future advances at each stage of the technique may be expected, but it is not likely that for military purposes the general procedure will be radically altered. More elaborate methods may, however, be used to supplement it.

AIR SURVEY.

The ideas of air survey, being new, may take some time to gain general acceptance. Practical men, whose strong point is their

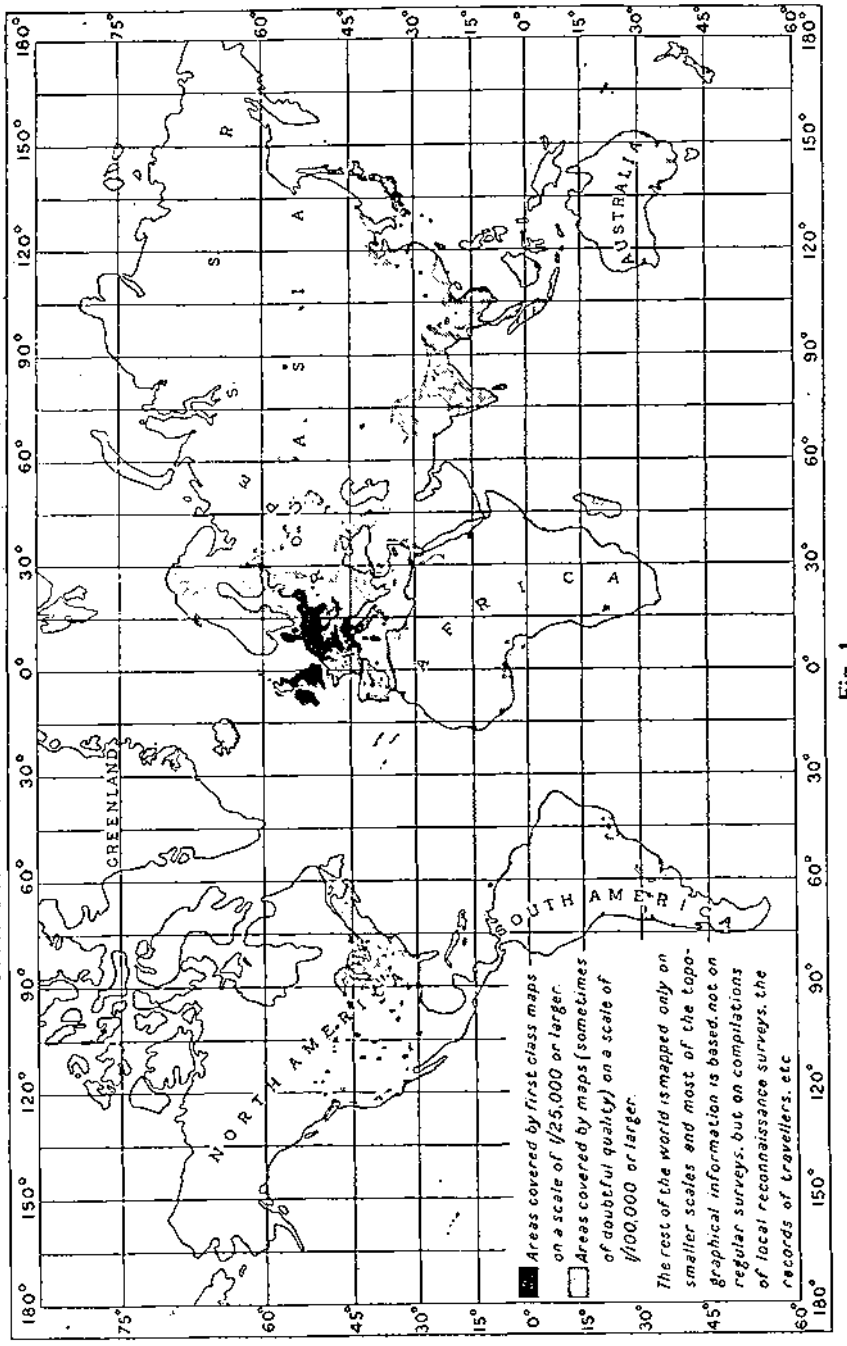

THE STATE OF MAPPING IN THE WORLD
NORTH AMERICA
GREENLAND
SOUTH AMERICA
EUROPA
ASIA
AFRICA
AUSTRALIA
Areas covered by first class maps on a scale of 1/25,000 or larger.
Areas covered by maps (sometimes of doubtful quality) on a scale of 1/100,000 or larger.
The rest of the world is mapped only on smaller scales and most of the topographical information is based not on regular surveys, but on compilations of local reconnaissance surveys, the records of travellers, etc

Fig. 1.

inability to imagine anything until they see it done, can only be convinced by a full-scale demonstration, and this at the moment is hardly possible. On the other hand, some of its more enthusiastic supporters regard it as a panacea for all survey difficulties. It will be well, therefore, at the outset to define its function.

The fundamental principle of survey, that of working from the whole to the part, remains, of course, unchanged. A regular survey must therefore start as before, with geodetic triangulation if possible, to be broken down later by means of triangulations of a lower order. The method of plotting detail and contours will depend on the scale of the map required. For the topographic scales (1/20,000–1/250,000) now under consideration, the plane-table would be used, taking as control the beaconed trig. points of a third order triangulation. It is this stage of the work that air survey is peculiarly suited to fulfil. In addition to the far greater speed of plotting, the use of air photographs provides a wealth of information that it would be difficult to compile on the ground. Moreover, the lesser requirements in the way of control, which follow each advance in technique, increase the accuracy with which maps of the country behind the enemy lines can be made. An air photograph, however, cannot give *all* the information expected to be shown on a map: it cannot, for instance, record the names of places. The interpretation of an air photograph, also, is not always easy, particularly on the smaller scales. On the other hand, accuracy of plotting is very easily checked by a supervisor, whereas the only way of checking a plane-table sheet is by virtually doing the job twice over.

The function of air survey, then, is to take the place of plane-tabling, and its principal advantage is speed.

The method may be sharply sub-divided into two stages: (1) the photographic, and (2) the cartographic. It will be more convenient to deal with the cartographic problem first.

A. THE CARTOGRAPHIC PROBLEM.

(*a*) *Photography as an Aid to Survey.*

Suppose that from some station commanding a good field of view a photograph is taken with the axis of the camera horizontal. Then, from a knowledge of the calibration data of the camera, we may construct on the photograph a graticule system depicting angles subtended at the perspective centre, in the same way that parallels of latitude and meridians of longitude on the surface of the earth depict angles subtended at its centre. In this case azimuths will be represented by vertical straight lines, and elevations by hyperbolic curves convex to the horizontal. With a knowledge, therefore, of the orientation of the camera axis at exposure, we have a pictorial record of angles in space to all objects in the field of view, such as

might have been obtained by an observer with a theodolite. Suppose, now, that the exact position of the camera station is known and that another photograph is taken from a second known station covering much the same field of view from a different aspect. From the data provided by the two photographs the positions in space of all points in the common field of view can be determined by means of two-ray intersections. Various methods of applying this principle have been evolved, ranging from actual determination of angles, followed by computation, to completely automatic plotting.

The photography of an area from two different points of view opens up the possibility of stereoscopy. In ordinary life, by having two eyes separated by a short eye-base (about 2½ inches), we obtain two slightly different plane views of the same object space, from which our brains interpret a picture in the solid. This faculty is seldom consciously called into play, since there are usually other factors enabling us to estimate relative distances, but it is interesting to note that in the animal world it is possessed only by beasts of prey, the eyes of herbivorous animals being so situated that they view the world as a flat panorama. Where the base separating the two viewpoints is large, then by observing the two photographs in a stereoscope we may obtain the same view of the landscape as would be obtained by a giant possessing the large eye-base. The country is seen in relief as a small-scale plastic model. This property is made use of in automatic plotting machines.

The application of this method is restricted by the limitation of the field of view. Though of great value in hilly country, it is of little value in flat or gently undulating regions. The advent of flying offered freedom from this restriction, by virtue of the almost unlimited field of view available. Since then, the application of air photography to every variety of survey has been closely studied and methods are now available to suit every kind of need.

(b) General Theory of Stereoscopic Pairs.

When two overlapping photographs are taken from known ground stations and at measured orientations, it is a simple matter to place them in a plotting machine so that they are in the same angular relationship one with the other as they were at exposure. By using an ocular system equivalent to placing the eyes in the two positions originally occupied by the lens, so that the left eye observes the left-hand photograph and *vice versa*, all angular relationships between the camera stations and the object space are preserved. The plastic model is, therefore, true in shape, but at a different scale. In the case of air photographs, however, the exact positions of the air stations are not known, neither are the orientations of the photographs. Some other procedure must, therefore, be devised.

Fig. 2 shows two photographs taken from air stations S_1 and S_2, and covering, in part, a common area of ground. In order to simplify the diagram, and the ideas to be inferred from it, we shall deal with the equivalent positives rather than the negatives. S_1 and S_2 are, therefore, the two perspective centres, from which perpendiculars to the plane of each plate meet the plate in the principal points P_1 and P_2. The angular relationship in space between S_1, P_1 and S_2, P_2, defined in any organized manner, will express the angular relationship between the two photographs. Now the images of a ground point Q will lie at q_1 and q_2, in the plane of the triangle Q, S_1, S_2, which contains the air base S_1, S_2 and is known as a basal

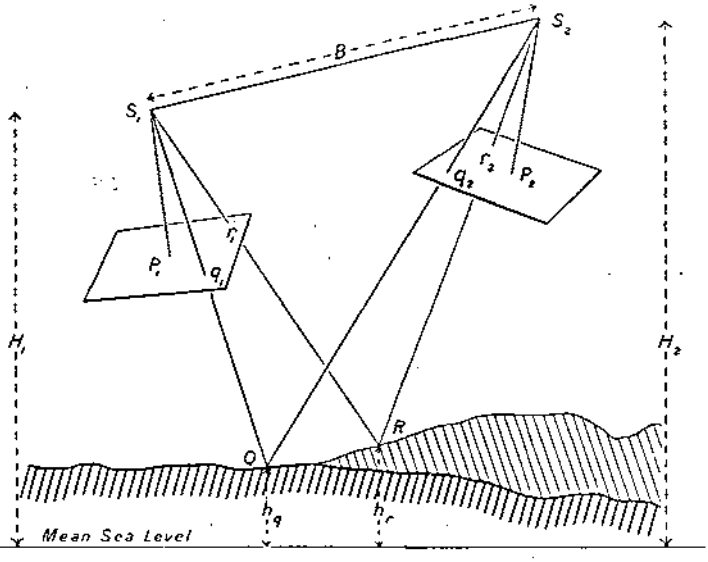


Fig. 2.

plane. Similarly, the images r_1 and r_2 lie in the same basal plane as the ground point R. If an instrument is devised, therefore, in which it is possible to orient the photographs in such a way that they occupy the same angular relationships as they did at exposure, a condition of such true orientation will be that pairs of corresponding images must lie in the same basal planes. Now it can be proved that if the photographs can be adjusted so that any five pairs of corresponding points lie in the same basal plane, then all other pairs will lie similarly in their basal planes, and the photographs are correctly oriented (Fourcade, *Transactions of Royal Society of South Africa*, Vol. XIV, Part I (1926)). To achieve this we must devise an instrument which, as far as the *pair* of photographs are concerned, affords five degrees of freedom. By a suitable system of observing on five pairs of points, departures from the co-planar condition may be adjusted, and true orientation achieved. The result will be a

plastic picture in three dimensions. We do not yet, however, know either the orientation or the scale of this relief model in space, since it is, so far, only related to an air base whose orientation and length are themselves unknown.

To relate this stereoscopic image to the ground we require three ground points of which the heights of all and the true positions of any two have been determined. The positions of these three images in the relief model are adjusted to fit the ground data by altering the scale and orientation of the relief model as a whole. The previous correspondence adjustments are kept fixed. The whole process is merely a generalized case of three-point suspension. A fourth control point supplies one condition of redundancy, and therefore a check.

(*c*) *Plotting Machines.*

A plotting machine is an instrument for reconstructing from a pair of overlapping photographs a spatial model in which the detail and contours may be traced out and plotted on a drawing-board automatically. In order to define the point in space observed, a floating mark is used; that is to say, a conventional mark whose apparent position in space may be altered by means of certain mechanisms connected with the drawing pencil. By adjusting the mark to lie coincident with the ground at any point, the position and height of that point are automatically recorded.

There are many types of plotting machine, differing widely in their optics and mechanisms, but the general principles of their operation remain the same and entail three stages :—

(1) Internal orientation.
(2) External orientation.
(3) Setting of scale and orientation of relief model.

(1) Every plotting machine consists essentially of two goniometers, which are dimensional replicas of the camera with which the photographs were taken, and are (in most cases) fitted with similar lenses. Internal orientation consists of the setting of the pair of photographs in their goniometers so that they occupy the same relationship to the rear nodal point of the lens as they did at exposure, and will depend upon the calibration of the particular camera used. Angular relationships between points on the plates and their perspective centres are now true.

(2) External orientation or the relative orientation in space of the pair of goniometers one with the other, consists of the adjustment into their respective basal planes of five pairs of corresponding points. These points are chosen in particular parts of the overlap, and want of correspondence can be observed at the floating mark as a displacement in the Y direction of one image relative to the other. It can

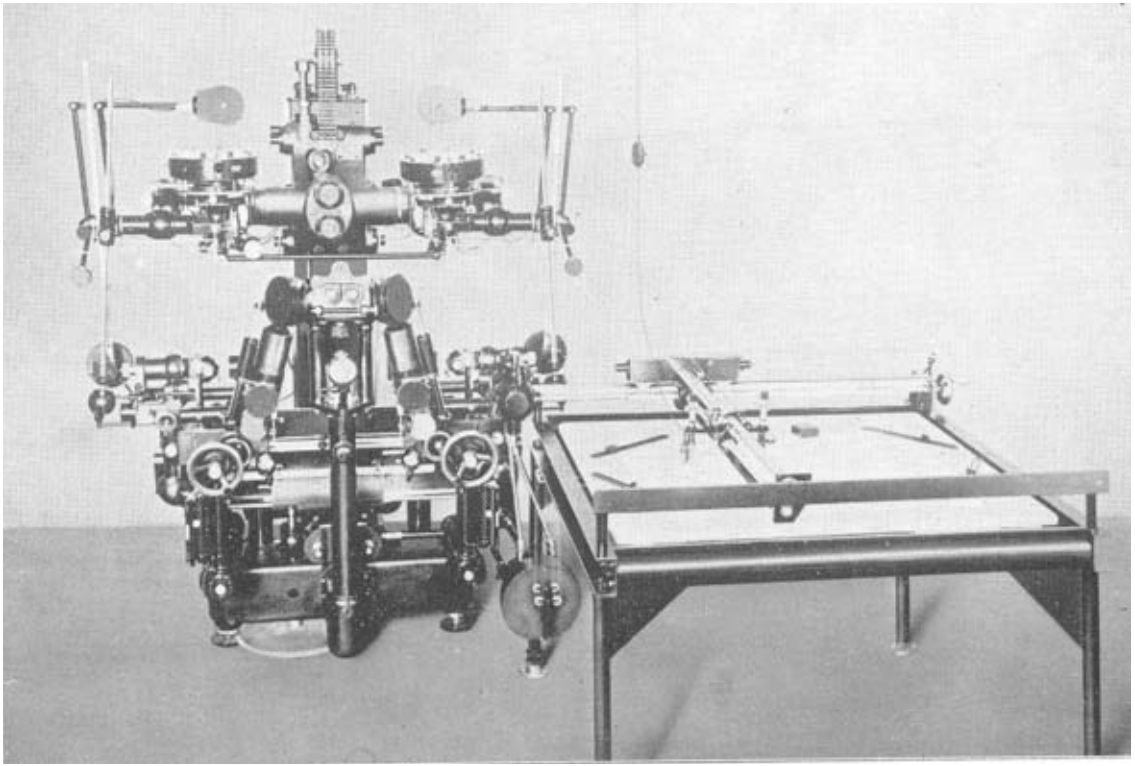
be eliminated at any point by one or other of the five setting movements, but the process is not direct, and a fairly elaborate drill for the five points, followed by successive approximations must be carried out. All points on the overlap should now be in correspondence. Internal orientation is not changed, and the reconstruction of the stereoscopic model is now complete as regards shape, though scale and orientation as a whole are still unknown.

(3) The scale of the relief model may be obtained by comparing with the known value obtained from ground survey, the spatial distance between two points as observed in and recorded by the scale constants of the machine. Orientation may be achieved by tilting the whole relief model about two horizontal axes at right angles to one another. Observations are made to three points known in height and situated at the corners of a well-conditioned triangle. From the differences between the known and the observed heights, the two required tilts may be easily computed and applied.

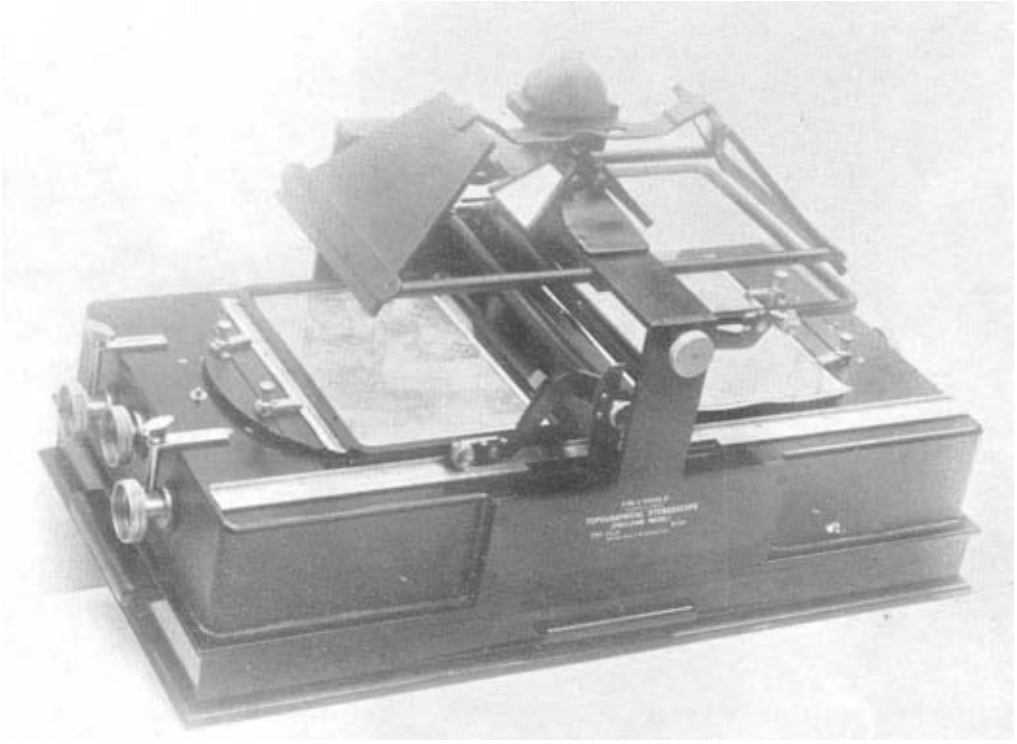
The subsequent use of the machine may be more easily understood by referring to a practical example such as the Zeiss Stereoplanigraph shown in Fig. 3. The two goniometers are seen at either end of a beam carried by the central column, the plates (or films) being illuminated from above. The operator sits in front of the machine and observes the photographs through the binocular system placed centrally. The two hand-wheels are for traversing the floating mark from right to left and from top to bottom of the field respectively. The height of the floating mark relative to the stereoscopic image of the ground is varied by means of the large flat wheel operated by the left foot. All other adjusting wheels and screws are for carrying out the three operations described above, and are used for the initial setting and then clamped. The drawing-board on the right carries a drawing pencil which then reproduces in the horizontal plane and to any desired scale the movements of the floating mark in the stereoscopic field.

To plot any given feature such as a road, the floating mark is made by means of the two hand-wheels to travel along the road, while at the same time it is kept in contact with the ground by means of the foot-wheel. The drawing pencil automatically draws a plan of the road, and a spot height at any given point may be read immediately off a counter. To draw a contour the counter is set with the foot-wheel to the required height and clamped. By means of the hand-wheels the floating mark is then moved about in such a way that it is always in contact with the ground, and the drawing pencil traces the plan of the contour automatically.

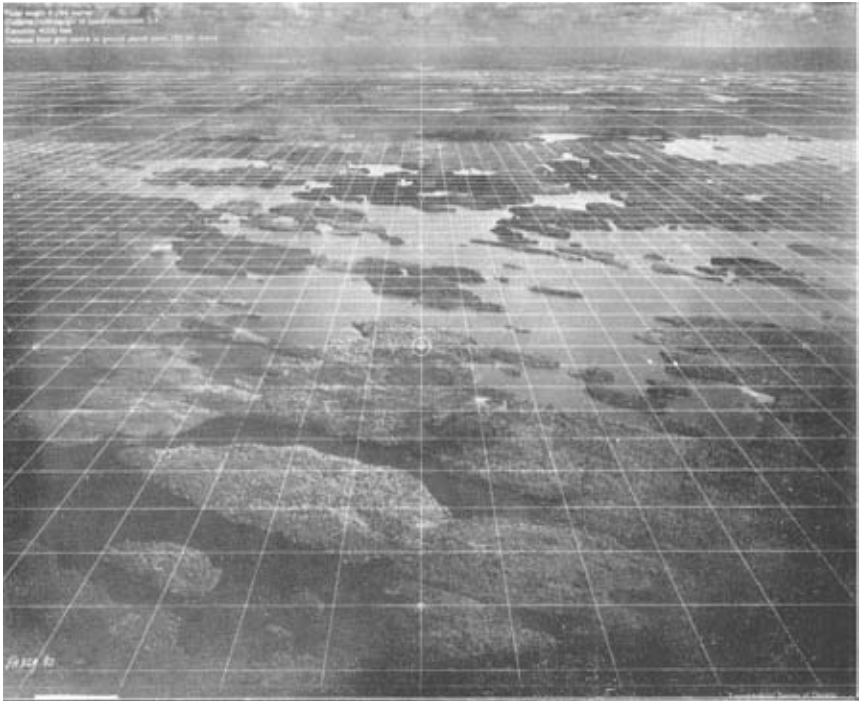
Many plotting machines have been designed and constructed and are doing good work all over the world except in the British Empire. Though a British model, the Fourcade Stereogoniometer offers probably a greater range of applicability than any other, it is some-



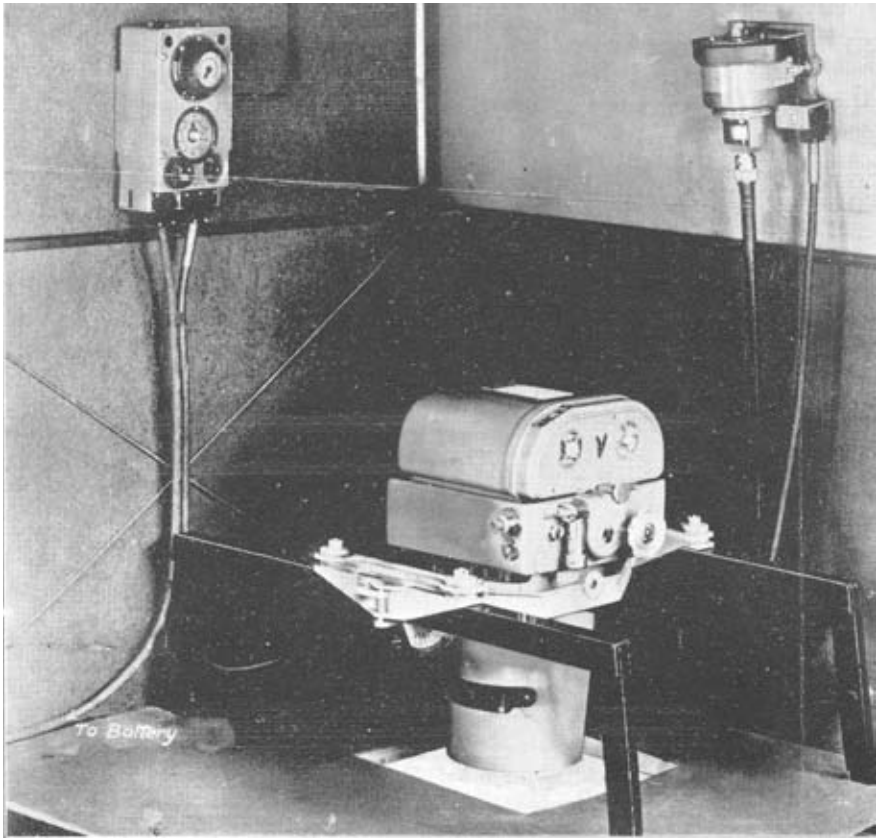
Air survey fig 3



Air survey fig 4



Air survey fig 6



Air survey fig 7

what ironical that its development at home has been made almost superfluous by the excellence of the maps of the Ordnance Survey, whereas the drastic curtailment in the name of economy of essential survey work in all parts of the Empire has militated against its application elsewhere. A discussion of the accuracy of such a machine should refer to particular conditions and any general statement is apt to be misleading, but, bearing this in mind, it may be assumed that using photographs taken at an altitude of 2,000 m. with a camera producing a scale of image of about 1/10,000, and having as control a triangulation giving at least four points per overlap, the accuracy of any plotted point will be within 1 m. both in plan position and height. Although they do not correspond exactly to British conditions, these factors have been chosen since they represent well-established practice on the Continent. They testify to the excellence of the method, but under the more likely Colonial conditions of greater flying height and scantier control would require modification.

The chief disadvantages of plotting machines are :—

(1) High cost—about £3,000–£4,000. This, however, does not render their use uneconomic provided that they are in constant use, as on any regular survey they probably would be. The chief objection to their use by private companies has always been the dangers of intermittent demand.

(2) Only one pair of plates can be plotted at once. To multiply the speed of plotting by multiplying the number of machines may involve too much capital outlay.

(3) The requirements in respect of ground control are at present somewhat exacting. It is here that the Fourcade Stereogoniometer offers the greatest independence, and research on these lines is hopeful.

For a great many purposes, however, and from the military point of view in particular, speed and easily portable equipment are essential, and a certain amount of accuracy may well be sacrificed to simplicity. The above method can deal with pairs of photographs taken at almost any angle and difference of height, and a common procedure is to converge two pictures so as to cover very nearly the same area of ground from two stations. If, however, special precautions are taken to ensure that the photographs are all exposed in as far as possible the same horizontal plane, and the fractional overlap shared by contiguous photographs in a strip is used to give a stereoscopic field, a simplified method, easily adaptable to mass production, is available. This is described in the following pages.

A further method, using oblique photographs and of more limited application, is described in the subsequent section.

(d) Simplification in Case of Vertical Photography.

Let us take the case of a pair of overlapping photographs taken at the same height and with the axis of the camera vertical. In practice, a close approximation to this can be achieved. When set in a plotting machine the two photographs will lie in very nearly the same plane. Consider, therefore, a simplified form of stereoscope in which the photograph holders are not goniometers but flat turntables. The photographs are placed on the turntables, with their principal points at the centres of rotation, and are oriented in their own plane. When viewed stereoscopically they will present a relief model, though slightly distorted, since angular relationships are no longer true. Provided, however, that the tilts on the photographs are small, and that we possess a series of spot heights obtained by a ground survey covering the common overlap, we may draw contours on this relief model which are sufficiently accurate for topographic purposes. The instrument necessary is small, of simple construction, and correspondingly cheap (Fig. 4). The floating mark consists in this case of a grid which can be adjusted so as to appear to float horizontally in space at any desired height. The contours are drawn on the photographs themselves and are then similar in nature to detail (Fig. 5,* where the three photographs are mounted for viewing stereoscopically). We require now some method of plotting detail.

A vertical photograph of flat country would (within the limitations of lens distortion) be a true plan of the ground. If a photograph is tilted the result is no longer a true plan, since the scale will be different in different parts of the picture; being, in fact, smaller on that side of the negative tilted towards the ground and *vice versa*. Now it can be shown that the distortion in position of any point in this way takes place radially from a point known as the isocentre, situated at a distance $f \tan \theta/2$ from the principal point and in the direction of tilt, where f = focal length of lens, and θ = angle of tilt. Angles subtended at the isocentre by points on the photograph and measured with a protractor will be the same as angles subtended by the corresponding points on the ground at the ground point corresponding to the isocentre, such as could be measured with a theodolite. In practice, however, the ground is seldom absolutely flat, and there are further distortions due to variations in ground height. On a vertical photograph, for instance, every contour is photographed at a different scale, the tops of hills being at a larger scale than the bottoms of valleys. These height distortions take place radially from the plumb point, which is the point where a vertical line through the rear nodal point of the lens cuts the plane of the photograph. It will lie at a distance of $f \tan \theta$ from the principal point, and in the direction of tilt. On a truly vertical

* At end of article.

photograph, therefore, the plumb point coincides with the principal point, which is then, even in the case of hilly country, angle true. In the case of a tilted photograph of hilly country there is clearly no point from which angles are true, since tilt distortions are radial from the isocentre and height distortions from the plumb point. Furthermore, there is no means of directly obtaining the tilt, since a body, such as an aircraft, moving in a homogeneous medium has no means of differentiating between acceleration and gravity. It is found, however, that provided tilts can be kept to within two degrees of the vertical, and ground heights do not vary by more than 10% of the altitude of the aircraft, we may take the principal point itself as being angle true. This, being a function of the camera only, is available from the calibration data.

Suppose, now, that a strip of nearly vertical photographs are taken at approximately the same height and in such a way that each photograph overlaps the next by about 60%. There will thus be a small area, in width 20% of the width of a photograph, common to every three successive photographs. In view of the radial assumption discussed above, each photograph may be considered as the data obtained by an observer on the ground, situated at the point of detail corresponding to the principal point, and taking rounds of angles to all points of detail appearing on the photograph. We now have sufficient data to build up a graphical triangulation, dependent on angular relationships only, which will determine the true relative positions of photographs along the strip. This is carried out on celluloid and is known as a minor control plot. It will be true to shape, and at some definite but unknown scale. Any point of detail may now be fixed by a two-ray—or, in some cases, a three-ray—intersection from the principal points of the photographs on which its image lies. If the positions of any two such points have been determined by ground survey, then the scale and orientation of the minor control plot are fixed.

When it is required to survey a large area, strips are flown parallel to each other and with a lateral overlap of about 25% between adjacent strips. In this case a minor control plot is constructed for each strip, and these will all be at different scales. The next stage, therefore, is to bring them all to some common scale. A grid, known as a master grid, is constructed to represent 1,000-metre squares (say) on some definite scale approximating to the scale of the photographs. On this are plotted all the points whose positions are available from ground survey and which can be identified on the photographs and intersected on the minor control plots. A control equivalent to a second order triangulation will be sufficient. All strips are then tied in to this framework of ground control, suitable points being chosen in the common lateral overlaps to ensure exact agreement between

adjacent strips. The result is a series of principal point traverses plotted to the same scale and in their correct relative positions on the master grid.

Finally, a sheet of celluloid of convenient size is placed over the master grid and the principal point traverses are traced off. On this sheet the detail is plotted from the photographs by placing them under the corresponding principal points and in the correct orientation and carrying out a series of intersections and interpolations. All detail drawn in this way will be plottably accurate. Contours are transferred from the photographs similarly.

All mapping material thus obtained must be fair-drawn according to the conventional signs and symbols adopted for the map. Plates are then prepared for as many colours as are required, and the map is reproduced and printed in the ordinary way.

The advantages of this method are :—

(1) Simpler and cheaper equipment may be used.
(2) Film negatives and paper prints are normal, with correspondingly simpler air photographic problems.
(3) Less ground control is required, and no hard-and-fast lay-out is necessary. Whatever control there is may be used to the best advantage.
(4) The work of plotting may be sub-divided among a large number of draughtsmen, thereby increasing the speed of map production.

It has not yet been possible to carry out any full-dress rehearsal, but more modest experiments indicate that a team of 12 men should, under favourable conditions, be able to produce a standard 1/25,000 sheet, 15 km. × 10 km., in about 100 hours. This time could probably be reduced about 40% by double-banking the team. The map would be fully contoured and in three colours, and the time is estimated from the receipt of the photographs to the delivery of the first batch of 500 copies. The importance of such map production during a campaign is obvious.

(*e*) *The Use of Oblique Photographs.*

For most purposes oblique photographs are of use more for reconnaissance and identification than for actual survey work, but various methods of plotting them have been devised, and their application in special circumstances should not be overlooked. One such circumstance is the use of high obliques in Canada, and this method has been perfected there and used on a large scale for many years.

A high oblique is an air photograph which includes an image of the visible horizon. Such photographs are of great value in the production of medium-scale maps of flat country where the topographical features are very clearly defined, and the maps of the Canadian lake country are an excellent example of their use.

Flying is normally carried out at a height of about 5,000 feet, and the camera is mounted in a tilted position so that the image of the horizon appears close to one edge of the picture. From this image, and a knowledge of the altitude of the aircraft and the focal length of the lens, an allowance for the refraction of the atmosphere and the curvature of the earth will derive the position of the true horizon. Hence, if some conventional system of grid squares be imagined as marked upon the ground, a correct perspective view of this grid system can be drawn on the photograph. An example is shown in Fig. 6. Detail is then transferred square for square from the photograph to a compilation grid drawn at any desirable scale, usually at about 1 inch to the mile. In practice a number of perspective grids are drawn first to cover the full range of altitude and tilt of the photographs, and the correct grid for any particular photograph can be selected from a knowledge of the altimeter reading and inspection of the horizon. A copy of the grid on glass is then superposed on the photograph at the time of printing.

B. The Photographic Problem.

Though the task of providing survey photographs taken in the required manner is entirely a matter for the Royal Air Force, the best results will not be obtained without an accurate and sympathetic understanding between the airman and the surveyor. In many cases the surveyor will actually be called upon to assist the airman in his navigation problems by plotting preliminary navigation strips, and in few cases will it be possible to carry out an air survey according to a standardized method. The necessary modifications will then require the maximum of mutual understanding. The surveyor should, where possible, learn to carry out photography and photographic flying himself. An outline of the factors involved is given below.

(*a*) *Characteristics of Aircraft.*

The characteristics desirable in an aircraft for survey photographic work may be summarized as follows :—

(1) Endurance. An endurance of 6 to 8 hours is desirable.
(2) Comfort. To ensure accuracy in navigation and camera operation under adverse weather conditions, comfort is essential.
(3) Stability. The greater the aerodynamic stability, the better the quality of flying as regards tilt, overlaps, etc.
(4) The pilot must have a good view ahead and to both sides.
(5) Speed. A cruising speed of about 100 m.p.h. is probably the most suitable, but greater speed is of value when photographing some way from the aerodrome.

(6) Climbing. When photographing hilly country, an aircraft of high performance is required to reach the necessary height with full photographic load.

(7) Multi-engine. For large surveys, and particularly in country unfriendly to a forced landing, a triple-engined machine, capable of maintaining level flight on any two engines, has the advantage of greater security.

These considerations lead generally to a choice of the larger types of aircraft for photographic purposes, and where transport of personnel and stores is to be carried out by air, the two functions may conveniently be combined.

The particular Royal Air Force aircraft for carrying out survey work has not yet been defined, and various types have been used. Some are not so suitable as others, and the surveyor should thoroughly acquaint himself with any particular limitations.

(*b*) *Cameras.*

The choice of an air camera will depend primarily on the method of plotting to be used subsequently. For the highest class of work done with automatic plotting machines, plate cameras specially designed for each particular machine have normally been necessary. The extra weight, however, and the greater complication of operation in flight have stressed the advantages of using film instead, and recent improvements in the stability of film bases are endowing the film methods with the precision which was previously lacking. Though all plotting machines are not yet adapted for use with film it is probable that plates will rapidly be superseded.

A film camera for air survey photography should have the following qualities :—

(1) The construction must be very robust, to stand up to hard treatment, engine vibration, etc.

(2) The arrangement for winding on the film and operating the shutter must be automatic, and capable of being set to work at any required time interval.

(3) A record should be made at the time of each exposure of an instrument panel carrying the following instruments : altimeter, clock, cross levels, and counter.

(4) To facilitate accurate calibration, fiduciary marks, carried in the main body of the camera, should be recorded at each exposure.

(5) A suitable mounting must enable the camera to be accurately levelled and orientated.

(6) For a given focal length (which may be chosen in accordance with the scale desired) the angular field covered by the lens should be as great as possible, consistent with lens distortion, image illumination, etc.

For some years the camera used in the Royal Air Force for survey photography has been the F.8, taking a picture 7″×7″ with a Ross F.4 7″ lens. For other purposes, though, a smaller camera, much more easily mounted in aircraft, has been developed, and this, the F.24, standard for all A.C. purposes, will probably become the standard survey camera as well. The size of picture is 5″×5″.

The F.24 (Fig. 7) consists of three main units.

(1) Film Magazine. Attached to the camera body in such a way that a number of magazines may be carried in the aircraft and quickly replaced without breaking the sequence of photographs. The film is 5½″ wide, and sufficient is carried in one magazine load for 125 exposures.

(2) Lens Cone. Attached to the camera body by a bayonet fitting and easily removed and replaced. Various lenses of focal length from 5″ to 10″ can be fitted, the former of which is the most suitable for survey purposes. At present a 6″ lens is standard, since the low marginal illumination of the normal 5″ lens renders printing far more difficult, but with the development of the new Ross E.M.I. lens, 5″ focal length may be taken as the future standard.

(3) Camera Body. Contains the driving mechanism for the film magazine and the shutter; also, an instrument box, glass register plate, etc. The shutter has, up to now, been of the focal plane type, but this produces either longitudinal or rhomboid distortion due to the speed of the aircraft. The common between-lens type places restrictions on the design of lens. A new louvre type, however, like a venetian blind working just behind the lens, overcomes these difficulties and will probably be used in future.

The camera can be operated by hand or by remote control, electrical or mechanical. Individual exposures can be made either independently as required, or regularly at a set interval. All operations, such as winding on the film, setting the shutter, and securing the film flat at the moment of exposure, are interconnected in the gear box, and incorrect manipulation is therefore impossible. An efficient vibration-damping mounting is essential.

For survey purposes the printing of the film may take one of three forms.

(1) Contact Prints. For reconnaissance, hasty compilation of mosaics, etc.

(2) Enlarged Prints. Produced with almost equal rapidity in a permanent enlarger. An enlargement of about 1½ improves the identification of points and is more suitable for graphical plotting, and such prints can be used in the stereoscopes and

other instruments previously designed to work in conjunction with the F.8 camera.

(3) Plate Positives. By contact printing on glass, for use in the Fourcade Stereogoniometer.

An important development is the multi-lens camera.

Multi-lens Cameras.—The importance of a wide-angle lens from the point of view of economy can hardly be overestimated. For instance, a 6″ lens fitted to the F.24 camera will, at 15,000 feet altitude, cover 5·6 square miles : a 5″ lens, under the same conditions, will cover 8·1 square miles. This entails a reduction of over 30% in the number of photographs to be taken, developed, printed and plotted ; and a reduction of about 17% in the cost of flying. The limit of angular field for a single lens, however, has now been reached, and rests at an obliquity of about 35°. This limits the diagonal of a photograph to rather less than 1½ times the focal length of the lens ; or, expressed otherwise, the length of ground covered by the side of a square picture cannot be greater than the altitude of the aircraft. Attempts at freedom from this restriction have led to the design of multi-lens cameras. Most of these consist essentially of several separate cameras built up together in such a way that contiguous units possess a small common overlap (*e.g.*, Zeiss Vierfach R.M.K.C/1). The views are therefore oblique to one another and to the vertical. Another type, *e.g.*, the Aschenbrenner 9-lens camera of Photogrammetrie G.M.b.H., Munich, aims at rectifying these obliques to equivalent verticals so as to form a common picture. The latest design on these lines is the 7-lens camera of Barr and Stroud. A square picture subtending 120° across the flats is covered by one central lens and six peripheral lenses working through prisms which deflect the optical axis obliquely through 45°. The lenses are Ross Xpres F.4 E.M.I. of 53 mm. focal length. The complete lens system can be fitted to the F.24 camera, and the resultant negative image consisting of seven sections is produced on standard roll film of 5½″ width. Printing is carried out in a special rectifier, where the six oblique pictures are rectified simultaneously to the plane of the central hexagonal image and all are given a small enlargement. The result is a picture 9 inches square, equivalent to one having been taken with a single lens of 66 mm. focal length and a semi-angular field of 60°. From 15,000 feet it covers an area of nearly 100 square miles at a scale of about 1/70,000.

Owing to the obliquity of the outer rays and consequent difficulty of identifying detail, the use of this camera will probably be somewhat limited, but, for reconnaissance purposes and for the production of medium-scale maps of undeveloped country—a vital need at the moment—it should be of the greatest value. Compared with the standard F.24 fitted with a 6″ lens, the number of photographs

required is reduced by 94% and flying costs by 75%. Standard camera mountings, roll film and developing equipment can be used, and the size of print is suitable for the standard simple stereoscopes.

(*c*) *Flying for Vertical Photography.*

In the majority of cases, vertical photography is the most suitable for survey purposes and the simplest to carry out.

In unsurveyed country, a few strips, known as navigation strips, are first flown to provide a skeleton framework. These are either plotted graphically or compiled in the form of a mosaic, and on this compilation the centre lines of all the filling-in strips are drawn. The photographs of the various navigation strips, which are crossed by the centre line of a particular filling-in strip, are then marked with the centre line and used as an aid to navigation. The more accurate the original navigation framework, the less margin of lateral overlap between strips need be allowed, and the greater the economy of flying.

The Pilot. Any good pilot can fly for survey photography with a little practice : the principal requirement is extreme care. The task of flying straight and level for long periods is arduous and monotonous, and anything which may help the pilot is of value. The greatest assistance is gyro control, which not only keeps the track very straight but reduces the tilts on the photographs to within about half a degree. This is of vital importance for the simpler methods of plotting, and in any case reduces the necessary margin of error for providing the required overlaps. No photography of any large area should in the future be undertaken without gyro control.

The Photographer. To photograph a strip it is usually necessary either to fly between two observed points (*e.g.*, taken from the navigation prints), or to fly over a given point and maintain thereafter a given compass course. In each case a straight and level flight must be made. Both methods entail the determination, either directly or indirectly, of the speed and direction of the wind. This added vectorially to the air speed determines the ground speed, the difference in direction between the two latter being the angle of drift. The duties of the photographer are :—

(1) To determine the wind speed and direction, and direct the pilot on to the correct course.
(2) To turn the camera through the angle of drift so that the photographs are not " crabbed."
(3) To trim the camera level when steady flight at the required height has been achieved.
(4) To set the time interval between exposures necessary to produce the required fore and aft overlap.

The accuracy of the above operations will depend very largely on the comfort of the photographer.

The time taken will depend on the methods and instruments used, and on the skill of the photographer and pilot, but the interval between taking off and starting photography, even close to the aerodrome, will seldom be less than 50 minutes. Sound meteorological information is therefore essential, particularly in cases where changes of weather are rapid.

(d) Some Quantities Involved.

When flying with the F.24 camera at a height of 15,000 feet above the ground, the area covered by a single photograph taken with a 6" lens is 5·6 square miles. Maintaining the normal longitudinal and lateral overlaps and allowing for a few extra cross strips where required, an estimate of about two square miles per photograph will give the number of photographs required to cover any given area. For an area of 10,000 square miles, arrangements should be made for dealing with 5,000 photographs, with probably three prints of each. With suitable weather, the rate of photography when such a survey flight is in progress may be taken as about 200 square miles per hour. The corresponding figures for different lenses may be estimated by remembering that the area covered by a single photograph will vary inversely as the square of the focal length.

THE MILITARY USES OF AIR SURVEY.

We have now briefly reviewed the procedure of taking and using air photographs. Its application to the problems of war and the creation of the necessary organization must depend on the type of demand, and this is not yet crystallized. The same principles will hold for any type of production but the detailed procedure will vary considerably. For instance, for fieldworks purposes, short strips flown by flattening out after a dive can be used to determine the width of gaps and the contours of the banks to a high degree of accuracy. If there is a demand for this type of work, suitable instruments for providing the best solution can easily be designed. Experiments up to date, however, have been chiefly devoted to the production of a first-class three-colour topographical map in the shortest possible time. If the figure arrived at, 100 hours, is too long from the tactical point of view, then the problem must be stated the other way round. How good a map can be produced in (say) 30 hours? To any definite demand of this nature a suitable organization can be evolved and a reasonable answer given. All that remains now, therefore, is to place the air survey technique in its proper military setting.

Every alternate photograph is contoured stereoscopically in conjunction with those on either side of it.
Contours at 25 m. interval, every 100 m. contour thickened. Spot heights as shown are obtained from trig. data supplemented

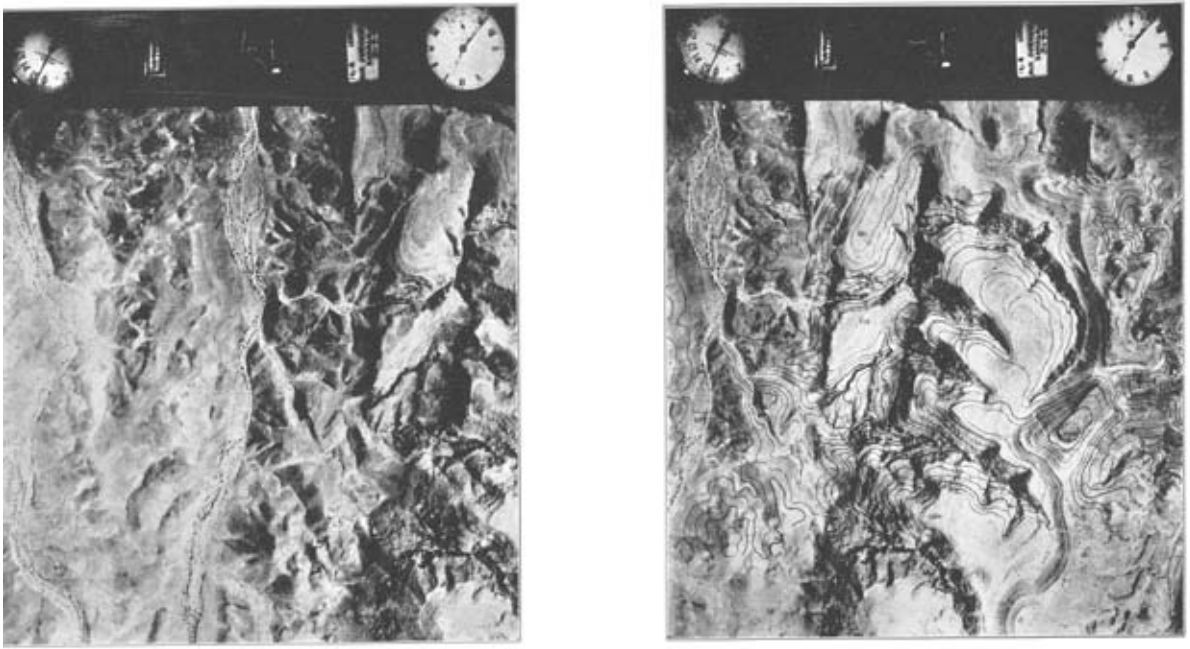


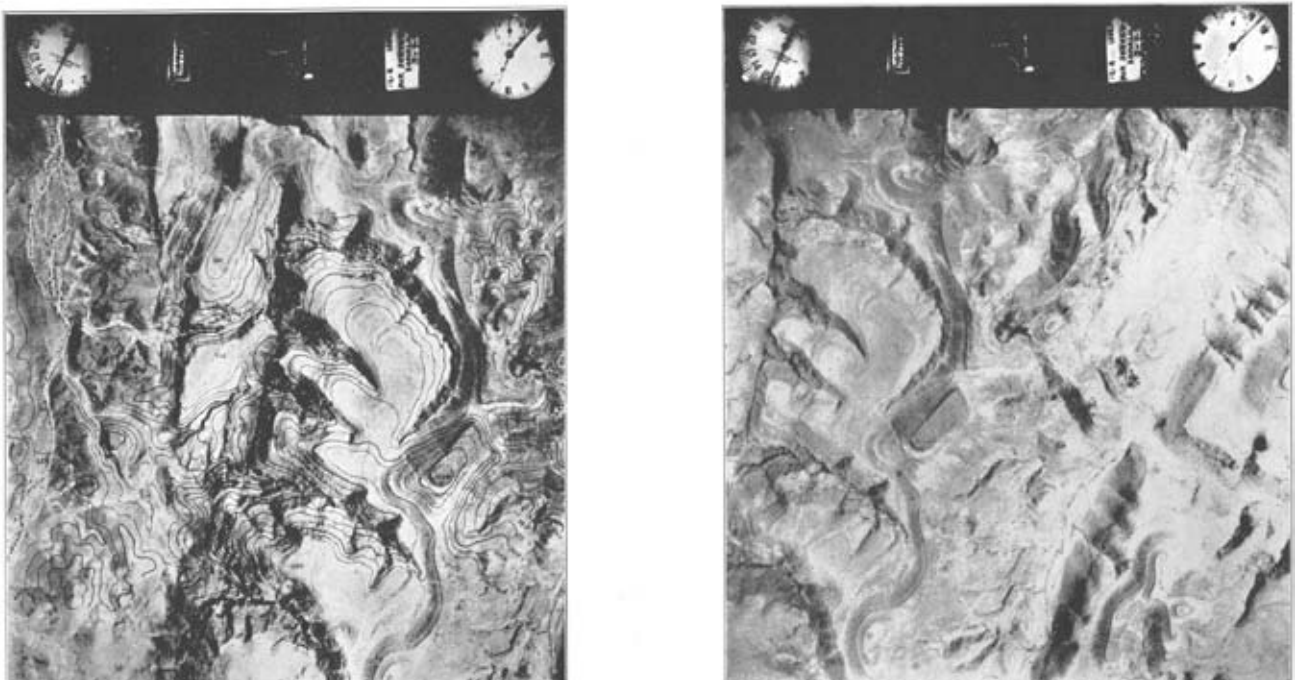
Fig. 5.

Specimen photographs showing contouring (LHS)

SPECIMEN PHOTOGRAPHS SHOWING CONTOURING.

stereoscopically in conjunction with those on either side of it.

contour thickened. Spot heights as shown are obtained from trig. data supplemented by aneroid barometer traverses.



Specimen photographs showing contouring (RHS)

EARTHQUAKE RELIEF.

By LIEUTENANT L. T. GROVE, R.E.

ON January 15th, 1934, North Bihar was shaken by a severe earthquake. There are many accounts of the events of those crowded few minutes. It appears that, two days before, the weather which had been warm for the time of year suddenly turned cold. The first warning of trouble was a loud booming noise like the sound of distant thunder. This was followed by a heavy shock and the ground went on swaying for two minutes. So pronounced was the sway that it was difficult to remain standing up, even on level ground. As the shock died away the earth in many places split or burst open and a mixture of water and a peculiar black slime came oozing up out of fissures and " blow-holes."

Widespread damage was done to an area comprising most of North Bihar between the Ganges and the foothills of the Nepal border, as well as in Nepal and Sikkim. The main shock seems to have run generally along a line from north-west to south-east and the five towns which suffered most were Bettiah, Motihari, Muzaffarpur, Darbhanga and Monghyr. Apart from Monghyr, which is on the river bank, comparatively little harm was done south of the Ganges.

In a country like India it is difficult to get an accurate estimate of casualties, but the number of killed was probably about ten thousand. Of these a high proportion were women and children, who were inside their houses at the time. The shock occurred at 2 p.m., when most of the men were out in the fields. Had it come twelve hours later, the death-roll would have been appalling.

As it was, material damage was the most serious item. Many of the fields, particularly in the north of the area, were covered with that slime which had oozed out of the ground and which, when it dried, proved to be a curious dark-coloured sand. This feature was emphasized and much exaggerated in the newspapers, which implied that North Bihar, an essentially agricultural country, was ruined. Such was not the case. A few fields were so covered that they could not be used again, but, on most, the sand was only two or three inches deep and it could be ploughed in. Far more serious was the damage done to buildings. These were mostly cheap and very rotten, and the earthquake destroyed them wholesale. Most of the better-class buildings and Government offices withstood the shock, but many were wrecked by the earth cracking or giving way beneath them. Nearly all road and railway bridges in the area were more or less damaged and some completely destroyed. Embankments were

shaken and needed extensive repairs. Most of the big sugar factories were put out of action at a time when the sugar cane was just getting ready for pressing, so that sugar, which is the staple industry in North Bihar, has suffered a loss which seriously affects the economic situation in the province.

It was under these circumstances that the Sappers and Miners were called in to assist with the relief work. This article is not a comprehensive survey of all the work done, but rather an attempt to describe the situation and the methods taken to deal with it in the early stages.

A telegram came to Roorkee on the night of January 18th. It was brief and to the point: "One Section Sappers with three officers experienced in bridging and demolition work proceed to Patna as soon as possible." Ievers, Henniker and myself were detailed. It was 11 p.m. when I heard the news and at 4 a.m. Ievers and I were in the Calcutta mail *en route* for Patna. Henniker with one section of No. 2 Field Company S. and M. followed by a slower train an hour later.

On arrival at Patna we were taken straight to the Chief Secretary's house. There we learnt what little information the local Government had about the situation in the north. There was not much. Patna itself had suffered little damage. Monghyr, Muzaffarpur and Darbhanga were reported to be in a bad way. The railway was definitely breached south of Muzaffarpur and it was thought that all the roads into Muzaffarpur and Darbhanga were out of action. A section of the Madras Sappers and Miners had already started work in Monghyr and we were to be employed in Tirhut district: firstly to open up road communications, and secondly to destroy such buildings as were still standing in a dangerous condition. Next morning, we were to do an aerial reconnaissance of the area to see what we could for ourselves.

The Chief Secretary's house was a solid building, two stories high, with the bedrooms upstairs. Exactly at midnight came another earthquake shock, strong enough to set all the doors and windows rattling. With one accord the entire household discharged itself on to the lawn presenting a motley appearance in pyjamas, shirts, slippers—anything that was handy at the time. Then followed a discussion as to whether it would be better to sleep in or outside. The shock itself was insignificant, but the incident gave us an idea of the nervous state of everyone who had been through the earthquake four days before.

Next morning early, we took off from Patna polo ground in a Fox Moth on our first aerial reconnaissance. The machine followed the line of the road from Patna to Muzaffarpur, which proved to be open to traffic all the way. It was extraordinary that this fact was still unknown in Patna four days after the earthquake. Muzaffarpur itself on the other hand was terribly damaged. From the air it

presented a desolate appearance of broken roofs with jagged walls rising out of heaps of débris. One heap of bricks, larger than the rest, was the Judge's house; another the Collector's bungalow, in which the porch alone remained standing with the Union Jack flapping forlornly overhead. The whole town was in ruins.

From Muzaffarpur we followed the direct road to Darbhanga. Some of the country was flooded, and parts of the road were under water. It looked as though the embankment had sunk in several places, and two bridges at least were broken. It was here that we first saw the curious round blowholes, through which the water and mud had come oozing out to flood the countryside.

Darbhanga appeared to be much less damaged than Muzaffarpur. Two large buildings, the Rajah's palace and the civil hospital, we could see had been shaken: but many buildings were still standing and not visibly affected by the shock. Some of these, we found later, had been ruined by subsidence of the ground and were only fit for demolition. After flying once round Darbhanga we turned for home. But now the ill-effects of an enclosed cabin aeroplane were becoming insistent and neither Ievers nor I had much interest in the return journey!

It was a great relief to land at Muzaffarpur. The polo ground here had been irreparably damaged by fissures and half the ground had subsided bodily to a lower level. We met the Collector and the P.W.D. engineers and walked round part of the bazaar on foot. It was decided that, for the present, roadwork should wait and the S. and M. section should get straight on with the demolition of dangerous buildings.

On January 21st the section arrived in Muzaffarpur and a start was made. The first day's work was necessarily experimental. Of the first four charges laid two failed completely, which was disconcerting. At the time we thought this was simply due to 1919 gun-cotton, but some days later, when the trouble recurred, it was traced to a single tin of damp primers. Meanwhile we saw that much of the work could be done with ropes without any explosive at all.

Next day half the party embussed in civilian lorries and set off for Darbhanga. The direct road being closed, we went *via* Pusa and Samastipur, seeing comparatively little destruction on the way. The railway was running as far as Samastipur and supplies for Darbhanga had to be sent up from there by road. While camp was being pitched we made a preliminary reconnaissance of the town and found the situation worse than it had appeared from the air. Many of the houses which remained standing were uninhabitable. The bazaar area was very congested with many high buildings and narrow streets. This was in a horrible mess. The houses were most of them rotten and the first shock had brought them tumbling down. The wretched inhabitants had been caught like rats in a trap. Many ran out of their houses and were caught in the narrow streets with no

chance of escape. Some of these streets had been filled with débris six feet deep and it was impossible to say how many bodies might be still lying buried. Most of the 2,000 deaths in Darbhanga happened in this area. Business was at a standstill and small parties of people searching among the ruins were the only signs of life.

On January 23rd we began the work of demolition. Two sub-sections worked separately, one in the main bazaar, the other on Government buildings and outlying tasks. Most of the work involved pulling down walls and portions of houses, and each party employed a gang of coolies to assist. Opportunities for the use of explosives were rare. The bazaar was so congested that it was more trouble to clear an area before blowing a charge than to do the work with ropes. A good many charges were fired on the outside jobs: but here, too, the rope method was more easily controlled and often just as effective.

We had expected that the house owners would be reluctant to have their homes pulled down, but at first this was not at all the case. They were so shaken by the earthquake that they were afraid of any wall or pillar which showed the slightest crack and we had more applications than we could deal with. Later on, when they saw the Sappers climbing about the ruins, their confidence began to return and in time they came to prefer pulling down their own houses rather than letting us demolish them.

On January 24th we blew down an isolated building in the bazaar. This was a two-storied house, surrounded by other hovels yet separate from them, and so damaged that it remained leaning over to one side in a precarious way. We called it "the leaning tower." Treating it as a frontier tower we put one charge of 20 lb. in the middle of the floor. Door and window openings were roughly blocked and we arranged to fire with safety fuze. Then came the problem of clearing the area. We only wanted a clear space of 30 yards all round, yet it took twelve policemen and as many Sappers nearly half an hour to do it. What with *purdah* women, donkeys, cows, goats, children and cripples, beggars and strays, it was a troublesome business and it fully decided us against blowing any more charges in these surroundings. When we did fire, there was a great cloud of dust, which hid everything for some minutes, and the "tower" was reduced to a neat heap of bricks. I had watched the explosion from a point 25 yards away and, apart from a few pieces of wood, no débris was thrown about at all. The building had merely collapsed where it stood, like a house of cards when someone breathes on it. Later we came to blow down several buildings of all sizes by this concussion method. The result was always the same. Any woodwork that was left was liable to fly up to 50 or 60 yards, but bricks hardly flew at all. The walls just fell outwards and the building collapsed flat.

For the next week both parties continued working on these lines. On a few occasions we tried cutting charges for some particular

purpose. But they were not satisfactory. They used an extravagant quantity of explosive ; they made a loud report which was much more trying than the muffled " boom " of a concussion charge ; and they threw bricks about in a disconcerting way. So we avoided them whenever possible. On January 29th work was held up by rain, which must have been very hard on the wretched people living out in the open or at best under improvised grass shelters. Fortunately no further casualties were caused by falling masonry on account of the rain.

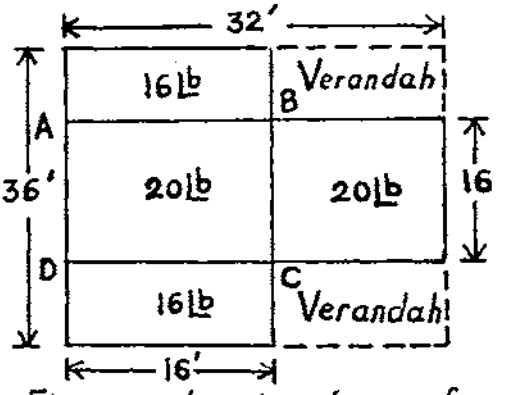
On January 30th the Superintending Engineer P.W.D. came over from Muzaffarpur to do a reconnaissance of the Samastipur–Darbhanga road. This road was open to traffic, but there were two critical bridges. One was a pontoon bridge in which an inshore pontoon had sunk. There was a nasty dip in the roadway, but it had been packed up with earth and brushwood and was in no danger of collapsing. The other was a screw pile bridge of six spans. The whole of one bank had been pushed forward about six feet, taking the abutment and the feet of all the piles with it. The heads of these piles were strutted by the roadbearers, and so did not move. Consequently the piles had been bent, some through nearly a right angle, and the centre of the bridge sagged about eight feet. It looked rather alarming : yet nothing was broken, not a bolt had sheared and the bridge continued to take lorry traffic without the slightest trouble.

This earthquake has emphasized the merits of screw pile bridges. They are quick and cheap to erect and so particularly suitable to a country where the riverbeds are soft and the heaviest forms of traffic do not go. Altogether I examined thirty such bridges in the earthquake area. Of these thirteen were more or less damaged, but only three were quite impassable. Of nineteen bridges of other types (timber pile, brick arch, R.S.J's on brick piers, etc.) ten were damaged and of these six were impassable. The screw piles (mostly of 4-in. diameter piping) seemed able to bend over to almost any angle and still carry a load. Eventually, of course, they will have to be dismantled and repaired ; but meanwhile communications are not interrupted. I believe they cannot be used where the riverbeds are rocky or filled with stones, as they are on the North-West Frontier.

By January 31st the immediate work in the bazaar and outside was finished. The streets now presented almost the appearance of " business as usual." Those shops which had escaped were open and their proprietors were carrying on a roaring trade. The less fortunate ones had improvised roadside stalls, from which they traded such merchandise as they had managed to rescue from the ruins. There was no shortage of food. Tailors with their sewing-machines and cobblers mending shoes in streets, already restricted by booths and piles of bricks, added to the confusion. On all the damaged houses coolies were at work dismantling the worst portions. While here

and there among the ruins a house, more solidly built than the others, remained standing just as if nothing had happened.

One demolition is perhaps worth describing. This was a gaoler's quarter, a well-built bungalow with four rooms and two verandahs. It had suffered very little damage, but had to be condemned owing to settlement of the ground underneath it.



Figures denote sizes of charge used.

In this case we placed four charges—one in the centre of each room. Door and window frames had to be salvaged, so these were first removed and the openings filled with dry brickwork. The four charges were fired electrically. As usual there was a muffled report, a cloud of dust and no flying débris at all. When the dust had cleared we found the verandah pillars and the three walls AB, BC, CD still standing. This clearly suggested the principle that a wall which has a concussion charge placed on *both* sides will not be destroyed. Further experiments confirmed this in the case of single-storied buildings. Where there are two or more stories the falling superstructure tends to bring everything down together. For this reason high buildings are more satisfactory to demolish than bungalows. In this particular case, had we omitted altogether the charge in the room ABCD, we should have saved explosive and at the same time produced a more complete demolition.

On February 2nd the party moved 24 miles by road to Madhubani, the headquarters of the northern subdivision of Darbhanga district. Here the bazaar had not suffered so much, but there was one area where the ground had been terribly shaken. There were only a few actual fissures, yet every building in that area was ruined. In most cases this was due to settlement of the ground which had left the houses tilted over at all sorts of angles. Some of them gave almost the impression of sinking ships. So far as we were concerned these houses were not "dangerous" and we only undertook to

Darbhanga.

A street in the bazaar. "... filled with debris six feet deep."

Muzaffarpur.

The Collector's bungalow. The Union Jack flapping forlornly overhead.

Earthquake relief 1 & 2

Darbhanga.

"Working in the streets."

A curious effect of the earthquake.

Earthquake relief 3 & 4

Darbhanga.

Wreckage of a house.

A street scene.

The hospital after demolition. The north wall still standing as it was befor

Earthquake relief 5, 6 & 7

demolish the civil court buildings and part of the municipal market. Besides this we repaired culverts in the town and built one small bridge on the main road into the bazaar.

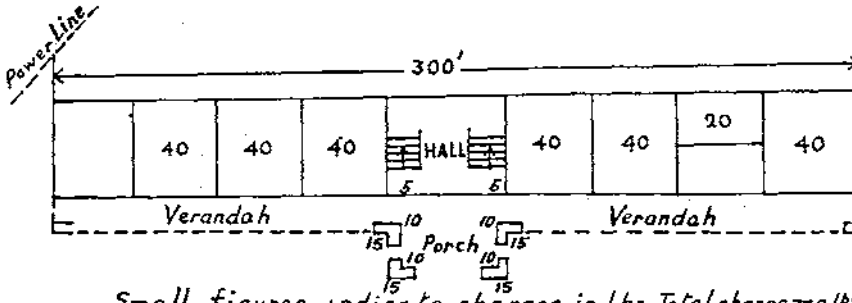
This bridge was over a 15-ft. clear span. There was no timber available, so it was constructed entirely of R.S.J's, which were salved out of the old civil court building. Three 12″ × 5″ girders carried the roadway, which consisted of 6″ × 3″ R.S.J's laid on the flat, the whole covered with 4″ of earth. In all 37 girders were used!

The country round Madhubani was considerably worse than nearer Darbhanga. The roads were mostly unmetalled and they ran along embankments designed to keep them clear of the annual monsoon floods. In many places these embankments had sunk and a great deal of earthwork is required before the next rains break. Many of the bridges had been destroyed. In one place, on the Benipatti road, a brick arch bridge had been completely carried away and a diversion was under construction. This was a "temporary" pile bridge, all labour and materials for which came from the surrounding villages. Thus the piles were branches from trees, as straight as they could be got. There was no pile-driver. The procedure was for several men to put their weight on a pile and so to sink it as far as possible in the mud: when it would stand by itself, they congratulated themselves and passed on to the next! This was a cheap and rapid method of construction! Roadbearers were made of branches like the piles and the roadway was a bamboo mat, formed by laying bamboos across the roadbearers and lashing them together with country rope. A few inches of earth on top served as a cushion and helped to distribute the load. It would have been interesting to see this bridge under test, but unfortunately it was not finished in time. The bridge builders at least had implicit confidence in their work! These two bridges formed an amusing contrast, which seemed to typify the difference between civil and military methods.

On February 8th we returned to Darbhanga and immediately set to work to prepare the hospital for demolition. As this was the biggest single job we undertook a sketch plan of the building is given. The hospital was built in 1925. The main block was 300 feet long and two stories high. In the centre was a large hall with a double staircase. To either side were four main rooms, each about 27 feet square. A verandah ran along the front of the building with a massive porch in the centre. The outside walls were two feet thick.

There were 17 charges. Seven concussion charges placed on the floor in the centre of each room and 10 cutting charges. The latter were placed in pairs on either side of the massive pillars carrying the porch and arranged one above the other to give a "scissors" effect. The larger charge in each case was placed on the outside of the pillar in order to minimize the chances of flying débris. All doors, windows, frames and fittings of every sort were first removed and stored

for future use. All openings were roughly blocked with bricks. No charge was placed in the end room because a power line passed close to the N.E. corner of the building. All charges were connected electrically and ready for firing at 11 a.m. on February 10th.



Small figures indicate charges in Lbs. Total charge 370 Lbs.

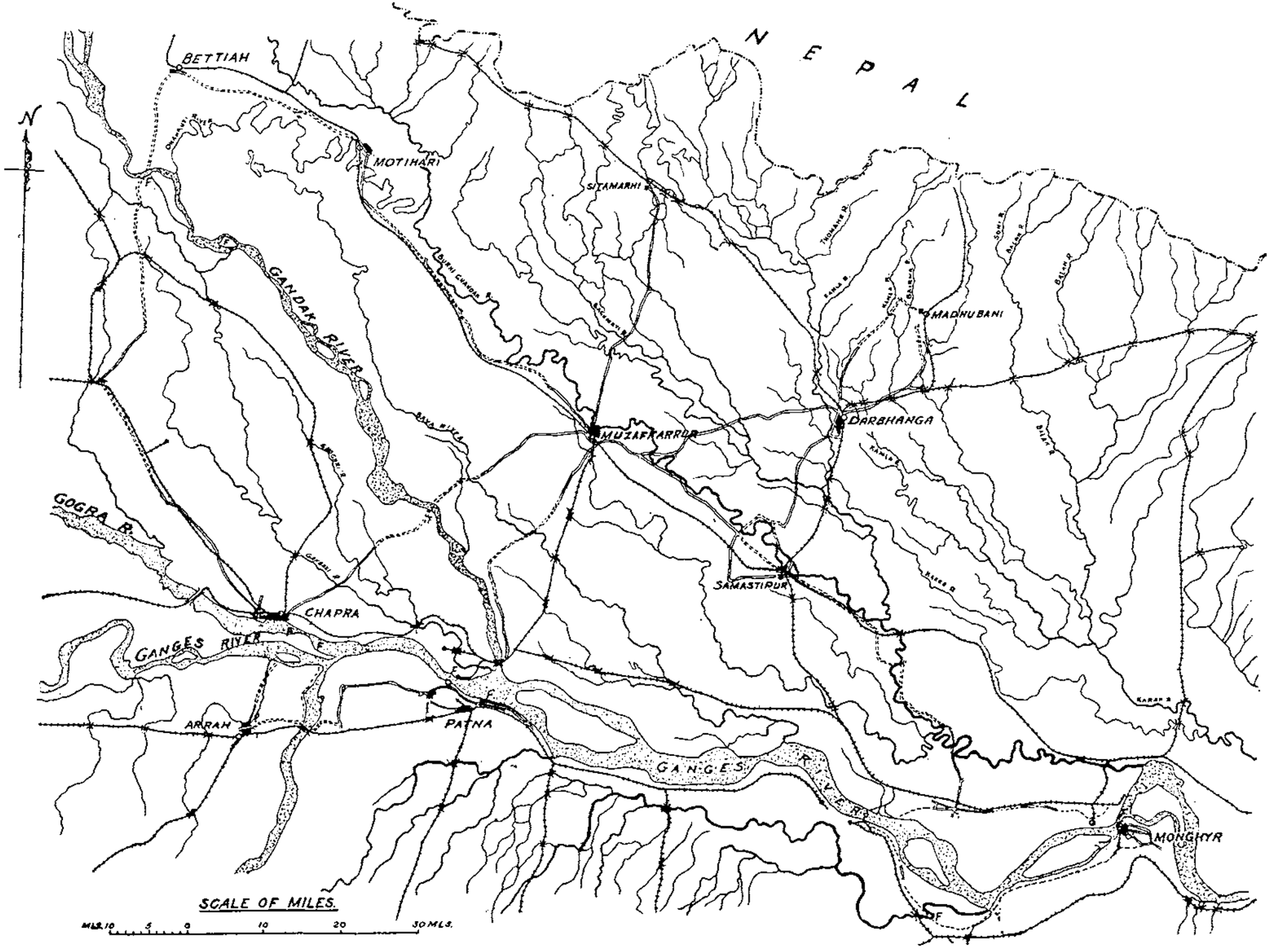
The explosion was an impressive sight. A wall of brown smoke shot out almost horizontally from the ground-floor rooms and then rose up and enveloped the whole building. We just had time to see the upper walls topple over before the smoke hid everything. The 370 lb. of guncotton went off with a muffled report, which sounded no louder than the 30-lb. charges we had been using regularly before. As the smoke cleared away we saw a long pile of bricks, with huge girders sticking out of it, and at the far end the north wall standing just as it was before. The rest of the building was completely demolished. It was very satisfactory. Not a brick had been thrown more than 20 yards away from the main pile. Everyone had been warned to have their windows open and the only outside damage was a few broken panes of glass in the other hospital buildings.

After this two smaller blocks were demolished in the same way, one by each sub-section. This completed our work in Darbhanga and the party left by bus next day for Muzaffarpur.

Meanwhile a second telegram had arrived in Roorkee calling for more Sappers. Accordingly the remainder of No. 2 Field Company had come down by train and the whole Company was now, on February 11th, scattered over Tirhut division. Two sections were salving bridges on the Muzaffarpur–Darbhanga road: one was building a bridge 30 miles from Motihari, while the fourth was still at work in Muzaffarpur. There remained Chupra and Sitamarhi. Next morning I took two sub-sections down by train to Chupra to see what we could do.

We stayed in Chupra four days. There still remained then some of the old Dutch planters' bungalows, built in the grand manner before the battle of Plassey. Most of these had been damaged and our only interesting task was to complete the demolition of one of them, a huge lofty building with wide verandahs and many tall pillars. The brickwork was so rotten that in places it could almost

EARTHQUAKE ZONE, BIHAR. JANUARY, 1934.



be pushed over: yet it gave us unexpected trouble. When we removed the door frames parts of the wall fell down and it was difficult to block up the openings. We placed three charges, each reduced to the absolute minimum, in three main rooms and fired electrically. Now there was a heavy roof and the side walls which carried it were fairly sound. The end walls on the other hand were rotten. When the charges were fired these end walls fell flat, but the side walls and roof remained. Cutting charges had then to be used. In all 157 lb. of guncotton were expended and it took three days to complete the job. If minimum charges are used then it is essential to block up all the openings in walls and roof. Otherwise the charge may be only partially successful and the demolition will then be very much harder to complete. This was the only case in five weeks where a concussion charge failed to do its job.

We returned to Muzaffarpur on February 17th to find the company in process of concentrating there. By now the situation was everywhere in hand. The main roads were all open again. The railway was through to Muzaffarpur and Pandol. All dangerous buildings had been demolished and householders themselves were employing local labour to pull down others. It only remained in due course to start re-building. There was nothing more for the Sappers to do and on February 20th we entrained for Roorkee.

Relief work usually seems to involve a series of disjointed tasks with no very connected programme. This was no exception. The immediate demolition of certain buildings was undoubtedly necessary and Sappers were just the people to do it. But the original section could have done all that was really necessary in ten days. When the whole Company was called for, some other work had to be found. There was an unlimited supply of material available in condemned buildings and, if some sort of bridging programme could have been produced, we might have done some really useful and valuable work. But no such programme was ever made. We left Muzaffarpur with the feeling that no one there could decide what to do next.

From the Sapper point of view this was good practice in the use and handling of explosives. The demolition of buildings is not of frequent occurrence in war. Explosives can seldom be spared. But everyone had a chance to see the effects of different kinds of charges —cutting and concussion—under various conditions. The conclusion we drew was that cutting charges for masonry are extravagant. They should be avoided when possible. Concussion charges are simple, economical, and most effective. The formula we used was the simplest possible:

$C = L + a$, where C = charge in lb.
L = length in feet of the longest wall.
a = a constant.

The constant "a" is put in simply as a precaution. A suggested value is :

For $L = 0 - 20'$, $a = 5$
$L = 20' - 30'$, $a = 10$.

The charge should be laid on the floor and not dug down in any way. Doors, windows or skylights must be blocked up. If there are several charges they should be fired simultaneously. This method is suitable for any ordinary building or frontier tower.

The cause of the earthquake has yet to be explained. The most ingenious suggestion I heard was that the Indian Peninsula is slowly moving northwards (about eight feet a year). The Himalayas in consequence are being squeezed up, and the earth's crust about the foothills is under immense pressure. Eventually it had burst at its weakest point—which in this case happened to be this portion of the Gangetic plain. This would explain the rumbling noise, the appearance of fissures and blowholes, and the eruption of sand and water from the depths of the earth. At least this explanation is as good as any other.

There are many stories about the earthquake. Perhaps two of them may be briefly mentioned here. The first concerns the Collector's wife at Muzaffarpur. She was in her bedroom when the shock began. Before she could get out the verandah roof crashed and blocked her exit to the garden : a moment later the dining-room and drawing-room, which formed the centre of the house, collapsed together : there remained only one other door to the room and that was jammed ! She finally escaped by climbing out over the ruins of the verandah roof. All this time the rumbling and shaking was going on, so that even outside it was difficult to keep one's feet. As she got on to the lawn a huge tree crashed and that portion of the garden which bordered on the river suddenly split off and subsided about six feet ! She turned and ran. But a long fissure appeared in the lawn directly in her path and a black mud came oozing out. This was the last straw and she had abandoned the attempt to escape, when the tremors ceased at last and she found herself, unhurt, amongst the wreckage of her home. Small wonder that the uneducated villagers and townspeople, after similar experiences, remained incapable of action for many days.

The other story concerns a fat village clerk. He was lying down in his house. When the shock began he lost no time in running out into the fields. There he stood watching the village being shaken to bits. Suddenly to his consternation the ground opened and he found himself engulfed in a deep crevasse. There was no time even to call for help as the earth closed overhead. He thought he was buried alive. After a few seconds the earth opened again and the clerk was borne to the surface on a surge of muddy water—alarmed but unhurt ! Indeed a providential escape. I cannot vouch for the truth of the second story !

A "MIX-IN-PLACE" ROAD.

By MAJOR F. E. ORANGE-BROMEHEAD, O.B.E., R.E.

THE possibilities and limitations of "mix-in-place" roads were dealt with in an article communicated by the R.E. Board in the March, 1934, number of *The R.E. Journal*. The following is a description of the construction by this method of a short stretch of road on Salisbury Plain. The natural soil was used as aggregate and "Terolas" emulsion as the binder. The work was undertaken as an experiment on behalf of the R.E. Board in co-operation with Messrs. Colas Products Ltd., of which firm, Brigadier-General E. G. Wace, who contributed an article on the subject in December, 1932, is a director. Messrs. Colas Products Ltd. provided expert supervision and advice in the present case.

SITE.

The site decided upon was the approach to a bridge over the River Avon known as Crossing "C." This was selected as (*a*) it was likely to carry a fair amount of traffic, and (*b*) the laboratory report on the soil was less unfavourable than that on other sites which were considered.

SOIL.

The topsoil consists of a loamy earth containing a considerable quantity of clay and about 25% of flints. It has a thickness of about 2′ 6″ and the subsoil is mainly chalk. The report of Messrs. Colas Products Ltd. on the soil was to the effect that, strictly speaking, it was not suitable for "Terolas" treatment but that, provided great care was taken with drainage, and the work was carried out under favourable weather conditions, there was a fair chance of success. The laboratory report on the soil is appended.

FORMATION.

The length of the road is approximately 400 yards across an open field. It is designed to be 20′ wide between ditches with the central 15′ treated and leaving 2′ 6″ of natural earth berms on either side. The formation was made by means of a Garret Road Grader which was towed by a medium Artillery Dragon. Ditches from 18″ to 2′ deep were cut by the grader which spread the soil between them to

form the roadway. After forming the road to shape, the top 3″ of soil was removed by the grader from each half-width of the road in turn and the sub-grade was thoroughly consolidated with a 10-ton roller. About 70 yards at the eastern end of the consolidated sub-grade under some trees was given a priming coat of " Colas " at the rate of 3 square yards to the gallon, with the object of providing an extra seal against the penetration of water from below. The value of this minor experiment, which was based on laboratory results, was, however, destroyed by the subsequent operations in which the film of bitumen on the base was completely broken up. After consolidation, and priming of the base, the topsoil was replaced and graded ready for treatment.

" MIX-IN-PLACE " PROCESS.

The " mix-in-place " process was carried out in two days, half the width of the road being treated on each occasion. The south half of the road was treated first on April 17th. The graded surface was prepared to receive the dressing by harrowing with a disc harrow. This broke up the aggregate satisfactorily except at the eastern end, where the soil was rather damp and heavy and the result not quite so good. " Terolas " was sprayed on the road surface by a pressure tank-lorry in four stages. The tank travelled at 1 mile per hour, spraying dilute " Terolas " at the rate of 1 gallon to the square yard. In the first application, the " Terolas " was diluted with an equal quantity of water, but in the second, third and fourth applications, the mixture was two parts of " Terolas " to one of water.

After each application of " Terolas," the road was harrowed twice with the disc harrow for mixing. Each spraying and harrowing made the road softer and muddier and some difficulty was experienced during the fourth spraying, owing to the skidding of the wheels of the tank-lorry which caused deep ruts. An attempt to correct these and other irregularities by taking the grader over the road proved a complete failure. The grader had no spreading effect, and the earth merely banked up in a soggy mass in front of the blade even when this was set at an acute angle. There was no mixing or rolling action and, if anything, the surface was made worse than before. The disc harrow was, therefore, reverted to once more. The roadway was, however, so soft and wet that the discs cut below the top 3″ and into the sub-grade, bringing up untreated earth. The condition of the road did not look promising. It was obvious that, for mixing earth of this clayey nature, the grader was useless and the disc harrow was by no means satisfactory. It did not seem possible to improve matters while the surface was so wet, so work was stopped for the day. Heavy rain fell during the night and no further work was possible until April 20th. On this date, after two fine days with

sun and wind, the shape of the southern half of the road, which was partially dried out, was much improved by harrowing with an ordinary tooth harrow borrowed from a farmer. This also broke up the lumps of mud and accelerated drying.

On April 20th, the treatment of the northern half of the road was also undertaken. The process was similar to that used on the southern half, four applications of " Terolas " being made, using the same dilution ratios as before. The mixing process on this half of the road was, however, carried out with an ordinary tooth harrow. It was weighted with some pieces of old rail to give extra " bite " and was found to break up and turn over the earth fairly efficiently. The earth remained in small nodules coated with " Terolas " and was not churned into mud as had happened when the disc harrow was used. The mixture was certainly less intimate than on the south half of the road, but the tooth harrow did not, at any time, cut into the sub-grade below the top 3" of earth being treated. The wheels of the pressure tank during its first passage left hard-bottomed ruts which would not absorb the " Terolas " and upon which the tooth harrow had no appreciable effect. To try to correct these without cutting into the soft part of the road, the disc harrow was used with flat rings fitted over the inner discs. The result, however, was negligible. At the second, third and fourth applications, in order to prevent damage to the road by skidding of the wheels of the spray lorry, the dragon was attached to it to tow it whenever there were signs of skidding. When work was ceased for the day, the north half of the road was of fair shape and the emulsion appeared reasonably well distributed.

Consolidation

Rain again fell on the 21st April, but by 23rd both sides of the road for the greater part of its length had dried out sufficiently to be rolled with a light roller. The centre of the road was first harrowed with the tooth harrow to improve the joint between the two halves and the shape of the surface. A 2-ton petrol roller, working from the edges, brought the road into approximately the correct shape and left it fairly smooth. There were, however, parts of the road which were still too soft for any rolling. There was further rain on April 24th which delayed drying, but by April 30th the road had dried off sufficiently to be consolidated with an 8-ton roller. This brought the road to a good shape. The treated earth was hardening but was still in a plastic condition. One spot, shaded by trees, still remained soft and the roller could not deal with it.

By May 3rd a car could be driven over the road without leaving appreciable ruts. On May 7th the condition of the road was tested by sending unladen three ton lorries over it. They proved too heavy,

and it was necessary to re-roll the road to take out the ruts. The surface was then left for the drying and hardening process to continue and no traffic was allowed over it. The precise time taken for drying cannot be stated as the Divisional Engineers left for bridging camp and nothing more was done until their return.

SURFACE DRESSING.

On June 20th the road was finally completed by giving it a surface dressing. It appeared hard and fairly smooth throughout. There was no doubt about its being waterproof, for the washing and scrubbing given to the surface to prepare it for dressing had no effect upon it whatever.

The surface dressing consisted of two coats of "Colas" sprayed on at the rate of 4 square yards to the gallon; the first coat being blinded by $\frac{3}{4}$" chippings, spread at the rate of 80 square yards to the ton, and the second at 120 square yards to the ton. Each coat of chippings was rolled with a 10-ton roller. A "broom-drag" was used to give even spreading of the chippings. When rolling, a slight spring could be seen in the road surface under the wheels of the roller, but no permanent mark was left by the edges of the wheels. The appearance of the road on completion was indistinguishable from that of an ordinary metalled road.

SUBSIDIARY EXPERIMENT.

As a subsidiary experiment, a stretch of 70 yards of natural earth roadway between the end of the "mix-in-place" road and the bridge was graded, consolidated and given a double surface dressing of "Colas" and chippings in exactly the same manner as the remainder. Traffic using the "mix-in-place" road must also pass over this stretch. A good comparison can, therefore, be obtained between the effectiveness of this thin surface carpet and the "mix-in-place" process.

RESULTS.

At the time of writing, the road has been in use for four months. It carried a fair amount of traffic during the summer which seems to have had little effect on it. The portion which was merely surface dressed also appears quite sound. Up to date, traffic has only used the road in comparatively dry weather and it has not been subjected to any prolonged spell of wet. However, provided the side drains are kept clear, so that water does not attack the base from underneath, there seems to be no reason why the road should not be capable of standing up to traffic under adverse conditions.

A "MIX-IN-PLACE" ROAD.

No. 1.—Graded roadway before treatment

No. 2.—Disc-Harrow preparing surface for treatment.

A 'Mix - in - place' road 1 & 2

No. 3.—View of pressure tank lorry spraying "Terolas."

No. 4.—Second view of pressure tank lorry.

No. 5.—Mixing with disc-harrow after first application of "Terolas."

A 'Mix - in - place' road 3, 4 & 5

No. 6.—Appearance of road before and after surface dressing.

No. 7.—Use of broom-drag.

A 'Mix - in - place' road 6 & 7

Preliminary Conclusions.

1. Even quite unpromising types of soil can be treated successfully by such a " mix-in-place " process as outlined above.
2. Fine weather is essential for good progress. The heavy rain experienced delayed progress considerably. No data can be evolved from this experiment as to the time such a road would require to dry out sufficiently to carry heavy traffic if the whole operation had been completed in dry weather. It seems probable, however, that a clayey soil of the type treated here would be somewhat slow in hardening up. Light pneumatic tyred traffic is said to assist drying.
3. For continuous rapid work, a large number of pressure tanks would be required; the actual number depending on the distance to the railway tank wagons. Much time was wasted in journeys to and fro for replenishing.
4. A spring-tooth harrow might prove the best solution for mixing heavy soil. Neither the disc nor tooth harrow was entirely satisfactory.
5. Much time and labour in gritting a road could be saved by using a tipping lorry in conjunction with a broom-drag. This process is much used in America.
6. The stores required for 100 yards of " mix-in-place " road, 15′ wide, are :—

" Terolas "	.. ..	1,250 gallons.
Water	.. ..	1,000 gallons. (Including watering before surface dressing.)
" Colas "	.. ..	250 gallons.
Chippings	.. ..	10½ tons.

Say about 22 tons in all.

APPENDIX.

Report on Laboratory Examination of Soil from " C " Crossing.

Amesbury–Netheravon Road.

Analysis.

This soil was graded as received, treating the lumps of caked soil as aggregate; the amounts of these lumps and the stones are shown in the

gradings. An analysis by the standard soil method (wet grading) was also made :—

		AS RECEIVED.			
		Stones.		*Soil.*	*Standard Method.*
Passing	200	–		–	54·0
,,	100	–		–	5·4
,,	80	–		–	2·7
,,	70	–		–	2·4
,,	50	–		–	3·3
,,	30	–		–	3·8
,,	20	–		–	1·5
,,	10	–		–	2·1
,,	1/8		46·8		2·1
,,	1/4	1·5		9·7	1·5
,,	3/8	2·0		4·2	2·0
,,	1/2	2·5		2·8	2·5
,,	5/8	2·3		2·3	2·3
,,	3·4	1·5		1·8	1·5
,,	1"	3·0		2·2	3·0
Retained	1"	9·9		7·5	9·9

The following mixes were made with the soil as received :—

(1) 100 parts soil.
8 parts " Terolas " diluted with
8 parts water.
Emulsion very badly distributed and coagulated.

(2) 100 parts soil.
16 parts water followed by
8 parts " Terolas."
Mix very heavy and " soggy." Coagulation and poor distribution.

(3) 100 parts soil.
8 parts water followed by
8 parts " Terolas " diluted with
4 parts water.
Mix better than Nos. (1) and (2), still rather soggy and bitumen coagulated.

It was judged that it would be impossible to handle this soil by the normal methods of mixing. An experiment was made, spraying the soil with 8% of " Terolas " diluted in the ratio of 2 to 1 with water, and turning the soil over by raking to expose fresh surfaces for spraying. This resulted in the aggregates of soil particles becoming coated with a film of emulsion which rapidly broke down to bitumen.

This last method would appear to be the only practical means of dealing with this particular soil.

The dilution ratio referred to above consisted of 2 parts of " Terolas " to 1 part of water.

SOME IMPRESSIONS OF THE U.S.A.

By CAPTAIN N. BODDINGTON, R.E.

MY impressions of the U.S.A. were certainly many and varied during a four months' E. and M. Course trip; one of the most interesting facts is the similarity between India and the States in that both countries have engineering works on a vast scale—the size of the Punjab Irrigation works impressed American engineers unfamiliar with those works—distances are immense and extremes of temperature, high in India and low in America (30–40 below zero being common), in both cases causing a long range, have to be contended with.

After the necessary formalities had been complied with, a start was made from London on August 3rd in a Morris Oxford 1933 Saloon, and Southampton reached in time to enable arrangements to be made for the car to be shipped the following morning; by mid-day this had been effected and S.S. *Alaunia* sailed an hour later.

Until we reached Havre, where a short call was made, the sea was calm and the sun shone; once past the Fastnet, however, conditions deteriorated rapidly and from then until approaching Newfoundland, where fog was encountered and it became necessary to heave to before entering Belle Isle Strait, rough seas were encountered. Having proceeded cautiously through the Strait, the fog suddenly lifted disclosing an iceberg some 400 yards distant, a grand spectacle.

The journey up the St. Lawrence to Quebec and Montreal proved a delightful contrast to the transatlantic crossing—bright sun, smooth water and well-timbered banks, sometimes three and at others thirty miles or more distant.

After leaving Quebec and passing the heights of Abraham the ship steamed under the Quebec bridge, a structure similar to that of the Forth, the approach to which created the illusion that there was insufficient clearance for the ships' masts.

At Montreal a member of the local Headquarters Staff met the ship and took over arrangements for unshipping, servicing and licensing the car, and clearing it and my baggage through the customs; that this was all accomplished in less than an hour is a striking instance of North American hustle and Canadian efficiency.

Having got into touch with the Embassy at Washington, the general itinerary, which underwent only slight subsequent alterations,

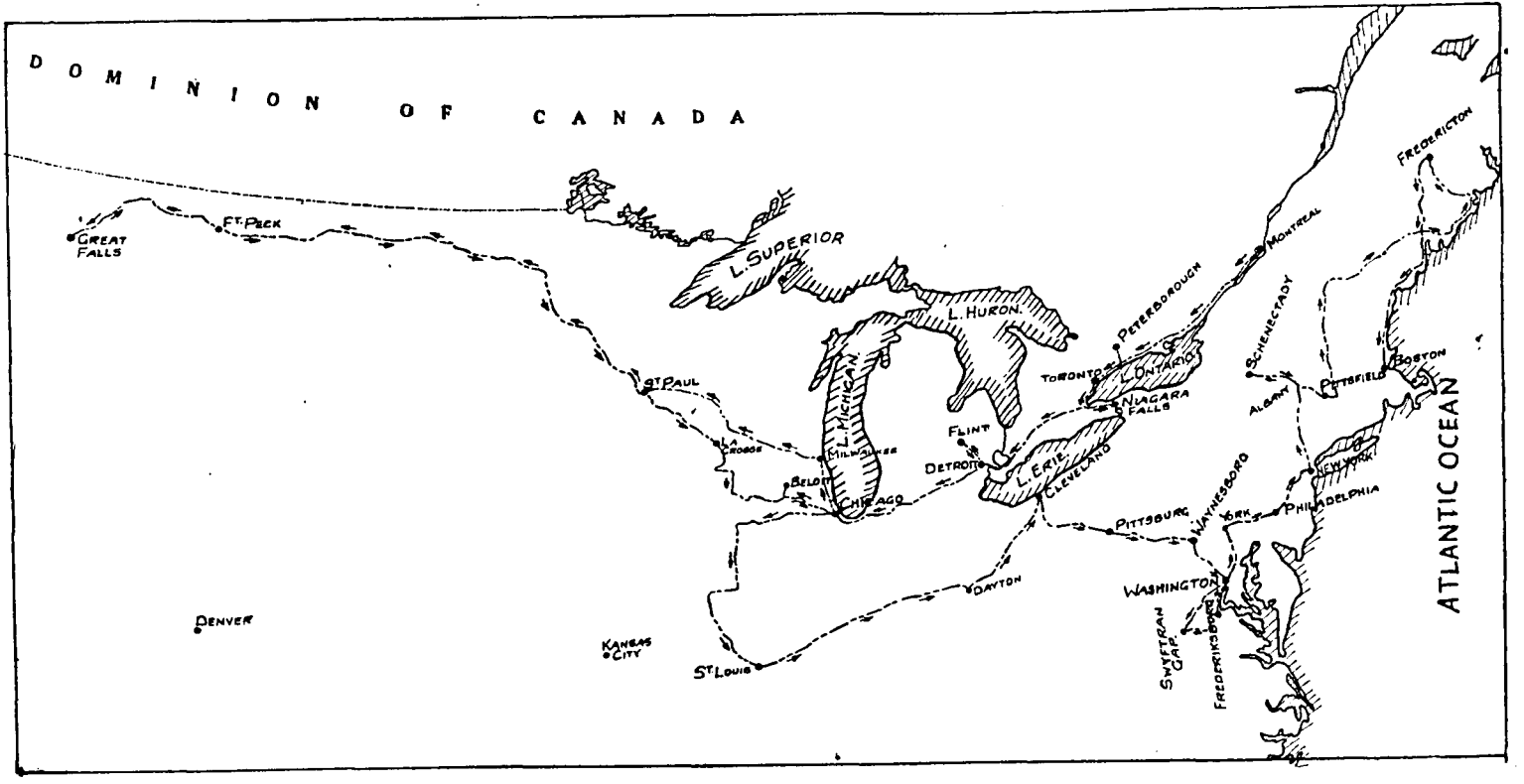
was settled and the final route is indicated on the attached map. In all, nearly 10,000 miles were covered by car, so a word as regards roads may not be out of place. In Quebec the main roads were nearly always winding and, except over short stretches, not very good; fortunately no secondary roads were encountered. In Ontario the main roads were good, usually of concrete, 18 to 20 ft. wide and straight; the secondary not so straight, but the curves were reasonable, the surface being gravel, often full of pot-holes and probably not very good in wet weather. As the country became more thickly populated towards south-west Ontario the good roads became wider and more numerous.

In the eastern part of the States there was considerable evidence of improvement being effected; the main roads were excellent—often six lanes broad with concrete surfaces and easy bends—nearly all the large towns have by-passes through the outskirts. The secondary were good, though not numerous when compared to England, but they are not infrequently oil-surfaced (taroil) and quite reasonably straight. Progressing westward the roads became straighter, less wide and less frequent, and where secondary roads were met they showed no evidence of being oiled. When passing through the cattle states of the Dakotas and Montana, even the main roads are often neither concrete nor oiled, but waterbound gravel with little or no foundation. These roads prove satisfactory when dry, but in the event of rain or soft snow they become definitely bad. To quote an instance in travelling under both conditions, the journey from Detroit Lakes in Minnesota to Williston in North Dakota, a distance of some 496 miles, took, on a fine day, 11½ hours as compared with 18½ hours for the return journey, some ten days later, when 1 to 2 ft. of snow had fallen and was melting, causing the gravel to sink through the black cotton soil and the roads to become rut tracks through miles of mud. It was interesting to observe, however, that the oil-bound roads did not suffer and that on these the snow melted very much sooner, though in the morning frost they proved slippery.

The normal cruising speed for cars in good weather on gravel, oiled or concrete surfaces appeared to be between 60 to 70 m.p.h. The Morris, though averaging 40 miles an hour over a day's run, including stops for lunch, petrol, etc., was invariably left standing. Actually most states had a maximum speed limit of 45 m.p.h. with 25 through villages, but little heed appeared to be taken of the former unless one of the police patrols was spotted following.

All roads were numbered, some—the main highways—with Federal or National numbers, the remainder with state or province numbers. These numbers were enclosed in a shield, in all about 18 in. square with 10-in. numerals, so there was no difficulty in following a route, especially as the signs were well sited and only 3 to 4 ft. from the ground. In addition to the signs at the main

ROUTE OF TRIP THROUGH U.S.A.



cross-roads, the route number was indicated frequently along the road, either on the telegraph poles or on special posts, in both cases at convenient heights; these latter were also always sited at a short distance, about 100 yards, on either side of every turning, so that if a wrong turn should be taken it would be quickly noticed. This system undoubtedly tends to reduce to a minimum that indecision, so noticeable on the part of motorists, at corners, which is frequently the cause of accidents.

With the exception of the older cities of Quebec, Boston, etc., the general layout of the towns proved very simple. The principle is rectangular, the avenues running one way and streets the other, a block, in Philadelphia called a square, being 600 to 1,000 feet each way. Running a hundred numbers to the block, not necessarily a hundred houses—odd numbers one side, even the other—and the hundreds in the house number indicated the street number; thus 1608, Pine Avenue, would be situated on Pine Avenue between 16 and 17 streets, or 1308, East 32nd Street, would be on the 32nd street east of the centre line of the town, usually designated Main or Market, and between 13 and 14 blocks east of that centre line. It is remarkable with what ease a stranger can find his way about, and in addition this regularity gives an accurate measure of the distance between points.

That there are very large numbers of unemployed is very noticeable by the street corner loafers, and even more by the number of hitch-hikers outside every town of any size; in some, as at Portland, for instance, about a hundred were passed in less than a mile all hoping for a lift north.

A considerable amount of relief is carried out by charitable organizations and, in Canada, by town relief works, but the lack of a system of unemployment insurance is acutely felt. Wisconsin State has recently started a system of a local character; it is remarkable, however, that less than one in ten employers of labour and certainly less than one in a hundred employees realize that the British system is insurance and not a form of charity. Admittedly few of them have thought about it at all, but those that have thought that our very inappropriately-named dole was the answer to a loafer's dream, something for nothing.

To combat this unemployment there is the C.C.C. (Civil Conservation Corps), which is composed of young men about 18 to 22 years old, few of whom have ever been in work and probably have little liking for it, organized on a military basis and administered very largely by army reserve officers (of whom there is an establishment of 80,000) and particularly engineers, also out of work. The great difference between the men and the officers is that the latter know work and most of them have been brought up in the hard school of engineering in the States. Being a civilian corps, although

khaki-clad, discipline is necessarily a little difficult to maintain, but the result has certainly been to improve physique and eradicate some of the dislike of work. The men get some 4s. a day and all found. They are scattered all over the country in small units about 100 strong; often a number of units are located close to one another on different stretches of one work. Work comprises road diversions and improvements, forest conservation and river and drainage works. Since most of these works are situated in the country, units have their own transport, usually Chevrolet trucks and trailers. Apart from their lack of training in arms, they appear to be a very excellent army reserve, for in the event of the proclamation of martial law they could become readily disciplined.

Two other forms of work provision are in force in order to assist in the alleviation of unemployment, in both of which the Federal Government provides the funds. In the first, the money is handed over to the States themselves to finance approved works under the States P.W.A. (Public Works Administration), and in this case the works are usually of a local character and are carried out in the larger towns, thereby reducing urban unemployment.

The second type are works carried out directly under the supervision of the Federal Government through the U.S. Corps of Engineers; these are very large works, such as the Fort Peck and Grand Coulee dams of the north-west and the Mississippi dams in the upper river before it joins the Missouri and the flood control works in the lower river.

The conditions governing the issue of capital to the works are that local labour must be employed, except for certain skilled jobs, and that the pay is at the rates laid down by the Federal Government. These rates vary with the locality, but 60 to 65 cents an hour for labourers and 90 cents an hour for skilled labour were the minimum rates in the north-west. Strict surveillance ensures that the contractors not only pay the labour at the correct rates and only for the maximum number of hours, but also that only labour from local districts is employed or, if that is exhausted, from other districts in the same state. This system caters for rural unemployment and prevents movement of the labour population.

The organization of the U.S. Corps of Engineers is very interesting, as, although they are not responsible for barracks, etc., this being the job of the Quartermasters, they obtain a vast amount of civil engineering practice from their responsibility for all river and harbour works; this, including as it does all works in connection with every navigable stream or waterway, opens up a vast field for experience.

The country is divided up into areas, each of which is dominated by the waterway it comprises, and this again is sub-divided into three or four divisions. The Upper Mississippi, for instance, from

the junction with the Missouri north, is a district run by a Colonel with a small headquarters at St. Louis and with Divisions of three or more Army Engineer officers at St. Louis, Rock Island and St. Paul, with a small extra office at Chicago.

The staff apart from these officers is entirely civilian and seems to be so organized that, in war, all except the chief military post can be filled by existing peace-time civilian employees; thus on mobilization, by the replacement of the senior officer by one from the retired list, the whole military staff could be released for training reinforcements recruited locally or for gaps caused by casualties, without disturbing the existing routine. One great advantage is that the officers being familiar with the district, particularly with the engineering element, are invaluable for picking and leaving the right men and also, being a family, are able to work together smoothly from the word go.

In order to give some idea of the scope of the river work carried out, it may be mentioned that it is a moot point as to whether the navy have more craft on the sea than the Engineers have in the rivers and harbours. It may easily be seen that since the Engineers have to vet all projects for navigable waterways, and as these include not only such big dams as have already been mentioned, but also bridges such as the San Francisco–Golden Gate and the New York–George Washington, they must not only start with a first-class theoretical training, but must keep it up, and they have every reason to be proud of being known by their works. That the Corps has retained these works is also partly due to the fact that in the States it is considered unethical to endeavour to deprive other engineers of their posts, and this argument has very justly countered every attempt on the part of civilian engineers to deprive the army engineers of these activities.

Wages have been referred to as from 3s. to 5s. an hour, but under the various codes in force the maximum number of hours is usually only 30 a week, so there is ample leisure in which to spend the family earnings. Since usually only one member of a family is employed, the money has to go farther, but the desire for the car and all other amusements remains the same or is, in fact, intensified by the increased leisure. As regards cars, every family has one; garages are not necessary, as the cars may be parked outside the house at night except in certain of the larger cities; taxes are light and insurance is not compulsory. In point of fact, all large factories have to keep a very large open car park for their employees, as otherwise they would find great difficulty in obtaining labour. On an average some 20% of the employees bring their own cars, but they also bring their friends, say another 40–50%.

As regards amusements, the cinema holds first place, then baseball and football. Gardening, since vegetables are cheap and it entails

work, is taboo. Clothes and foodstuffs are cheap, much the same as in this country, and yet wages remain high; rents certainly are high, often double to four times those in England, but the general expenses of a stable family do not appear of necessity to be higher than those obtaining in this country. Despite high wages, however, the population seems less contented than that of the industrial areas of England, which possibly may be accounted for by the fact that, in this country, the lower wages give opportunity for more employment and in consequence greater happiness.

A very pleasant Sunday was spent in Stonewall's country. Leaving Washington on Saturday afternoon and going west about 50 miles to Warrenton, which is just south of the Mason–Dixon Line, it was noticeable that at the local cinema the negroes had to pay their cash at a separate office and sat segregated, a very different attitude to that assumed in Detroit, Chicago and the northern states, where the jostling of the negro population has to be seen to be believed.

Despite this the negro population in the south appeared much happier and certainly more cared for than in the north, where a trip with a police cruiser car, complete with two sub-machine-guns, from midnight to 4 a.m., at Detroit, had disclosed conditions as bad or worse than the slums of this country. It also revealed the criminal propensities of the negroes to the extent of a stabbing murder, an assault with a brick, probably murder by morning, and other minor crimes, all of which were apparently to be expected nightly.

Leaving Warrenton at 7 a.m. the road to the Blue Mountain was taken, and along the top of this watershed ran a magnificent road recently completed by the C.C.C. This is known as Skyline Drive and it certainly runs along the ridge for the major part of its 40 miles length; from many points along it, both the Shenandoah Valley and the East Virginia Plain towards Fredericksburg can be seen. We left the ridge at Swiftrun Gap and returned through Culpeper, after lunch at Fredericksburg. The 52-mile run on a four-lane concrete road along the coast formed a pleasant change.

The whole area of the Civil War, and in many cases the sites of the Rebellion and Indian wars, are marked with cast-iron notices giving details of the actions fought at particular points, the forces engaged, the generals and actual dispositions, with movements before and after, in some places with diagrams; this enables the motorist to follow a particular campaign without the assistance of a textbook.

A point that is noticed particularly was that, although the eastern part of the States is well wooded, all the timber is immature and there are no large trees; all are stated to have been cut down or burnt. There are, however, some very fine old and large trees in the towns; this, however, only accentuates the scrub jungles.

Leaving Washington and on to Philadelphia, where the low head

hydro-electric stations of Coniwingo and Safe Harbour on the Delaware River provide power for both Baltimore and Philadelphia, it was noticed that an excellent combination of steam and hydro was employed as follows. When the river was full, the hydro plants took the base load to their maximum capacity and the steam station the peaks; at low river, however, the steam station carried a constant base load to its maximum and therefore at its most economical load, allowing the hydro to carry the peaks and at other times to store water in the fore-bay for use during peak periods.

An example of the speed at which hydro machines can be put on the line was demonstrated; one of 7,000 kva. was started up from standstill and put on three-quarter load in under a minute, and after running a while was shut down and brought to rest, all in under five minutes—a very different story to that of a steam turbine.

After Philadelphia, New York, the road into which, through, or rather over, New Jersey is remarkable in that speeds of over or under 45 m.p.h. are unpopular, all traffic moving at this one pace. Lorries are banned on that part of the last few miles, known as the Skyway, which is in fact an elevated highway. This leads to the Holland Tunnel—speed in which is 40 m.p.h.—and comes out into New York at 23rd and Ninth Avenue, corresponding to, say, Marble Arch for convenience to the rest of the city. This is far the speediest entry to the city, all others being congested similarly to those in London.

The Holland Tunnel, as regards design, is only second to that recently opened under the Mersey, though neither as yet seem to be anything like loaded to their proper capacity.

After a week-end in New York the journey was continued up the Hudson to Albany, Schenectady and Pittsfield, the home of the American G.E.Co., and then on through to Boston and home by the *Laconia*, which was unfortunately caught by the mid-Atlantic gales of December, necessitating heaving to for 24 hours and in direct consequence of which the ship was two days late.

The Morris went fairly well, but the springs were not nearly strong enough for the weight of the car, driver and about 350 lb. of luggage and spares. In addition to broken and fatigued springs an axle broke in Montana, but was replaced with the spare carried; a rear hub ball-race got chewed up and was with difficulty, and a midnight chase over St. Louis (some auto shops never shut), replaced by a single-eight ball-race instead of the original double-fourteen ball-races; in fact, the only similarity was the inside and outside diameters, the difference in thickness being made up with a washer. Cold weather caused two valves to stick up, necessitating decarbonizing and replacing and grinding valves. The distributor cracked and shorting was overcome by drilling large holes across the cracks. Lastly, a big-end went and the piston had to be taken out at the roadside, crankshaft oil holes bound up, sump replaced

without spilling oil, and the 45 miles in, completed at 25 m.p.h. Actually the job only took some 1½ hours and, as a micrometer was carried, the shaft was at the same time measured for re-metalling. The re-metalled bearing was later put back in two hours and has since done some 3,000–4,000 miles, while the patched-up hub has done some 6,000.

Oil consumption ran up to 500 miles to the gallon, probably owing to the rings getting stuck up due to a gummy deposit in the slots; this seems to have been caused by the American oil, as the oil consumption has gone down now that British oil is being used. In any case, as the car has done some 40,000 miles, it was not bad and the petrol consumption of over 21 miles per imperial gallon was good for a 16-h.p. car. Petrol cost anything from 5½d. to 1s. 4d. an imperial gallon, depending on the distance from the fields and whether there was a gas war on or no. No American cars seem to have sunshine roofs and this caused a lot of favourable comment, while right-hand drive, louvres and trafficators also caused comment; speed and first cost were not received favourably, but the finish and upholstery were both considered to be markedly ahead of similar American models.

As regards the financial side of the trip, the passage third class cost £30 return and was quite comfortable; the freight on the car cost a like amount. Expenses of the car for the 10,000 miles amounted to some £65, to include petrol, oil, garage and repairs, etc., but not including depreciation and insurance. Hotels are expensive and averaged about three dollars a night, exclusive of food for which another two dollars a day must be added. To this again there is the expenditure incurred by smokes, drinks and suchlike hospitality, laundry and the other thousand and one necessities of life; and, in spite of rigid economy, only three dollars were left out of £320; these three dollars are, however, coupled with a very interesting experience, the acquisition of considerable engineering knowledge and the memory of a host of very delightful personalities, amongst whom the U.S. Corps of Engineers, members of the U.S. Department of Commerce and Industries and British Consular Service with whom contact was made, will always be particularly remembered for their kindness and assistance.

THE OVERLAND TRIP FROM INDIA.

By LIEUTENANT W. F. ANDERSON, R.E.

INTRODUCTION.

MOST people serving in the north-west corner of India have probably at some time toyed with the idea of varying the usual, all-too-well-known route home by sea, and cutting across the fascinating part of the world between India and the Mediterranean.

Actually, however, several factors contribute to make this route little used: weeks, often precious, must be taken out of a home leave; there is anxiety as to the cost; there is a general lack of information about travelling conditions in Persia; and a certain amount of forethought is needed to arrange suitable travelling companions and to obtain permission to do the trip.

It is hoped that these notes from a diary of an overland trip recently completed may give an impression of two of the most enjoyable months two Sapper subalterns ever spent, and that the notes on ways and means at the end may be of use to anyone who may be sufficiently enthused to do the journey for himself.

The accompanying sketch map shows the route followed.

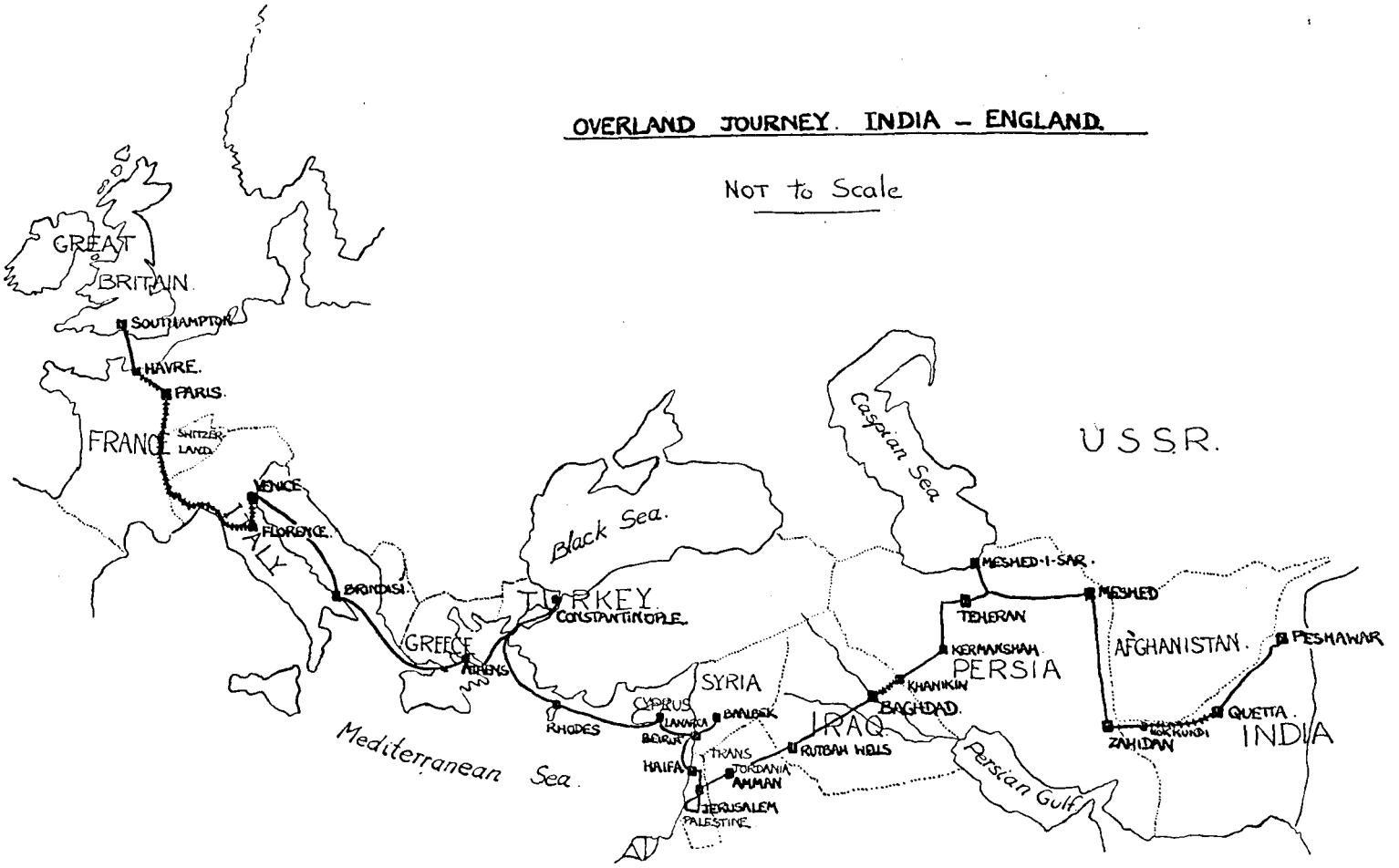
PESHAWAR TO QUETTA, 725 MILES.

We originally intended to start by going through Kabul and Herat and so direct to Meshed; permission to do this, however, was refused. We rather feared that it would be so.

Failing this, leave was applied for to go by the route Kabul–Kandahar–Quetta. Sanction for this was obtained, but too late to be of use: at least a ten days' wait would have been required for Afghan visas.

We were therefore forced to go by the more usual route Parachinar–Razmak–Wana–Fort Sandeman–Loralai–Quetta. This section is too well known to be worth describing, though, of course, intensely interesting to us, seeing most of it for the first time.

We started off from Peshawar on April 7th, in a rather disreputable-looking Ford car, with five years' frontier service to its credit. This car had already been sold to a very accommodating brother officer in Peshawar, so a Pathan driver was taken along with us to drive it


OVERLAND JOURNEY. INDIA – ENGLAND.
NOT to Scale
GREAT BRITAIN
SOUTHAMPTON
HAVRE.
PARIS.
FRANCE
SWITZERLAND
VENICE
FLORENCE.
ITALY
BRINDISI.
GREECE
ATHENS
TURKEY
CONSTANTINOPLE.
Black Sea.
Mediterranean Sea.
RHODES
CYPRUS
LARNACA
BEIRUT
HAIFA
SYRIA
BAALBEK
TRANS JORDANIA
AMMAN
JERUSALEM
PALESTINE
IRAQ
RUTBAH WELLS
BAGHDAD.
KHANIKIN
PERSIA
KERMANSHAH.
TEHERAN
Caspian Sea
USSR.
MESHED-I-SAR.
MESHED
AFGHANISTAN.
PESHAWAR
QUETTA.
INDIA
ZAHIDAN
Persian Gulf

back from Quetta. He parted from us on Quetta railway station with a seraphic smile on his face; no one will ever know just what load of sweating Indian humanity he picked up as fares on the way back, but at any rate he returned the car without serious damage, as the new owner paid for it. Frontier hospitality is unique and the cost of this section of the journey was practically the cost of our petrol and oil.

QUETTA–ZAHIDAN (DUSDAP), 460 MILES.

The North-Western Railway now only plies as far as Nok Kundi, a place about 150 miles short of Zahidan.

The railway that was laid in 1918 still exists as far as Zahidan and was in operation until 1932. As the railway was only being run for the benefit of Persian trade, the North-Western Railway rightly threatened to close down unless certain duties were removed; this threat, much to Persian surprise and annoyance, they subsequently carried out.

The rail journey, even in the beginning of April, was moderately warm, and the scenery, except at dawn, when the hills of the Afghan frontier showed up to the north, consisted of an expanse of glary desert, now and then relieved by tufts of scrub.

One feature of interest was the moving sandhills, blown from south to north by the wind, and sometimes fifty feet high and a couple of hundred yards long.

The plan adopted when one of these sandhills reaches the railway is to build a loop line to a flank, so spaced that the sandhill will be clear of the old line by the time it reaches the loop.

Nok Kundi is an extraordinary place: a township of some 500 souls in the middle of a howling wilderness, entirely provisioned from Quetta, and kept in drink by a water train that comes out from Quetta once a fortnight.

The arrival of this, and the weekly passenger train, are the chief events in Nok Kundi.

After a four hours' wait here, we got comfortable enough seats in the mail lorry on to Zahidan. This was easily the worst section of the road, consisting of alternate sections of bumpy, hard-baked mud, and soft yielding sand; only large, low-pressure tyres, and considerable local knowledge on the part of the driver, kept us from being stuck more than once, and one felt that it would go ill with a heavily-laden private car.

We were fortunate in our travelling companions, a party of a dozen Kurram militiamen, bound for Meshed and Baghdad on a pilgrimage, led by a delightful old Subadar who was very good company. Customs formalities at the Persian frontier at Mir Jawa took about

12 hours for the party, but our part of the examination, conducted in bad French, was soon over, and we were able to get a good night's rest in the old railway inspection bungalow.

Zahidan–Meshed, 600 Miles.

We were not so fortunate in our lorry for the next stage of the journey, having to be content with a rather confined space in the back amongst the freight, in company with four Persians and two women in *purdah*.

The party was, however, cleaner than might have been expected, and very polite and cheerful. Specimens of Persian food were pressed upon us, but the combination of jolting and petrol fumes did not make any food particularly welcome. The senior member of the party was a grizzled old man, some four foot six high, who improved the minds of the party with lengthy dissertations on religion, including a highly-embroidered version of the story of Joseph and his brethren, which took four hours by the clock. His complete lack of dentures made it rather hard to gather more than the general gist of what he was saying, but it was a good way of passing the time. The lorry was on a mail contract and had two drivers working in alternate shifts ; consequently, they only stopped for four hours or so during the night, which made it rather hard to get enough sleep.

The accommodation at the halting-places on this section was poor and insanitary, and in Turbat-i-Haidari we were forced to shave and wash in the drinking water we had brought along with us, the official water supply consisting of a pea-green stagnant pool in the courtyard of the *serai*. Out of our first purchase of eight Persian eggs, four proved bad. This temporarily put us off Persian food and we fed mainly off our two days' iron ration ; bad luck this, as we found out later that this does not fairly represent the state of eggs in Persia !

As soon as we started to climb on to the Iranian Plateau the weather turned chilly and wet, and we arrived in Meshed on the third afternoon, cold and dirty, still in our hot-weather kit. This was probably the least enjoyable section of the whole trip, but amazingly cheap, costing only £1 for 500 miles.

The bath and change at the British Consulate were pure bliss. We spent three days there as guests of Major and Mrs. Gastrell who were truly delightful hosts.

Meshed–Teheran, 600 Miles.

Finding that it was possible to hire a complete car at the rate of 2d. per mile, with no obligation to pay for the return trip, we engaged

an ancient Dodge and a rough but competent Birjandi driver, and set out for Teheran, with the idea of visiting Meshed-i-Sar on the Caspian Sea *en route*. Heavy rain delayed our start by one day and made our progress along the road a series of short rushes and violent skids as we pulled up to avoid breaking springs in the deep water-courses cut across the road. Persian roads are quite unbridged except for the major perennial rivers, nor has any attempt been made at side drains: breaches in the road are filled in fairly quickly as they occur by gangs impressed from the villages lining the road, but there is no attempt to secure a level surface. The vibration, consequently, is terrific and we found it inadvisable to sit under a hard part of the car's roof; one advantage of this bumping about was that we needed none of the usual laxatives required by motorists on a long run! The food and accommodation on this section of the route were very much better, and there was one rest house which boasted its own electric-light set. The drive through the Elburz Mountains was a most spectacular one: a climb of a thousand feet or so off the Iranian Plateau, and then a continuous drop of 6,000 feet down to sea-level; in a couple of miles the country changed from bare rounded hills to a rocky gorge with wooded and grassy slopes almost like the Wye Valley. A snowstorm made visibility poor, otherwise there would have been some fine snow peaks in the distance.

The north side of the pass was a hive of activity owing to the construction work on the new Caspian Sea to Persian Gulf railway. The difficulties of this section of the line are tremendous, the rise from the Caspian Sea being so rapid that the railway has to climb in a series of corkscrew tunnels. All the bridging is being done in reinforced concrete, the materials being imported from Russia.

The railway has been under construction for three years, and at a modest estimate will take another six to complete; something like a third of the nation's budget is absorbed by it, so it is not surprising that it is unpopular in the country, and it is said that if the reigning Shah were to die now it would be left uncompleted. The general opinion is that the money would have been much better employed on road development which would have benefited a much larger area more quickly.

The headquarters of this part of the railway construction is Shahi, a brand-new town with a rather pretentious square and public buildings, obviously copied from French ideas of town-planning. The Shah intends to make Shahi a summer resort for Persian society, and was spending the Muharram holidays there himself. We and all the other motor traffic were held up for two hours here waiting for the retinue of the Shah's wife (or one of them) to arrive by car from Teheran. Five cars drove into the town accompanied by a continuous blast from all five horns, whereupon we were allowed to

1.—Send-off from C.R.E. Peshawar's Office, April 7th.

2.—A shave in Birjand serai, using a pile of bullock skins as dressing table.

3.—A street in Meshed. The golden dome of the shrine can be seen in the distance.

The overland trip from India 1- 3

4.—After a narrow escape from a fall of rock in the Elburz mountains.

5.—Second temporary bridge across a spate; the lorry seen in the background broke the first one.

6.—Taking on another 200 gallons of petrol at Rutban Wells.

The overland trip from India 4-6

continue our journey. Apparently it is not unusual for traffic to be held up for a whole day on a main road when the Shah or his retinue are on the move.

Thanks to this delay, it was after dark when we reached Meshed-i-Sar on the Caspian, but we managed to find the Orient Hotel, which we had had recommended to us for its superior cuisine. And the Russian hotel proprietor did all that was said of him: we fed on salmon steaks and heaped plates of caviare at a rate of about 9s. per day.

We spent one whole day by the Caspian and did a very rapid bathe in very chilly water, chiefly to add it to our collection of "seas bathed in." This part of the coast was flat and uninteresting, and in April completely deserted.

The return journey through the Elburz Mountains was full of incident. We left at dawn under a rather lowering sky, and had just got to the foot of the hills when we were held up in a large queue of cars: heavy rains had caused wash-outs in at least two places farther up the road, we learnt, and as the alternative route was completely cut by spates, we should probably be stuck where we were for at least a day. This estimate, however, proved to be a bit gloomy: four hours later a road gang had put a temporary timber bridge over the first of the breaks.

A heavy lorry for some reason was selected to test this out first: it promptly broke the road bearers on one side and collapsed half-tilted over in the spate. After another hour's delay a second and stronger bridge was made. As we neared the top of the pass we were driving through six inches of wet snow and had a narrow escape from a large fall of rock which piled itself up against the side of the car as we were backing out of a traffic jam, with two other lorries coming the other way. The damage proved to be nothing worse than a twisted mud-guard and a dented door and, much to our amazement, a rather shaken driver was able to drive the car away.

Just as it was getting dark, we were held up by a further wash-out just on the point of being repaired. Our driver took advantage of this and nipped across the gap in front of all the other cars that had been waiting there, thus saving a long wait at the passport control barrier a mile farther on. Our last adventure was with a mud slide, in which we found a carload of French business people well and truly stuck and apparently quite resigned to remain so; the two men of the party surveyed the scene despondently while the women waded about calf-deep in the deepest part of the mud. Actually it was only ten minutes' work to push both our own and the French car through the mud, and I don't think either of us got as muddy as the French females in the process.

Eventually we reached Teheran at 9 p.m., fairly weary, to find that

our hostess, the wife of the Military Attaché, in the kindness of her heart, had staged a party in our honour, to be followed by a visit to the Canari, the one and only night-club of Teheran. We felt like a bath and then a bed, but decided that the honour of the Corps was at stake, so managed to last out until about 3 a.m. The night-club was a depressing place, not unlike an inferior A.B.C. restaurant, with a space about 25 feet square in the centre, on which four couples at a time took it in turns to dance. The cosmopolitan collection of would-be revellers was interesting; only one Persian was present, and one felt that the whole thing was rather forcibly imported to make Teheran feel itself up to date and westernized.

Teheran as a town suffers very much from this policy of slavishly copying the West in general and France in particular. Large office blocks and shopping streets are being put up with not even an awning to protect the head of the shop-goer from the sweltering Persian sun.

The new Teheran would have been more beautiful and practical if they had retained the usual Eastern verandah or arcade which makes the old Persian bazaars so attractive. As we drove into the town our guide naïvely asked us which we considered the finer town, Teheran or Paris. We had not the heart to disillusion him, but replied that we had not yet seen Paris so couldn't judge.

A feature of modern Teheran is the great number of men in uniform—of one kind or another—seen in the streets.

We were again entertained royally in Teheran; we were roped in for a reception at the Japanese Embassy, where we wished that our French had not been so paralytic.

TEHERAN–KHANIKIN.

We decided to try front seats in a lorry once more for the next section and arranged a contract for rather less than £1 for the next 400 miles. All seemed to promise well when we were visited by a slice of very bad luck: our driver was overtaken on the road by his long-lost brother, a lorry-driver like himself. We did not think much about the touching reunion at the time, but it proved to be a great nuisance. Not only did they take it in turns to breathe each other's dust for the next 300 miles, but the reunion had to be celebrated in cups of tea on an average every 30 miles. The lorry-drivers' union in Persia seems to get free tea in exchange for free transport for the hotel-keepers.

Further, whenever either lorry broke down the party was held up; and there were endless delays in collecting freight. Consequently we were fed up with lorries and their drivers by the time we reached

Hamadan ; quite unreasonable, of course, as we were not the paying part of the load, and were not prepared to make it really worth anybody's while to hurry.

We would not have minded the delays in the towns at all, if the driver only had given us some idea of how long they would be. "Half an hour," as we learnt by bitter experience, would certainly not be less than an hour and might even turn out to be four ; but we did not like to count on this too much, and wander far afield from the lorry, or we might quite easily have been left behind.

The country passed through was interesting, however, and the company quite pleasant. The food on this section was quite eatable, though the manner of its presentation sometimes left a good deal to be desired. In one place we ordered some meat, which was served after some delay ; we had nearly finished when the complete entrails of the animal were carried out through the restaurant. The driver seized a succulent morsel and started to eat it raw, while his apprentice took the bladder and blew it up as a balloon. We walked out into the fresh air rather abruptly !

Eventually we took seats in a touring car for the last 80 miles, so as to catch the night train from Khanikin into Baghdad and so get an extra day there.

We looked like spending a night at the customs barrier at Khanikin, as the Persian official announced that he was tired after a long day and intended to close down. We, being soldiers, he argued, must be used to minor discomforts and delays of this kind ; we would not be more than 12 hours late in getting into Baghdad. We said that we quite saw his point, but, of course, would esteem it a tremendous favour if, etc., etc. . . . He eventually relented and let us through.

We said good-bye to Persia with some regret ; nevertheless it was good to get into the more friendly atmosphere of Iraq.

KHANIKIN–BAGHDAD, 120 MILES.

The Iraqi customs house was rather an amusing contrast : we found it in complete darkness ; after much shouting on the part of our guide, a vast man came forth in pyjamas and greeted us in a very friendly way in English : "Some tea for the officers at once, Abdul, and bring me some forms and a pen." In less time than it takes to tell he pushed across two forms for us to sign with *Nil* scrawled across every heading, and informed us that we were through. All the while he fed himself unceasingly with pistachio nuts from his pyjama pocket. In ten minutes he was back again in bed, leaving Abdul to collect 6d. for the tea and 2s. 6d. "customs charges."

Whatever this was for, it was cheap at the price: there surely never was a more trouble-free customs. The train journey into Baghdad was uneventful, and in fact our travels from now onwards were more stereotyped. The R.A.F. at Hinaidi, just outside Baghdad, were very hospitable, and not content with entertaining us, assisted us in arranging the next stage of our journey. This was a tremendous piece of luck, as their machines only do the trip three or four times in the year, and they fitted in with our plans to the very day. The plane followed the line of the new oil pipe; we went in it as far as Amman. The flight was, of course, extraordinarily interesting, though rather marred by violent air sickness for nearly all the passengers.

From Amman we hired a car to Zerka, where we stayed a night with the Trans-Jordan Frontier Force; this we followed with three days' sight-seeing in Jerusalem, three days with friends in Hebron, visits to Beersheba, Gaza, Haifa, Nazareth and Galilee. Finally, we took a Lloyd-Triestino coasting steamer from Haifa. This part of the journey, though just as interesting to us as any part that had preceded it, is on a recognized tourist route, so will not be described at any great length.

Most of the steaming was done at night and we had days ashore at Beirut, Lanarca, Rhodes, Piræus (for Athens), and a day and a half in Constantinople. We left the boat at Venice and came home from there by Florence, Turin and Havre. We did not waste much time on this last section, as cash was beginning to run out. We steamed up Southampton Water just eight weeks and one day after leaving Peshawar, having covered just 8,000 miles all told.

Thanks to the Government of India's generosity in giving £50 instead of a passage on a troopship, the trip had cost only some £20 more than the normal journey would have done, with five weeks' living at home after it.

The costs of the various sections are instructive: the nearer we got to home the more expensive travelling became.

Expenses are tabulated below:—

	Miles.	*Cost.*	*Cost per head per Mile.*
Peshawar–Quetta ..	730	£6	1d.
Quetta–Baghdad ..	2,600	£23	1d.
Baghdad–Haifa	1,040	£7	¾d.
Haifa–Venice	2,730	£34	1½d.
Venice–Southampton ..	960	£15	2d.
	8,060	£85	1¼d.

Other expenses, not fairly chargeable to travelling, were :—

Purchase of clothes and necessaries ..	£7
Photographic costs	£6
	£13

Thus making total cost of the trip £108.

Miscellaneous Practical Notes.

(1) *Money.*—Was taken in the form of letters of credit, cashed in the large towns as we passed through ; this method was perfectly satisfactory.

(2) *Clothes.*—We took Indian hot-weather kit, grey flannel trousers and sports coat, store suiting and dinner jackets. A pair of Jodhpurs would have been useful, likewise a tail coat (for the Japanese Legation reception).

(3) *Equipment.*—We took bedding rolls and camp beds with us as far as Baghdad, where we handed it over to Cook's.

(4) *Rations.*—We had with us about two days' supply of tinned food, a kettle and some " tommy's " cookers ; we kept this stock replenished and used it whenever the food looked too unappetizing ; this also we jettisoned at Baghdad. We also took a large thermos flask which we sat on and squashed on our third day in Persia, but did not miss overmuch !

(5) *Languages.*—No language except Persian was of much use in Persia, except in the few large towns, where French was spoken. A few weeks spent before the trip in learning up a smattering of Persian were very well repaid.

THE BATTLE OF HARBIN.

By CAPTAIN J. V. DAVIDSON-HOUSTON, R.E.

INTRODUCTION.

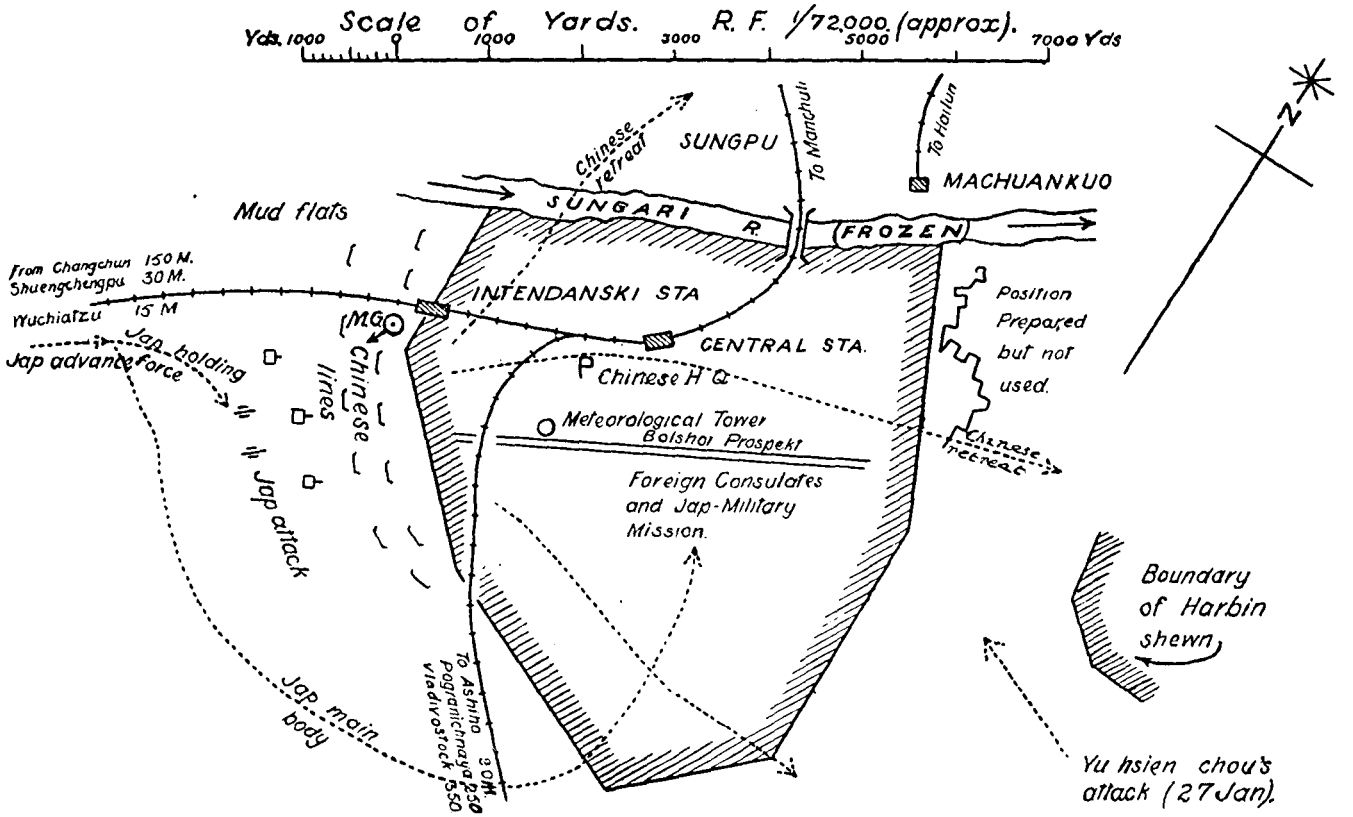
DURING the last three years a country as big as France and Germany has been detached from the Chinese Empire and placed under the protection of Japan. In the military operations involved, a small, modern army took the field against vastly more numerous but almost mediæval forces, with the inevitable result. These operations, therefore, if treated in the conventional way, would be of little value to the military student, and a mere jumble of weird names to the layman. It is my purpose, therefore, to describe my personal observations and experiences during the Manchurian campaign in the hope of rendering this piece of Far Eastern history more intelligible, if not more interesting.

DESCRIPTION OF MANCHURIA.

A brief description of the theatre of operations will not be out of place. The name "Manchuria" was given to the country by foreigners on account of its being the original home of the Manchus. The Chinese, however, who now form ninety per cent. of the population, refer to it as "The Three Eastern Provinces." When the Japanese assisted Manchuria to independence, the name "Manchou Kuo," meaning "Manchu State," was adopted, to indicate its separation from the so-called Chinese Republic. It is an awkward word to say, and there seems no reason why we should not continue to use the expression "Manchuria," which means the same thing after all.

Manchuria is bounded on the north by Siberia, on the south-east by the Japanese possession Korea, on the south-west by China proper, and on the west by Mongolia; it is thus well qualified to be called "the cockpit of Asia." The centre of the country consists for the most part of a vast plain, extensively cultivated during the summer but a frozen desert in the winter; it is here that the chief cities, Mukden, Harbin and Changchun are situated. The regions near the frontier are more mountainous, but few of these ranges are very high or rugged, and do not present a barrier at all comparable with the Alps or the Hindu Kush. The vast majority of the inhabitants are Chinese engaged in agriculture or commerce; there is a

BATTLE OF HARBIN.



considerable minority of Mongol tribes living a nomadic life on the western prairies, and a sprinkling of Manchus and Tunguses. During the last 35 years, there has been considerable railway development, but the communications of the country depend on two main arteries: the Chinese Eastern Railway, owned in 1932 by Russia, and the South Manchuria Railway, owned by Japan. The climate is one of extremes. In the summer, temperatures of 80 to 100 degrees Fahrenheit are registered, while in the winter I have known the thermometer to drop to 40 degrees below zero. At this period the rivers are frozen to a depth of several feet, and mechanical transport can move freely over the ground, but during the thaw and the summer rains the country often becomes impassable even for horses. There are hardly any roads worthy of the name. For this reason the Japanese confined their main operations to the winter months, although the low temperature favoured the Chinese.

OUTLINE OF THE OPERATIONS.

The causes of the Japanese invasion are not within the scope of this paper; the Manchurian operations began on September 18th, 1931, when the Japanese suddenly seized Mukden, the capital of the country and the site of the Chinese arsenal. Thereafter their forces advanced methodically along the network of railways, and thus brought the whole of Manchuria gradually under their control. Organized resistance was crushed, and further operations consisted in "mopping up" irregulars and bandits in outlying districts. It must be realized that in 1931 the Japanese were by treaty allowed to keep troops in Manchuria for the protection of the South Manchuria Railway, which made their task considerably easier. The Japanese occupation of Manchuria can be broadly divided into three phases:—

(1) The capture of Mukden and the south.
(2) The capture of Harbin and the north.
(3) The capture of Jehol.

I have already referred to the seizure of Mukden. As I was fortunate enough to be with the Chinese Army at the Battle of Harbin, I will describe those operations in greater detail. My experiences in Jehol have already been related in "Ten Days in Jehol" (*R.E. Journal*, March, 1934).

SITUATION AT THE BEGINNING OF 1932.

By the end of 1931 the Japanese Army had overrun Southern Manchuria, and had driven all Chinese regular forces from that region. In the north, however, there remained the vast tract of country between Kirin and the Russian frontier, containing the Mongolian

pastures of Barga, the Chinese Eastern Railway, and the important towns of Hailar, Tsitsihar and Harbin. Harbin, the seat of government of the Sino-Russian enterprise known as the Chinese Eastern Railway, is the meeting point for railroads running north, south, east and west. It appeared logical, therefore, that the invaders should turn their attention in this direction early the following year.

Description of Harbin.

Harbin lies on the south bank of the Sungari River, in the midst of a wide, undulating plain. In summer, this plain is covered by crops of beans and giant millet; but at the time to which this narrative relates, it presented a bare, treeless expanse, devoid of any cover, but frozen so hard as to permit the movement of troops in all directions. The city owes its existence to the Chinese Eastern Railway, and its character is mainly Russian, the inhabitants consisting of impoverished "Whites," Soviet railway employees, and immigrant Chinese and Japanese. From the Central Station the northern line crosses the Sungari by a steel bridge some 800 yards long, and runs to Manchuli on the Siberian border; south-west of the town, the line forks into two branches, one of which turns southward to Changchun and Mukden, and the other eastward to Vladivostok. From Machuankou, on the opposite bank of the river, a railway ran northward as far as Hailun, though the latter is now connected with a branch from Tsitsihar. There are no modern roads leading to Harbin, and the river traffic is stopped in the winter months by the freezing of the Sungari to a depth of six or more feet. The neighbourhood of the city, in common with most parts of Manchuria, has long been a happy hunting ground for bandits, and the Japanese invasion caused a boom in this industry, whose ranks were swelled by defeated and disbanded Chinese soldiers.

The Opposing Forces.

The nearest Japanese forces were those at Changchun, the junction of the South Manchuria and Chinese Eastern Railway systems, 150 miles to the southward. Owing to the necessity for considerable garrisons all along their extensive communications, the Japanese Command had only a weak division of some 8,000 men available for field operations in the north. As the advent of the thaw in late February or March would render the country impassable for transport, it was necessary for them to prosecute operations without waiting for the complete "pacification" of South Manchuria. The Japanese troops were well equipped and clothed for a campaign in a zero temperature; nothing heavier than the divisional field artillery was required for dealing with the Chinese, while aircraft, tanks and armoured cars were available if needed.

In addition to these forces, General Honjo could count on the half-hearted co-operation of Hsi Ch'ia, a Manchu whom the Japanese Army had installed as Governor of Kirin. The strength of the Kirin forces operating with the Japanese was always a doubtful quantity, since whole units frequently deserted with their arms, and were a constant source of anxiety to their allies. In any case they were of little value, being indifferently armed and accompanied by little or no artillery; they were provided with Japanese staff officers, who found it difficult to instil Staff College doctrines in their Chinese colleagues.

Harbin became the rallying point for all those forces still prepared to oppose the invader and the "Running Dogs" who had gone over to his side. These troops consisted of the regular garrison, under the joint command of Generals Ting Ch'ao and Li Tu, and a heterogeneous collection of irregulars, deserters and bandits, calling themselves "The Army for the Salvation of the Country." All these forces were untrained, ill-disciplined, and provided with few modern rifles or machine-guns; they had no aircraft or mechanized units; while their artillery consisted of weapons varying from modern 75-mm. field-pieces to muzzle-loading eight-pounders. The total force thus available for the defence of Harbin amounted to about 20,000 men.

A Gilbertian factor in the situation was the presence in Harbin, throughout hostilities, of the Japanese Consulate and the Special Military Mission, both of whom enjoyed quasi-diplomatic privileges, and were able to communicate by wireless with Japanese forces in the vicinity.

YU HSIEN CHOU'S ABORTIVE ATTACK.

I arrived in Harbin from Peking on January 25th, 1932, only just in time to witness the ensuing operations, for rail and telegraph communications with the south were interrupted on the following day. Japanese aeroplanes flew over the city, and dropped leaflets printed in Russian and Chinese, assuring the inhabitants of the benefits of Japanese occupation and pointing out the evils of the former administration. Irregulars continued to pour into Harbin from the south-east, causing many of the inhabitants to bury their valuables and hoist Polish flags on their houses. This curious choice of nationality may have been due partly to the fact that the colours tallied with the red-and-white armlets of the irregulars, and partly to the ease with which the flag could be made up. These new accessions to the garrison were mostly mounted on shaggy Mongol ponies, and armed with every kind of weapon, including red-tasselled spears; they were preceded by standard-bearers, carrying three-cornered "dog tooth" flags inscribed with characters denoting

bravery and patriotism. From these troops it was ascertained that they were being followed up by the Kirin Army, which was advancing upon Harbin from the south-east.

Early next morning a Japanese aeroplane arrived on its customary mission of dropping leaflets, and this time was subjected to ineffective rifle fire, without, however, inducing the aircraft to discharge anything more dangerous than paper. That night the Kirin troops, consisting of a mixed brigade under Yu Hsien Chou, halted at Ashiho, a small town 20 miles to the south-east. There were no signs of Japanese troop movements, and it was clear that General Honjo hoped to induce Harbin to surrender without having to attack it. If force were necessary, it was desirable that it should be applied by his Chinese allies rather than by foreign troops.

On the 27th, I was awakened by sounds of firing, so drove to the eastern suburbs of the city and took up my position upon the roof of a house, where I obtained an excellent view of the battlefield. The attackers numbered about 2,000 infantry, who advanced across the open plain at the walk, in a succession of extended and irregular lines. The advance was covered by the fire of three-inch mortars, whose projectiles mostly burst harmlessly in the gardens of the suburbs. The Harbin troops replied with rifles and mortars, firing standing among the houses. Nobody on either side bothered to take cover, and casualties were few. Every now and then, however, a wounded man could be seen, slung like a pig from a pole, being carried by " stretcher-bearers " from the field ; while a soldier would take an occasional shot at a cowering civilian for the sheer fun of making him run.

The foremost line of the attack had approached to within 300 yards of the houses, and it seemed possible that the rare spectacle would be presented of two Chinese forces coming to grips ; suddenly, however, a tremendous volume of fire broke forth, the Kirin troops hesitated, halted, turned round and began to walk away. At once the firing died down, and an exulting yell arose from the defenders. Banners were waved, bugles blown, and the Harbin troops started to form up in the open spaces. A regiment of cavalry, on their woolly little ponies, started out in pursuit, but came home again after nearly catching up the retiring enemy, much as a dog will run barking after a stranger who passes his house. As the " cavalry " were armed with nothing but carbines, it would have been interesting to have observed their methods of shock action. Yu's brigade retired to billets in some villages at the southern entrance to Harbin, and desultory sniping went on through the night. The action gave the impression of an eighteenth-century battle, where the whole field could be surveyed from a single observation post, and where the effective range of infantry weapons did not exceed three hundred yards.

JAPANESE ACTIVITIES.

As soon as it was evident that their Kirin allies were but broken reeds, the Japanese began to take an active part. Late in the afternoon, two aeroplanes flew over the town and dropped a number of bombs; I was amused to see two Japanese civilians signalling to them, with ground strips, in a field close behind the defensive perimeter.

One of these machines came down with engine trouble on the frozen mud-flats west of the city, and was immediately surrounded by Chinese troops under the impression that they had shot it down. The pilot descended from the machine and calmly walked off to the nearest garage under the protection of his extra-territorial privileges, leaving the observer in charge of the aircraft. The Chinese soldiers, who numbered about a hundred, gradually grew bolder and approached the aeroplane with the intention, no doubt, of taking possession of it. This was too much for the gallant little observer, who opened fire in all directions with his machine-gun. In the ensuing melee the Japanese officer was riddled with bullets, and the troops dispersed, possibly in fear of vengeance from an unexpected quarter.

The machine was full of propaganda leaflets, now soaked in blood, and carried two bombs underneath each plane, while two had already been released on either side. A large crowd of Russians and Chinese swarmed round the machine, and took no notice of repeated warnings that the bombs might easily explode. Just before sunset, four motor-cars arrived on the scene, and disgorged Colonel Dohihara, head of the Military Mission, with 30 armed volunteers in the black uniform assumed by able-bodied civilians of the Japanese community in time of emergency. The crowd fell back, and the volunteers formed a cordon round the aircraft. Petrol was poured over the machine, which was then set on fire, the Japanese guard remaining until there was no possibility of extinguishing the blaze. Dohihara and his satellites withdrew, and the crowd surged forward again, heedless of warnings given by the more sophisticated. Realizing that this was no occasion for dallying, I quickly withdrew; but within a very few minutes a series of violent explosions was heard, and the sun went down on one of the most gruesome sights it is possible to see, even in Manchuria.

THE JAPANESE ADVANCE.

On the 28th of January, I was shown copies of two secret telegrams addressed to the C.E.R. Director from Moscow. The first stated that the Japanese claim to transport troops on that railway

would not be recognized, and that Soviet employees were to render no assistance in this respect. The second, timed a few hours later, instructed the railway authorities to render to the Japanese Army any assistance that they might require. Whatever might be the reasons for the sudden change of attitude, the fact remains that on this day several Japanese troop trains left Changchun for the north. On the same date, the notorious " night life " of Harbin was temporarily suspended, desultory rifle fire could be heard on the outskirts of the town, and the deserted streets echoed to the clatter of mounted patrols.

On the 29th it was learned that the Japanese advance along the railway was being delayed by damage to the line, carried out by irregulars who retired as soon as they had caused the enemy to halt and detrain. Ting Ch'ao gave out that he intended to resist the Dwarf Slaves to the death, but on the same day granted a two-hour interview to the Japanese Consul ; a Chinese general is never averse to negotiation, even after battle has been joined. Several emissaries, however, who were sent in from the Kirin troops to discuss a *modus vivendi*, were beheaded on their arrival in the courtyard of Ting Ch'ao's yamen. It was now clear that the main threat was from the south-west, and the defenders began to erect hasty and inadequate works in that quarter. These works consisted of two lines of posts, at about 400 yards' distance and 30 yards' interval; each post was in the form of a semi-circular breastwork occupied by two or three men, but, owing to the frozen condition of the ground, it had only been possible to scrape up little two-foot banks of surface earth, supplemented by some of the thin snow which had recently fallen. There were no trenches, and the guns were disposed on the open plain 500 yards behind the infantry. On the south-east of the city, however, an elaborate system of trenches had been dug in the autumn of 1931, and was never used. The Japanese began to bomb the defensive positions daily, but the projectiles were old mortar-bombs taken from the captured arsenal at Mukden, and their effect was more moral than material.

By the 30th Harbin had taken on the appearance of an invested fortress, and no traffic of any sort could pass in or out. The buildings in the Japanese quarter were heavily sandbagged and guarded by volunteers, and police were detailed to protect the foreign consulates. Rumours were constantly coming in that the invaders had appeared in the suburbs, but a personal reconnaissance the following morning revealed a Chinese brigade in full retreat from Shuangchengpu, where it had met the enemy and declined to remain. These troops appeared to have suffered no casualties, and stated that they had run short of ammunition and were proceeding to Harbin for the purpose of obtaining some more.

On the 1st of February, Li Tu sent one of his brigades in requisitioned motor-buses towards Shuangchengpu, with the avowed purpose of avenging the recent defeat there. These vehicles were taken straight off the streets of Harbin, and made slow progress over the roadless ground, while the droshky drivers reaped a rich harvest in the town. Parties of irregulars removed rails at several points along the railway, and attempted to demolish a steel girder bridge by burning piles of straw on the track. The C.E.R. authorities formally protested to Ting Ch'ao, as the local representative of the Chinese Government, but Ting replied that the damage was being done by ill-disposed persons over whom he had no control. Japanese aircraft attempted to bomb some of these parties, but they were able quickly to disperse to neighbouring farms and to continue their work as soon as the enemy was out of sight.

All next day the town waited for news of the brigade, and especially of the motor-buses, which had gone forth to meet the foe. An ominous silence brooded over the country until the morning of the 3rd, when the brigade came streaming back in disorder, having lost all but a few of its vehicles. A novel sight was the arrival of some unfortunate wounded, a number of whom were carried on litters slung from poles, while others had endured the ordeal of being drawn across country on wooden sledges. It is not surprising that the Chinese soldier is averse to becoming a casualty, for there are many instances of the callous treatment to which he is subjected on such occasions. Later in the day, three aeroplanes swooped down upon the defences, opening fire with their machine-guns, but the marksmanship was such that I did not observe a single hit. Their bombing, however, was more effective, consisting in flying very low and dropping four or eight bombs at a time. It was possible, by means of field-glasses, to see these bombs released, and to take cover before they exploded; a party of soldiers was struck, however, and every man killed except one. In accordance with local practice, no attempt was made at treatment for the wounded man, as he was too badly hit to warrant hopes of recovery.

On the evening of this day the Japanese motorized advanced guard, which moved parallel to the railway along which the main body was being transported, arrived at Wuchiatzu, a village some 15 miles away. The irregular cavalry, instead of protecting the rear of the retiring infantry, soon caught them up and galloped into Harbin well ahead of them. Their morale was such that several of them fired at me from the saddle and subsequently apologized.

On the 4th of February, several units filtered into Sungpu, on the north bank of the river, but did not cross the ice. These troops belonged to the Heilungkiang leader, Ma Chan Shan, who was still breathing defiance at the Japanese from his retreat in the far

north ; and they remained on the other side of the Sungari in order to see how the situation would develop.

The Japanese Attack.

On February 4th, a Japanese infantry brigade, accompanied by approximately one cavalry regiment and 12 field artillery guns, had already detrained at some point down the line, and came into action against the Chinese garrison of Harbin.

The action began at dusk with a salvo of shrapnel directed on Intendantski railway station and the western defences. There were only eight Chinese guns capable of replying, and these were 77-mm. pieces manufactured in the Mukden Arsenal under foreign supervision. Many of the guns carried no sights, while there was no artillery observation ; they were fired at random in the direction from which the enemy fire was believed to be coming. One field gun, bearing the mark " Putilovski Arsenal, 1902," had been run up a slope and secured by a rope to a telegraph pole, in order to give the piece an elevation of some seventy degrees and so to outrange the Japanese artillery. Unfortunately no ammunition was forthcoming for this weapon. Darkness eventually set in, and the firing gradually died down without any considerable casualties having been caused. The population of Harbin passed the night in a state of tension and their overcoats.

At daybreak on the 5th the bombardment recommenced, the Japanese using nothing but shrapnel, presumably with a view to doing as little damage as possible to the city and to foreign property. I took up my position on the top of the meteorological tower of the Chinese Eastern Railway, whence I was able to view the whole field. The Chinese artillery, being unable to observe the enemy, fired wildly " into the blue," some of their shells bursting dangerously near the guns. The infantry lines were early evacuated, the men running for the cover of the houses, leaving some 30 dead behind them. One Japanese shell, ranging too far, scored a direct hit on a Russian civilian in Bolshoi Prospekt, and tore him to pieces. It was possible to see the attackers' battery positions in some farms about 3,000 yards away, and to observe the bursting of the shrapnel over the western outskirts of the town. The Chinese artillery, seeing their infantry streaming towards them, limbered up and were in retreat by 9.30 a.m.

The defenders could now be seen, drifting in disorder to the north and east ; some crossing the ice and seeking temporary shelter on the north bank of the Sungari, while others followed the railway toward Pogranichnaya and the Russian frontier, looting as they went. Only at this time did the Japanese infantry move forward, and at once came under the fire of machine-guns hidden among the

buildings at Intendantski Station, which was directed against their left front. As the attackers were restricted to the use of nothing more destructive than shrapnel, their artillery continued to engage the enemy on this part of the front, while the rest of the force, preceded by a cavalry advanced guard, made a wide detour in column of route and entered the city, without opposition, from the south. The Chinese machine-gunners, realizing that their position had been turned, gave up further resistance, and by 3 p.m. had joined in the general retreat.

There was an element of humour in the head of the Japanese column entering one end of a street, and having to halt in order to let the rearmost Chinese get out of sight at the other end. As the victorious brigade began to arrive at the centre of the city, there were scenes of the wildest enthusiasm on the part of the Japanese and Russian inhabitants, who lined the streets, waved flags and shouted " Banzai ! " The Military Mission, which had been quietly co-operating with the attack from behind the Chinese lines, immediately distributed pamphlets and posted proclamations, reassuring all law-abiding citizens but threatening dire penalties to those of hostile intent. The Chinese police, with commendable promptitude, changed their armlets for some of Japanese design, and prepared to maintain law and order on behalf of their new masters.

The 4,000 men, before whom Ting Ch'ao's 20,000 were straggling across the plains, were joined on the following days by the remainder of General Tamon's Division, and organized resistance was at an end.

* * * * * *

CONCLUSIONS.

By April, 1933, the Three Eastern Provinces and Jehol had been incorporated into the new state of Manchoukuo, and since that date military operations have been confined to punitive expeditions against guerrilla bands.

Can this campaign, strangely unlike those to which we have become accustomed in the West, afford any lessons to the modern student of war ? I suggest that the following deductions may usefully be made :—

(1) Against a semi-civilized or guerrilla enemy, absolute *security* is more important that *surprise* or great *mobility*. The Japanese were aware that even a minor disaster would stiffen incalculably the resistance of an enemy so prone to self-deception as the Chinese ; while the local population might be encouraged to harass their flanks and rear communications. They consequently sacrificed surprise to a great extent by taking eight days to reach Harbin from Changchun, a distance of only 150 miles by rail. The advance was

extremely methodical, the trains being preceded by armoured cars on flanged wheels, which reconnoitred sections of line before any troop train moved over them. The advance was stopped, and covering parties detrained, whenever damage to the track was encountered; while potential raiders were kept at a distance by protective detachments carried in lorries. In the case of an opponent like the Chinese, such a deliberate and irresistible advance was more certain of success than one carried out at high speed but with the accompanying risk of "unfortunate incidents." Jehol was occupied by three converging columns totalling little more than 8,000 men, which advanced methodically along three main approaches, preceded by aircraft, armoured fighting vehicles and small motorized advance guards. The aircraft induced the Chinese to withdraw their guns, while the armoured forces cleared the valleys and opened the way for the infantry occupation. Chengte Fu was entered without opposition by 500 men and a brass band.

(2) The Japanese interpreted the principle of *Economy of Force* as prescribing the use of inferior weapons against an inferior enemy. Their aerial bombs were merely trench-mortar shells manufactured in the Mukden arsenal, and captured when that city was occupied by the invaders. The percussion device included an ordinary 12-bore cartridge, and about 30 per cent. failed to explode. Many of the armoured cars were actually light motor-cars covered with metal plating which was probably hardly bullet-proof; the horse transport consisted of requisitioned native carts and drivers. The troops which came into action at Harbin did not exceed one cavalry regiment, two four-gun field batteries, and three companies of infantry; their casualties were negligible. In the advance through Jehol, the mechanized arm was the only one which really came into action; the infantry were used for consolidation and occupation.

(3) With regard to the Chinese forces in Manchuria, they never once "put up a show." They had the benefit of German staff work, of vastly superior forces, and of twenty years of civil war. The National Government had spent large sums in the purchase of aircraft, tanks and other modern weapons. Against this must be set the fact that the Chinese infantry were sent into action with beheading swords, spears, and hopelessly inadequate quantities of rifle ammunition. The mechanical weapons in the hands of the Government were considered too valuable to waste in fighting, and the few motor-lorries available were employed for private purposes. Under such conditions, could any troops in the world face a modern army?

A BATTLEFIELDS TOUR.

By MAJOR C. P. WORSFOLD, M.C., *p.s.c.*, R.E.

TOURING the battlefields of the Great War has formed a prominent part of training programmes throughout the army during 1934. Many officers have had an opportunity of studying on the ground the actions of 1914, and in particular the battle of the Aisne and Le Cateau. It is, therefore, with some hesitation that the writer commits to print the impressions gained during a somewhat ambitious tour organized for the S.M.E. and the Chatham Area.

The primary object of this tour was to give officers who were commissioned after the Great War an impression of the doubt, delays and difficulties inherent in war. By so doing one might hope to counteract the excessive optimism sometimes engendered by tactical exercises in peace. The tour had for its secondary object the study of situations which actually arose in war on the assumption that both sides were armed with the latest weapons and were organized and trained on modern lines. Since all arms, the Navy and the Air Force were represented in the party, this study was not confined to purely engineer problems.

The itinerary was an extensive one. It included visits to no less than five different battlefields. The two main features were a day and a half spent on the River Aisne in studying the crossing of the river and the battle for the Chemin des Dames in 1914, and, by way of contrast, a morning spent in study of the crossing of the Sambre et Oise Canal by the IX Corps in November, 1918. These will be discussed more fully later.

HIGH WOOD.

On the Somme battlefield a very brief visit was made to High Wood which served to impress one with the enormous importance attached in 1916 both by ourselves and the Germans to the possession of direct observation over the enemy's communications, and this in spite of the large numbers of aircraft available.

LE CATEAU.

Time was running rather short when we got to Le Cateau, and it was only possible to visit the two flanks of the line. We were fortunate in having two eye-witnesses with the party.

The fog of war was very thick on the morning of the battle. This was driven home to us by the picture of the 59th Field Company moving into Le Cateau to collect stores for preparing the position,

with the town already occupied by Germans. Fortunately they were warned in time. Then, thanks to their training as infantry, instead of moving off to find some other job of work, the company appreciated the threat to the right flank, and on its own initiative dug itself comfortably in. It is not too much to say that this saved the situation as far as the 5th Division was concerned. On the left flank of the Le Cateau position the disaster to the King's Own will leave a lasting impression of the danger of neglecting precautions for local protection.

Vimy.

A visit to Vimy Ridge was arranged on the way home. A few trenches are preserved in concrete on the Ridge with machine-gun and trench-mortar emplacements, snipers' posts, dugouts, and part of a mine system. It all seemed very orderly to those familiar with trenches, but it gave an excellent illustration of the limited objectives and tremendous physical difficulties of trench warfare offensives.

Many were impressed with the short gap, only 30 yards, between the opposing lines, which had resulted from mining and countermining. They found it difficult to believe that it was possible to live for long on such close terms with one's enemy.

Loos.

There was time for a short halt on the Loos battlefield. Here there seemed little object in attacking, no commanding feature to gain, and only a confused medley of mining villages facing the cavalry in the event of a complete break through. The flat country with its towering slag heaps and its villages straggling everywhere is the last that one would choose to-day for offensive operations.

Loos was an experiment that failed. It leaves one with the feeling that the cream of Kitchener's first hundred thousand were wasted through lack of foresight and bad staff work. No doubt also force of circumstances and lack of training contributed largely to the failure.

Demolitions on the River Oise.

We made the most of our survivor from the 59th Field Coy. and visited the scene of his exploits in 1914 when demolishing bridges over the Oise at Varesnes and Pontoise. His vivid narrative brought home to us, firstly, the difficulty of deciding when to blow up the bridge, and, secondly, the importance of being lucky in war. To set off for three miles back into enemy country sitting on a box of guncotton tied to the carrier of a motor-cycle, then to climb up the cable of a suspension bridge and place your charge on top of the tower, with an enemy cavalryman likely to appear round the corner at any moment, demands no ordinary ration of luck.

In spite of all the rules for ordering demolitions, few who heard the

story would be content with less than a light tank as escort to the demolition party in such a situation to-day.

"BIG BERTHA'S" EMPLACEMENT.

A surprise addition to the programme was a visit to "Big Bertha's" emplacement, a sister gun to the one that shelled Paris. The emplacement seemed smaller and less elaborate than might have been expected, but the gun was only designed to fire at a fixed elevation. It is satisfactory to record that the gun killed more Germans than Allies, since it burst after the third round, killing 50 of the crew and spectators.

THE BATTLE OF THE AISNE.

Returning now to the principal feature of the tour, the battle of the Aisne. There are two main impressions which stand out vividly: firstly, the overwhelming importance of energy, initiative and resolution in commanders to prevent an advance becoming "sticky"; secondly, that in mobile war, orders from commanders at rearward headquarters seldom reach the troops before the situation on which they were based has completely changed. It follows that a commander can only exercise control by basing his orders not on the actual situation at the moment, but on the situation which he foresees at the time the orders will be executed.

THE CROSSING.

The actual crossing of the Aisne was not seriously opposed except at Missy. Nor were many of the bridges properly destroyed. There are, however, one or two points of engineer interest which emerged from the description of the crossings. The most important is that none of the divisions seems to have thought of sending R.E. reconnaissances ahead either with the cavalry or the vanguard. It is true there was a field squadron with the cavalry division, but this hardly exonerates each division from making some provision for early engineer information about its own crossing places.

The second point is that the bridging train does not appear on the scene until 24 hours after the R.E. first get down to the river. True it was only a horsed unit and took up a lot of road space, but the system seems to have been to hold it back until reconnaissances had actually been carried out, and then to send it up in portions as required. The better alternative would surely have been to sub-allot it to the leading divisions according to probable requirements. Thirdly, it is really remarkable that in spite of heavy shelling it was possible to maintain pontoon bridges in situations where, though the actual bridges were not under direct observation, the approaches on both sides were in full view right down to the banks.

The Value of Modern Equipment.

The possession of present-day bridging equipment might have exercised some influence in places, notably in getting more of the 5th Division over on September 13th, and so increasing the strength of the attack on the Chivres Spur. One or two Kapok bridges would have been very useful to the 5th Division at Missy, and to the 3rd Division at Vailly. In general, however, bridging difficulties were of minor importance compared with the difficulty of artillery support and the confusion of un-coordinated attacks.

The Aqueduct at Bourg.

The canal aqueduct across the river at Bourg provoked much discussion amongst our technical experts. This aqueduct is a massive steel structure carrying the canal, and also a towpath on either side. The Germans in 1914 only damaged the towpaths slightly and in consequence our horsed transport and field artillery were able to cross the Aisne without difficulty. The question was whether, assuming the towpaths had been completely destroyed, it would have been profitable to drain the canal and so use the intact portion of the aqueduct for tanks to cross.

It appeared that some six miles of canal would have to be drained, and possibly a large reservoir. The general consensus of opinion seemed to be that this would take much too long to make it of practical value.

The 11th Brigade at Venizel.

The action of the various formations after crossing the River Aisne was studied in some detail, particularly the remarkable night advance of the 11th Infantry Brigade, under Brig.-General Hunter-Weston, at Venizel, and the struggle, or one might say the race, for the actual ridge of the Chemin des Dames on the right of the 1st Corps. The 11th Brigade advance, in the dark, with tired men across a river, through villages and woods, without previous reconnaissance, and in complete ignorance of the enemy's whereabouts, ranks high as an example of an occasion when the end to be gained justifies departure from the strict precepts of the training manuals. Brig.-General Hunter-Weston correctly appreciated that though the state of his men was bad, that of the enemy was probably much worse, a point which is all too often insufficiently recognized by commanders.

The attacks on the Chivres Spur were really the first attacks by the B.E.F. against organized and entrenched infantry in a strong position. That they failed was inevitable with the sketchy artillery support which could be provided and an evident lack of co-ordination.

THE FIGHT FOR THE CHEMIN DES DAMES.

The struggle for the Chemin des Dames is remarkable for three things, the evil influence of orders issued with an incorrect appreciation of the situation, the slowness of the advance in comparison with that of 4th Division, and the difficulty in getting information back about the leading troops.

The 1st Division ordered an advance along one road with an advanced guard, in spite of the fact that it was obvious that the enemy were in some strength on their immediate front. The result was that, as in an encounter battle, units were committed piecemeal and deployment took a long time. On the other hand, an advance on a wide front with a limited objective would certainly have secured a large part of the all-important ridge.

It seems little short of tragic that the Coldstreams and the Queens should have actually got across the ridge and secured the invaluable observation, but should not have succeeded in getting back the information. Had they been able to do so, they might have been reinforced and the battle would have been won. Again, time was all-important in the race for the ridge, yet the 4th Guards Brigade were held back and moved about between crossing places for nearly 24 hours because they did not know that the Connaught Rangers of the 5th Brigade were already established half-way to the Brigade objective.

THE BATTLE AS IT MIGHT BE FOUGHT TO-DAY.

In considering the problem of fighting the action under modern conditions, an extra 24 hours was allowed in order to ensure a simultaneous attack by the B.E.F. and the flanking French armies. Although this would have made the German defence much stronger, it would have greatly improved the artillery support for the attack. The latter was worked out in some detail, and it seemed possible that a light barrage could be used on ground which was inaccessible to tanks. The necessity for using all resources for survey, both R.E. and R.A., and giving them very early direction, was apparent.

The general conclusion reached by subsequent discussion was that in such an attack, though the initial plans might be decentralized to brigades, it would be absolutely essential for corps headquarters to fix all the relative timings. Otherwise it would be impossible to ensure the co-ordination of flanking units of formations, of artillery programmes, and, most important of all, preservation of the momentum of the tank attack.

THE CROSSING OF THE SAMBRE ET OISE CANAL, NOVEMBER, 1918.

Turning to the crossing of the Sambre et Oise Canal, the chief interest lies in the fact that an assault crossing was made against

very determined and highly-organized opposition. The conditions were very different to 1914, and approximate closely to what might be expected nowadays.

The successful crossing of the 1st Division south of Catillon was contrasted with the partial failure of the 32nd Division, north of Ors. The latter may be attributed partly to stiffer opposition, but, mainly, to lack of time for planning, to lack of opportunity for thorough reconnaissance, and to inferior equipment. Some of the original air photographs for the operation were available, and in spite of close examination, no member of the party was able to discover a wide ditch on the near side of the canal, which in 1918 actually contributed greatly to the difficulties of the 32nd Division.

It is notable that on the 1st Division front there were enemy posts on the near side of the canal actually at the time of the attack, and on the 32nd Division front up to the night before. This may have helped the 1st Division since the posts were easily rushed. At the same time it made it necessary for the enemy counter-barrage to be some distance from the canal, and so the bridging parties and assaulting troops escaped it.

Another interesting feature of the 1st Division crossing was that folding boats of a sort were available. Their use was attempted, but abandoned owing to machine-gun fire. There is no doubt that for a gap of this nature (60 ft. of water with no current) the light floating bridge such as the Kapok is infinitely better than ferrying with folding boats.

The chief point for discussion was whether it would have been better to attempt a silent crossing than one under a barrage, as was actually done. The effect of the barrage was to rouse the enemy everywhere, bring down a heavy artillery counter-barrage on the assaulting troops, a machine-gun barrage on the banks, and fixed line enfilade machine-gun fire on the canal. Our own barrage could not affect the enemy posts concealed in the far bank of the canal which, in the event, were actually able to stop the bridging by direct aimed fire in the dark.

It is unlikely that a silent crossing would have been discovered until the bridges were actually on the point of being launched, and even then there would have been a minute or two's precious respite before the enemy's defensive fire broke out. This would have enabled the leading infantry to get across to the comparative safety of the enemy bank.

In conclusion, mention must be made of the very excellent arrangements for the tour made by an ex-member of the Corps, Captain G. A. Gregson, of Messrs. Gregson & Gregson, 28, Quai De L'Escaut, Calais. The party, 52 in number, was a large one, and taxed the hotel resources of the small towns which were selected as stopping places.

TWO RAFTING EXPEDIENTS.

By MAJOR C. C. S. WHITE, M.B.E., R.E.

A BRIEF description of how to float an "Austin Seven," and make a raft of two rifles and groundsheets to carry the remainder of two men's equipment and clothing, may be of interest.

1.—FLOATING AN "AUSTIN SEVEN."

General Considerations.

Calculations show that an "Austin Seven," or any ordinary motor vehicle, when wrapped in a waterproof cover, possesses ample buoyancy.

The real problem is lifting the vehicle and launching it without tearing the waterproof cover.

Various methods of carrying by means of spars and slings were tried in succession. The first satisfactorily evolved was one by which the weight of the car is taken by the tarpaulin itself. This naturally requires a strong tarpaulin. It was improved upon by using the normal cover for an L.S.W.* lorry, and slings to carry the weight of the car. As tarpaulins are seldom absolutely water-tight, it is advisable to stop up the exhaust pipe before wrapping commences. A potato serves this purpose excellently.

Method A.—Using a Tarpaulin.

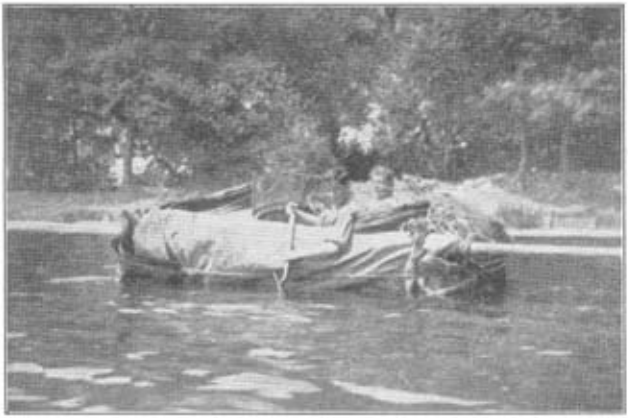
The Austin is placed diagonally at the centre of a 15′ x 15′ tarpaulin, as in Fig. 1. The "side" corners are turned in to the centre and lashed together, the lifting spars being placed in the fold thus formed. The front and rear corners are then turned in, and secured. Finally a lashing is passed right round the whole package below the spars. The photograph illustrates this clearly.

Stores Required.

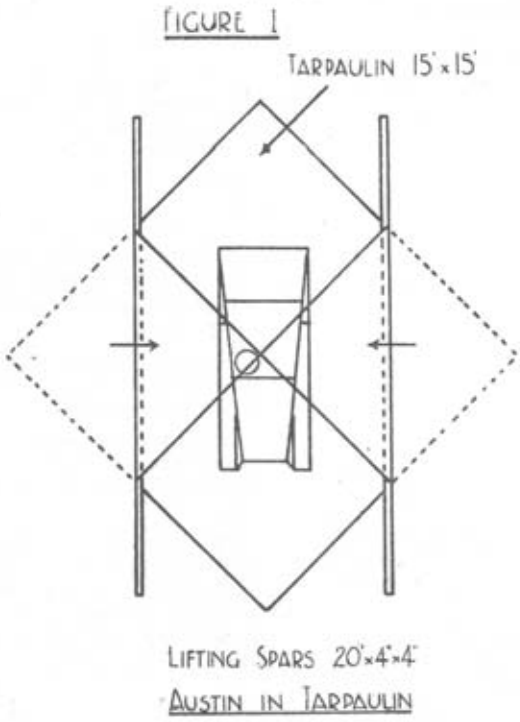
Tarpaulin, strong, 15′ x 15′	1
Spars, stiff (about 20′ x 4″ x 4″)	2
Lashings, 1½″	8
Shovels, R.E. or G.S. (for paddles)	2

The raft so formed is well balanced and floats steadily. It is capable of carrying six men in full marching order, but is more stable and more easily controlled with two only. Shovels make excellent paddles.

* L.S.W. means "Light Six Wheeler." This lorry carries a load of 30 cwt., and is the type of vehicle with which field companies are now equipped.



"Austin 7" floating on Mytchett Lake.



Two rafting expedients.

Method B.—Using the Cover of an L.S.W. Lorry.

The general idea is the same as in the first method, except that in this case the weight of the car is carried by four slings attached to the eyes of the wheel hubs and looped over the two longitudinal spars. The L.S.W. cover forms an outside wrapping but does not carry any weight.

A working party of 1 N.C.O. and 8 Sappers, properly drilled, can make this raft in 2 minutes 20 seconds, and launch it under average conditions in 1 minute 10 seconds with the assistance of 4 extra Sappers. These men are not essential but, if available, assist in carrying.

The following detail of the drill evolved describes the method of construction.

Detail of Drill.

"Fall in in single rank facing stream."	
"Number."	The N.C.O. details the work of each number.
"In double time—Form float."	Nos. 1 to 4 bring up and lay out the lorry cover with the longer sides parallel to the bank. They immediately fold over the four corners, A to B as in the diagram, Fig. 2.
	Nos. 5 to 8 bring up and position carrying baulks and 2 and 4 fold over end flaps as shown in Fig. 3.
	Car man-handled on to centre of cover—Fig. 4.
	Nos. 5 to 8 raise carrying baulks, fix and adjust slings from wheel hub to carrying baulks.
	Nos. 1 to 4 lash carrying baulks across front and rear of car (one lashing in front and one in rear of car).
	Nos. 5 to 8 make a dog's ear at each corner of cover and make fast with a lashing, starting from No. 5 working backwards. 5 to 6, 6 to 8 and 8 to 7, who then makes fast the end of the lashing.

FIGURE 2.

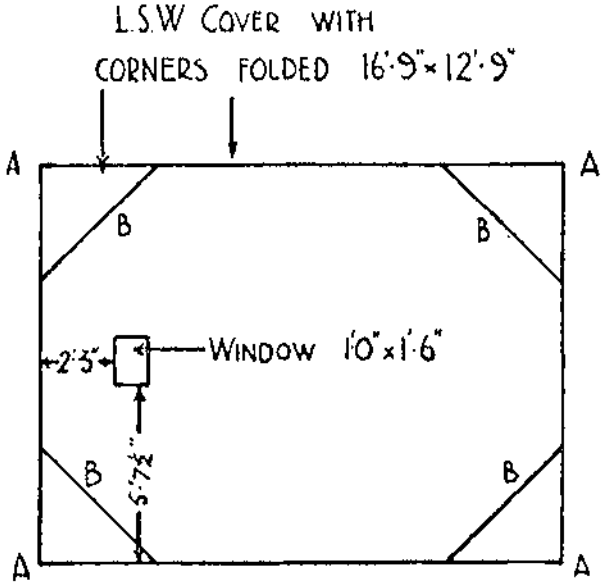


FIGURE 3

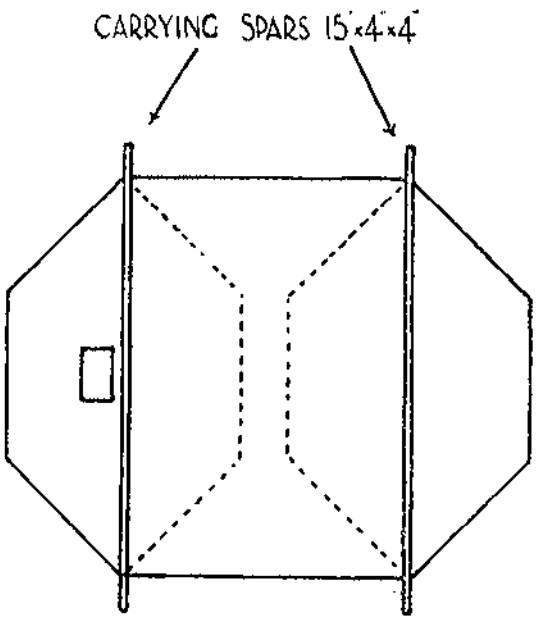
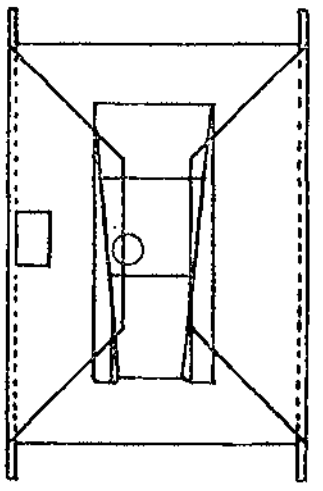


FIGURE 4



Austin in L.S.W. Cover.

Method of Carrying.

Four men on each side, lifting on carrying baulks ; with the extra four men there would be six men on either side.

Stores Required.

Cover of L.S.W. (Morris Commercial) ..	1
Timber, 15′ x 4″ x 4″ lengths	2
Lashings, 1½″	7
Shovels, R.E. or G.S. (for paddles)	2

2.—RIFLE AND EQUIPMENT RAFT.

The chief use of this raft is to keep a man's rifle, ammunition, etc., dry when crossing rivers. It enables men to swim the river unimpeded and put on dry clothes on arrival at the far bank. The raft is easily pushed by one man as he swims so, if the men are suitably detailed in two's, the stronger swimmer can propel the raft, leaving the weaker to swim by himself.

The arms, equipment and clothing of two men are stacked on a groundsheet, as shown in Figs. 5 and 6. The second groundsheet is then placed on top and tucked underneath the rifles. The first groundsheet is laced together with either the spare boot-laces or pull-throughs. It is essential that the packing be carefully done and that particular attention be paid to the corners, which must *not* be folded down in what would be the neatest manner.

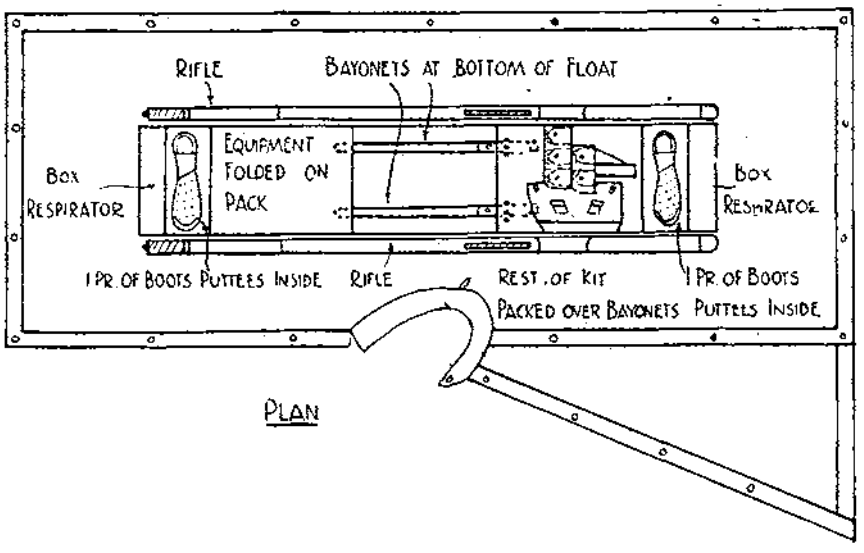
CONCLUSION.

These two expedients were the most successful of several tried at Aldershot during the 1934 training season.

The writer is now toying with the idea of floating a 30-cwt. lorry and will welcome any suggestions, particularly with regard to launching it.

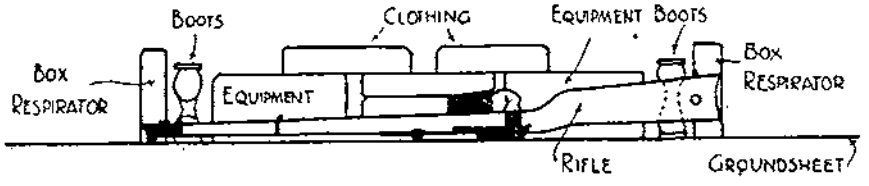
Rifle and Equipment Raft.

FIGURE 5

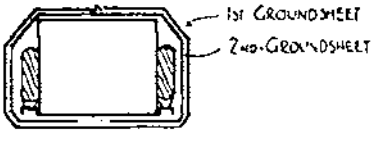


PLAN

FIGURE 6



ELEVATION



SECTION

GROUNDSHEETS LACED THRO' EYEHOLES

PROFESSIONAL NOTE.

A PORTABLE STEEL ROAD.

(Extracted by permission from *The Engineer* of 30th November, 1934.)

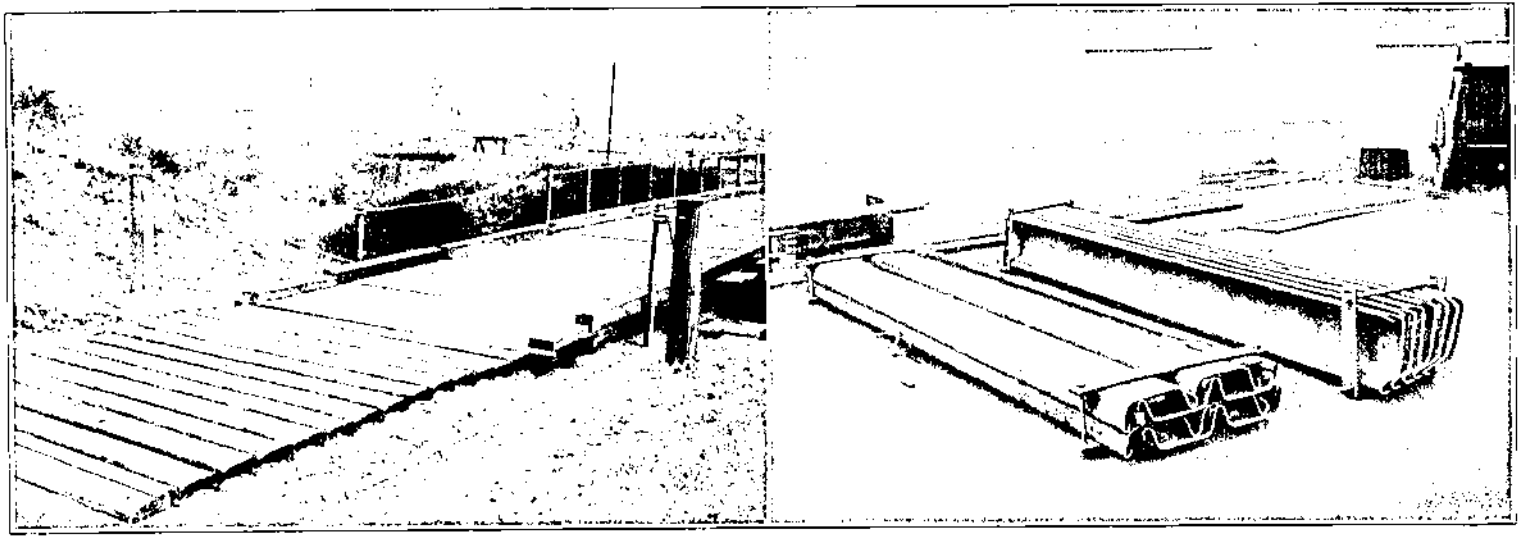
THERE has recently been developed, primarily for military purposes, a form of steel road construction which, it is claimed, can be rapidly laid over soft or marshy ground. The method adopted makes use of a series of pressed steel channels laid transversely to the length of the road. The channels are made so that the flange of one channel interlocks with the adjacent flange of the next. The act of engaging an additional channel with one already in the road is illustrated in one of the accompanying engravings, while in another the channels or troughs are seen laid as an approach road to a temporary bridge.

The channels are made of steel of uniform thickness from $\frac{1}{8}$-in. to $\frac{3}{16}$-in., depending on the nature of the load to be carried. A form of channel provided with a longitudinal flute down the centre for greater strength is being experimented with, and will probably be superior to the type illustrated herewith. It will be appreciated that within reason the softer the surface of the ground the better, because the channels are then more thoroughly supported and less liable to deformation. The normal forms of temporary road construction used by the Army are those of sleepers or timber planks spiked to longitudinal bearers, or, where circumstances are favourable, the "mix-in-place" process. The new steel construction is claimed to possess the following advantages over the former methods:—(*a*) Greater ease and speed of laying. It can be laid by unskilled labour, and in the dark, rain, and mud. It can, moreover, be jointed up just as fast as the material can be off-loaded from lorries. Only a moderate amount of work on the formation is required. (*b*) Economy in transport. The steel construction has an advantage over all other methods except that of "mix-in-place." An engraving above shows the channels "nested" for transport purposes.

In war the construction described may have several uses other than that for traffic roads, *e.g.*, lorry standings, floors for temporary workshops, stores, etc., tracks for mechanical excavators, and similar purposes. The transverse grooves formed by the joints

A PORTABLE STEEL ROAD.

(Extracted by permission from *The Engineer* of 30th November, 1934.)



Steel channel approach to bridge.

Channels nested for transport.

Laying the channels.

A portable steel road 3

between the channels, or, in the later pattern, by the flutes in the channels themselves, are found not to be unduly rough for motor transport vehicles at a moderate speed. In practice, however, they would be filled with dirt from alongside the road in order to provide a smooth riding surface. For curves special channels, wedge-shaped in plan, would be supplied. The commercial applications of the new steel road are thought to lie in purposes analogous to those mentioned above. Contractors ordinarily use old railway sleepers for their temporary roads and standings. This method is, of course, cheaper in first cost than the special steel construction described. The latter can, however, be easily taken up and relaid, and, moreover, for an equal area, shows a saving of 50 per cent. in transportation. The inventor is Major (now Lt.-Col.) H. S. Briggs, A.M.I.MECH.E., R.E., of the School of Military Engineering, Chatham, and the construction is covered by British Patent No. 407,433.

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.)

HISTORY OF THE GREAT WAR.

MILITARY OPERATIONS, FRANCE AND BELGIUM, 1918. THE GERMAN MARCH OFFENSIVE AND ITS PRELIMINARIES.

Compiled by BRIGADIER-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., R.E. (retired), *p.s.c.* Maps and Sketches compiled by MAJOR A. F. BECKE, R.A. (retired), Hon. M.A. (Oxon).

(Macmillan and Co., Ltd., London, 1935. Price: Text 12s. 6d., Maps 5s. 6d., vol. of Appendices, 6s. 6d.)

Adequately to review this volume, although it covers the fighting on six days only, March 21st to 26th, 1918, requires much more time than is available before the next *R.E. Journal* goes to print. It is intended to discuss only some of the points which have been the subject of controversy during the last fifteen years or have been unknown to or insufficiently understood by the man in the street. This volume came to be published out of its turn because the work on it was more advanced and because it was felt that the lessons of the fighting it describes would be more valuable to the training of the Army now than if it was delayed.

East v. West. Sir James Edmonds reminds us that there were Easterners and Westerners in Germany as well as in England. In the British Army there was only one officer of high rank who differed from his chief. From the moment they met for the first time, Sir Henry Wilson encouraged the Prime Minister (Mr. Lloyd George) in his ceaseless efforts to seek an easier and less costly decision elsewhere

than on the Western Front. Even he became a Westerner after he had been appointed C.I.G.S., though possibly only by force of circumstances.

In his opening chapters, the official historian traces the story, from the spring of 1917 onwards, of the discussions bearing on the question whether the soldiers were right in holding that the decision could only be obtained on the Western Front.

Only a few weeks after the outbreak of the Russian Revolution on March 12th, 1917, the C.I.G.S. (Sir William Robertson), a staunch Westerner from the first, presented on May 9th a paper entitled "The Military Effect of Russia seceding from the Entente," in which he said: ". . . We should be prepared for the worst, namely "that the Central Powers will be free to concentrate their forces against their "remaining enemies. . . . It must not be assumed that the whole of the German "Army will be available for operations in the West." Sir William Robertson was "a firm believer in the final success of the Allies, and his final conclusion in this paper was that the results of Russia making a separate peace need not entail disastrous consequences either on the Western Front or in Italy; but he made it clear that for economy in shipping Great Britain must keep her troops as near England as possible, and the maximum number must be made available to assist in holding the Western Front, so that the defection of Russia should not be followed by the collapse of France. This was written before the mutinies among the French troops. He held that we must limit our forces in Eastern theatres to the minimum required for our essential interests and should start by getting away from Salonika as quickly as possible.

No action was taken on this paper by the Government during the next two months and, as it proved, but little for many months after. The German U-boats soon settled the question of economy of tonnage, and despite the adoption of the system of convoy and many other expedients by the Admiralty during the summer of 1917, shipping losses, though diminishing, were still alarmingly high.

Looking back, there was not much wrong with Sir William Robertson's appreciation of May 9th, 1917. Whether the withdrawal of the British contingent from Salonika would have led to that port becoming a base for German U-boats is doubtful. What is certain is that neither this paper nor the recommendations (in a similar strain, but including a suggestion of unified action for studying rapid movements of Allied troops from one front to another) which were submitted by the five Allied Generals—Foch, Pétain, Pershing, Cadarna and Robertson—to the Allied Conference held in Paris on July 25th and 26th, 1917, shook the determination of Mr. Lloyd George to get the direction of the war into his own hands by hook or by crook. His first reaction to the memorandum submitted by the Generals was immediately to urge a heavy thrust against Austria from the Italian Front. General Cadarna dissented, saying it was impossible for him to take the offensive (preparations for which would take time) between October and the following April, presumably because of the liability of sudden floods in the Italian rivers during the winter and early spring which might endanger his communications. The P.M. then urged a knock-out blow to put Turkey out of the war. This, his military and naval Chiefs of Staff had no difficulty in showing the Conference, was impracticable. Salonika was again mentioned, but the Conference broke up with nothing settled as to clear Allied plans for 1918.

Another conference took place two months later, on September 25th, at Boulogne, to settle the question of the extension of the British Front demanded by the French at the instigation of General Pétain, the C.-in-C., who had come to "the conclusion "that to make the situation of the French Army safe should Russia collapse and "Germany bring greatly increased forces against the Western Front—what might "happen to the British he did not consider—he must have a reserve of 40 divisions, "and that unless the British were compelled to take over more of the line, he could "not find them." [At that time Général Pétain was nervous about a German outflanking movement through Switzerland, and as the French Army guarded 580 km.

of the line, and the British Army only 150 km., demanded that the latter should extend its right as far as Berry au Bac, or at least as far as Couchy le Château.] M. Painlevé, the French Premier, backed up his C.-in-C. with a somewhat doleful picture of the situation regarding French casualties and man-power.

The result of this conference was that " the British Government accepted, in principle, the extension of the line held by the British Army on the Western Front, but left the amount of the extension and the time at which it should take place to be arranged between the two Commanders-in-Chief." A highly important agreement between Mr. Lloyd George and M. Painlevé changing the whole system of command, without consulting the C.I.G.S., was not made known to him though he attended the conference. Sir Douglas Haig was not present. This envisaged the immediate organization of an Inter-Allied War Cabinet, having as its permanent executive an Inter-Allied General Staff, over which General Foch (the French Chief of Staff) was to preside. The new Chief of the Inter-Allied G.S. was to have under his orders behind the junction of the two Armies the Franco-British reserves " until such time as " public opinion in England would permit of his being made generalissimo." As British representative in the new organization Mr. Lloyd George proposed to designate General Sir Henry Wilson.

This private agreement was far-seeing as to the need of a generalissimo, but it was hardly fair to either the British C.I.G.S. or the British C.-in-C. to negotiate it behind their backs. Nothing was heard of it until M. Painlevé issued his book, *Comment j'ai nommé Foch et Pétain*, in 1923! Next day Mr. Lloyd George visited Field-Marshal Sir Douglas Haig at G.H.Q. When the question of the extension of the British Front was put to him by Mr. Lloyd George, he at once replied that the Government should set their faces against doing any such thing until the plans for 1918 had been settled, and as regards these plans he was of the definite opinion that the sound policy for the Allies was to assume a defensive attitude everywhere except on the Western Front, which had been accepted by the British Government as the decisive one, and that the necessary troops should be selected and trained for this front. The Prime Minister appeared to think that no offensive would be possible in France and Flanders in 1918. Sir Douglas Haig's view was " Beat the Germans (on the Western Front) and the rest would follow."

How difficult Mr. Lloyd George made it for the British Army to stand up against the German onslaught on the Western Front is another story.

It will be convenient here to interpolate what the official historian has to say later about Sir William Robertson. " He had never been able to gain the confidence of " the P.M.; he had consistently given support to Sir Douglas Haig; he had " constantly urged the organization of man-power on a proper footing; he had " successfully led the opposition to schemes for winning the war in the East; and " he had accurately forecast the dangers of not strengthening the Western Front to " the utmost. . . . . The accurate intelligence gathered as regards the enemy forces " and intentions; the consistent and carefully considered advice which the General " Staff, under his leadership, tendered to Ministers—whose anxiety to hasten the " conclusion of the war, and at the same time to avoid heavy losses, and particularly " to evade fighting Germans, was only natural—coupled with its sound appreciation " of strategical requirements as shown by the subsequent course of events, paved " the way to the victory which was to be achieved later." The success Sir William Robertson achieved in preserving the loyal and helpful relations which invariably existed between the General Staff at the War Office and the G.H.Q's of all Armies in the field without exception, is by no means common in the stress and turmoil of a great war.

" His disability—and in that he does not stand alone among great soldiers, who " deal with brute force and not with rhetoric—lay in his lack of outward grace; the " total absence of any power of persuasion, save a blunt and often rough statement of " opinion; and a complete inability to understand the minds of civilian statesmen,

" his masters, or to make clear to them what he considered the mere elements of " sound strategy, with which every educated man, he thought, must be familiar." The reviewer can add: Patience he had, but not of the Marlborough type; the diplomacy of a Marlborough or a Napoleon was outside his province; but he was straight as a die, the embodiment of common sense, a demon for work, determined as a bulldog; and beneath this rugged exterior he hid the kindliest of hearts and was a constant friend.—(*To be continued.*)

H.B.B-W.

THE WAR MEMOIRS OF DAVID LLOYD GEORGE.

VOL. IV.

(Ivor Nicholson and Watson. Price 21s.)

Mr. Lloyd George has already filled out his Memoirs into four large volumes, and we may expect at least two more. A fulsome account of his work and reminiscences could have been reasonably compressed into less space, but Volume III showed us that his purpose had expanded into attacking others for their share, while Volume IV is very largely devoted to vilifying Earl Haig. Signs are not wanting that very many of the public resent these attacks.

Volume IV begins with a chapter on the Imperial War Cabinet, one of those innumerable Committees with which Mr. Lloyd George delighted to make war. It was doubtless a matter of wise Imperial policy to assemble and consult the leading men of the Dominions, but Councils and Committees are by no means the best agencies for action. The old trouble with the Aulic Council will be remembered. Committees divest themselves of responsibility. War Councils are habitually indecisive. But Mr. Lloyd George took great pleasure in presiding over them and giving them his strategical views.

With a work so concerned with the omniscience of the author, it is not surprising that there are important omissions. We have not been given, for example, by any means the whole account of the Calais Conference of February, 1917, when Mr. Lloyd George appeared in full support of a ready-made plan for placing Sir Douglas Haig and the British Armies under the untried General Nivelle. The Conference was ostensibly called for the purpose of discussing Transportation matters, but these were quickly disposed of, and the C.I.G.S. and Commander-in-Chief were confronted with a proposal which, had it been carried through, would have brought disaster to the British Armies. The opposition, which Sir Douglas Haig was in duty bound to raise to this dangerous plan, did not make for any friendlier feeling towards him on the part of Mr. Lloyd George; but once again the soldier saved the situation.

When Mr. Lloyd George assumed the Premiership in December, 1916, he looked anxiously round for a cheap victory which he might claim as the first-fruits of his new *régime;* and his gaze fell upon the Turks. He very soon persuaded himself that it would require little real effort to finish them off; and so when the Chief of the General Staff was called upon to find reinforcements both for Palestine and Mesopotamia, and watered down the schemes for want of trained men, Sir William Robertson fell under the Premier's displeasure, and thereafter shared with Sir Douglas Haig his odium and animosity. " In Palestine and Mesopotamia nothing and nobody could have saved the Turk from complete collapse in 1915 and 1916 except our General Staff " (p. 1804). " The War Office saved Gallipoli from falling: for two years it protected the feeble garrison of Palestine from meeting its doom. It did what it could to avert the capture of Baghdad " (p. 1804).

There are chapters on Creating the Air Ministry, Stockholm and Mr. Arthur Henderson, Problems of Labour Unrest, Electoral Reform, the Austrian Peace Move

and the Vatican and Kuhlmann Peace Move. In that on the Labour Unrest we are not told much about the method of settling them.

The book contains many statements which can be refuted from its own pages.

Chapter LXIII, which deals with the Campaign of Passchendæle, is the one which will most attract the attention of military readers. In it, Mr. Lloyd George excels himself as a prejudiced critic of strategical affairs. He protests vigorously that he was unaware of Sir D. Haig's plans for the Flanders campaign until June, 1917. Yet he quotes a letter written by Sir William Robertson to General Joffre on December 1st, 1916, which refers to the (Asquith) Government's anxiety about the German naval activity on the Belgian coast and its desire that the occupation of Ostend and Zeebrugge should form one of the objectives of the campaign next year (p. 2117). How could Sir Wm. Robertson have invented this proposal himself?

Further, it is evident that Mr. Asquith and his War Cabinet (of which Mr. Lloyd George was the most active member) were fully aware of the proposals, for the book quotes in full a draft letter dated 21st November, 1916, instructing the C.I.G.S. to consult with Sir Douglas Haig and the Admiralty and report personally to the Prime Minister at an early date what action he considered feasible (pp. 2119-20). This letter stated "The War Committee were absolutely unanimous on the very great desirability, if it is practicable, of some military action designed either to occupy Ostend and Zeebrugge, or at least to render those ports useless for destroyers and submarines. There is no operation of war to which the War Committee would attach greater importance than the successful occupation or at least the deprivation to the enemy, of Ostend and especially Zeebrugge" (pp. 2119-20).

Whether this letter got beyond the draft stage or not, it is clear that Mr. Asquith's War Cabinet, including Mr. Lloyd George, had been discussing a Flanders attack as early as November, 1916. How, therefore, can Mr. Lloyd George pretend that the Cabinet were kept in ignorance?

Sir William Robertson and Sir Douglas Haig therefore had Cabinet sanction for preparing a scheme. Neither of them were under any delusions as to the submarine danger, and if the Germans could be driven off the Belgian coast a great part of that danger would be overcome. Both knew, of course, that such a project had not formed part of the Allied programme agreed to at Chantilly on November 16th, 1916, hence Sir Wm. Robertson's letter to Joffre dated December 1st, 1916. But if the great offensive planned at Chantilly met with success, there would probably have been no need for the Flanders attack. At least, it could wait.

When, at the Conference of May 4th, 1917, at Paris, held to consider the Allied action after the Nivelle failure, Mr. Lloyd George appeared as a stout "Westerner," and urged most vehemently that "we must go on hitting, and hitting with all our might until the Germans cracked," was it not natural that Sir Douglas Haig should take this as favourable to his plan for the Flanders attack? Neither he nor the C.I.G.S. had ceased their preparations for it; but if they had not hitherto disclosed their detailed plans, was there not very good precedent? The French had just suffered a terrible disaster, owing to the disclosure of their plans for the Nivelle attack. There had been altogether too much talk about them. Politicians and political generals had openly wrangled about them, with the inevitable result that the Germans knew them too; and all surprise was out of the question. Was Sir Douglas Haig to run the same risk? He wisely kept his plans to himself as long as he could. If the War Cabinet laid down the policy, it was not for Mr. Lloyd George to decide on the locality of the attack or the form it should take.

So the Flanders offensive was not a hastily prepared scheme, nor was it evolved without the knowledge of the War Cabinet, least of all of Mr. Lloyd George. After the Nivelle misfortune, and in face of the critical state of the French Army following it, it fell to the British Army to keep up the pressure, and prevent the Germans from attacking the French. How narrowly the British Armies had escaped from being involved in the French disaster if Mr. Lloyd George's plan for placing them, lock,

stock and barrel, under Nivelle, had been carried out, will probably only be realized after the publication of Lord Haig's Diaries, but students of existing authorities can already form some opinion.

The pressure was kept up. The pictures painted by Mr. Lloyd George—the horror of the mud, the appalling casualties, the Staff-officer in tears, the eye-wash reports, the crass obstinacy of the Commander-in-Chief—all are painted in to appeal to the emotion, to hide the real issue, and to magnify the transcending wisdom of the man who, some seventeen years later, tells us how he tried to prevent it. No courage is needed to paint the picture. The courage was with him who persevered. Was Sir Douglas Haig alone in sublime ignorance, or indifference to the state of affairs in the Passchendæle area? He knew, better apparently than his detractor, how vital it was to take pressure off the French, and he loyally carried on until winter had made it reasonably certain that the Germans would not attack that year. Was he, the father of the British Legion, indifferent to the sufferings of the troops?

The Passchendæle "swamp" was no swamp until the early and continuous rains combined with the terrific artillery bombardment had made it so. In peace-time, the country was undulating or gently rising from the Ypres Canal. Any area chosen for the attack would have become as much a quagmire under such conditions; nor was the mud confined to our side of the lines.'

Mr. Lloyd George represents the British troops as being disheartened and murmuring after the Passchendæle attack. These men were no more disheartened than were the men of the Merchant Service who put to sea time and again after being torpedoed. The soldiers in Flanders were of the same race as those stout-hearted sailors. Had they been demoralized and had Sir Douglas Haig been as incompetent as Mr. Lloyd George in his rancour describes him, would the troops have stood up in March, 1918, and gone through to the victories of August-November under the same leadership? Confidence in Sir Douglas Haig remained to the end; the confidence of hundreds of thousands of fighting men. This may be strange to Mr. Lloyd George, but he does not know soldiers.

He does not understand the loyalty between soldiers brought up in the same schools of thought and training. He sneers at what he calls the professional "bug," and at the support which Sir William Robertson gave to the Commander-in-Chief. During his political career, he had doubtless never met with so many men imbued with the same ideals as he did when he came in contact with the Army and Navy.

He quotes Mr. Bonar Law as sceptical about Haig's plan (p. 2158), but he has told us in previous volumes that Mr. Bonar Law always was sceptical; that he had gloomy forebodings about every project.

Lloyd George's own envoy, General Smuts, whom he sent to France to report on the situation after the Nivelle battle, came back with the strong conviction that the pressure on the Western Front must be kept up (Vol. III). Yet who was to do this but the British?

Mr. Lloyd George says he received thousands of letters from individuals who took part in the battle, confirming his description of the conditions. This is not remarkable; there were hundreds of thousands of men who took part. The writers—those who were genuine participants—could see no farther than their wretched shell-holes or the dug-outs on the Ypres Canal bank; but it is not from such viewpoints—honestly given though they may be—that statesmen should draw their conclusions. Even while he was Prime Minister, Mr. Lloyd George appears to have encouraged the most junior officers to send him their opinions.

Mr. Lloyd George pretends that, so far from being pinned down on the Western Front by the Passchendæle operations, the Germans were able to find divisions for the attack on Riga and on the Italians at Caporetto. The Germans, of course, found troops for these attacks from the collapsed Russian Front. Reporting a conversation between Count Erdodi (an emissary from the Austrian Emperor), and Prince Sixte, the book says, "At the present time, he (Count Erdodi) warns the

Entente that, out of 80 divisions, Germany has just moved 41 from the Eastern Front to take them to the Western Front" (p. 2014). Again, writes Mr. Lloyd George (p. 2127), "Thus they (the Germans) could and did transfer some of the best and freshest troops to the Western Front and substitute for them divisions exhausted in great battles in the West without filling them up to strength. Their best fighting material and their reserves were thus available for the West." The pressure at Passchendæle is thus acknowledged as effective in one part of the book but denied in another.

Writing of the results of Passchendæle he says, "There is no man to-day, military or civilian, who does not deplore the Flanders offensive of 1917—not merely as a good idea badly bungled, but as a rash and ill-conceived venture impossible of execution under circumstances which must have been known or ought to have been known to those who had planned it. At that date the campaign had its worshippers everywhere. . . . It was extolled in the Press and on the platform" (pp. 2265, 2266). And thus Mr. Lloyd George himself, writing to M. Painlevé on October 30th, 1917, ". . . Despite all the battles won by the Allies this year—and these victories are undoubtedly brilliant . . ." (p. 2385). The campaign so vehemently denounced by Lloyd George in 1934 was considered by him a brilliant victory in 1917.

When he had got over his scare after the Nivelle disaster, Mr. Lloyd George again turned his thoughts towards Italy, and continued to blame the General Staff for their opposition to closing down on the Western Front in order to transfer men and guns to the Italian Front. He lightheartedly forgets all about his insistence in May, 1917, on a policy of continued pressure on the Western Front. Despite his assertions that Foch, Pétain and Micheler were now all in favour of his plans, could he have persuaded the French Government to move a single French division out of France at that time? If the French Army was not in a fit state to make any further attacks on its own home front, was it likely to fight on the Italian front? That French divisions were ready to go there in November, 1917, is a tribute to the recovery which Sir Douglas Haig and his Armies had enabled them to make while he kept the Germans at grips in Flanders; a respite which General Pétain made full use of, and which he gratefully acknowledged.

Mr. Lloyd George quotes Pétain and Foch as being opposed to Haig's Flanders offensive, but in Chapter LI (Vol. III) he has already told us that Pétain and his generals were in thorough agreement, "in principle and in detail" with the British proposal to continue "hitting and hitting with all their might" on the Western Front.

If Mr. Lloyd George had had his way, by the end of 1917, (supposing we had escaped disaster in May), further large British forces would have been committed to operations in Italy, Salonika and Palestine. All would be absorbing large numbers of units on communications, and much shipping; and all quite unlikely to have achieved any of the striking successes with which he always clothed his schemes in advance.

Some spectacular success somewhere or other was what he needed. He delights in superficial comparisons from military history. He recalls Sherman's march through Georgia as an example of passing round a flank, as if there could be any comparison between the weakly-held Confederate lines with the German lines from Switzerland to the sea. Every modern external theatre involved a new front with flank problems of its own, a new G.H.Q. with large numbers of auxiliaries, new lines of communication to guard, new demands for shipping, new exposures to submarine attack, and so on. The war would have been lost in France while Mr. Lloyd George sought victory in Carinthia.

This desire to scatter the forces in as many theatres as would-be strategists with schemes at the Council-table cared to propose became more fully realized after the Armistice, when political demands gained precedence, and the British Army became distributed in most of the countries of South-Eastern Europe and the Near East. But can it be said that they accomplished anything?

Mr. Lloyd George's habitual preference for foreign military celebrities over our own is well illustrated on pp. 2102-2104. He had asked Sir Douglas Haig in September, 1917, for his " considered views as to the military position which would be created in the event of the complete elimination of Russia from the war." " When the promised document arrived it seemed to me to be more concerned with convincing the Cabinet of the importance of prosecuting the Passchendæle offensive and of guaranteeing to the Commander-in-Chief an unfailing supply of men to fill up casualties than it was with the problem which I submitted to him. He repeatedly expressed the most complete confidence that if we fulfilled his requirements as to men the Germans could be defeated whether Russia went out of the war or not." " A few extracts from this inebriated document will be given in the Passchendæle chapter. It breathes the fumes of a confidence stimulated by the constant draughts of carefully distilled reports placed on the table of the Commander-in-Chief . . . such is the intoxication produced by the unlimited power whose slightest expression carries death or mutilation to myriads " (p. 2102). Was ever a victorious Commander-in-Chief so slighted as Sir Douglas Haig was by his own Prime Minister ?

Mr. Lloyd George further quotes Sir D. Haig's conclusion. " But I see no reason " to apprehend failure. Everything goes to show that the power of endurance of " Germany and her Allies is so severely strained that the mere fact of our ability and " evident determination to maintain the struggle to the end may suffice to turn the " scale at any moment. Even if they hold out till next year, and if our success in the " field then is of a limited nature, our enemies cannot face a further prolongation of the " war, with the full development of America's strength . . . to be reckoned with " (p. 2103).

A manly opinion. But Mr. Lloyd George prefers Foch's (which was the same).

" He was a painstaking professional soldier with a sound intelligence of a secondary quality." " He did well in the concluding stages of the 1918 campaign—under Foch's supreme direction " (pp. 2265, 2266). These are some of the remarks of an ex-Prime Minister on the military character of the Commander-in-Chief of by far the largest British Armies ever seen in the field. The test of a man's character lies in deeds, not words.

And so the bitter attack goes on. But the more Mr. Lloyd George assails him, the nobler stands Sir Douglas Haig. He knew that he was being undermined from behind, but his courage never failed him. He knew that he had the confidence of his troops, and every Armistice Day shows the respect and affection which his memory recalls to thousands of the survivors of the Armies he led to victory.

Mr. Lloyd George accuses the Intelligence Staff of cooking their reports so as to encourage the C.-in-C. in his belief that the Germans were crumbling : yet on p. 1560 in Vol. III he has written, " I pointed out that both France and Great Britain were apt to underestimate the measure of success already achieved."

An amusing sidelight in this wordy narrative is the discovery that the responsibility for ordering London churches to ring their bells belonged to the War Office (p. 1839).

Searching round for a possible successor to Sir Douglas Haig, Mr. Lloyd George says, " It is a sad reflection that not one amongst the visible military leaders would have been any better. There were amongst them plenty of good soldiers who knew their profession and possessed intelligence up to a point " (p. 2266).

The Battle of Cambrai is described in Chapter LXIV, and there are chapters on the Caporetto Disaster, the Inter-Allied Council and a Summary of the 1917 Campaign.

Enough has been quoted from this book to show its main character. It rouses curiosity as to how the victorious Commander-in-Chief and the General Staff will fare in the next two volumes.

W.H.K.

AUSTRIA-HUNGARY'S LAST WAR.

Vol. III.

Edited by the Austrian Army Ministry and the War Archives, published by the *Militaerwissenschaftliche Mitteilungen.*

The period covered by this volume is four months only, viz., September to December, 1915. It is a bright and eventful period, full of interest to the reader, Austrian or otherwise. For the former it must have the special charm that things were still going well with the Central Powers. Although the entry of Italy into the war had provided Austro-Hungary with a new foe on a new front, Italy's progress towards Klagenfurt and Trieste was being well held on the Isonzo. Serbia, having cleared its land of the invader, after the crushing defeat inflicted on Austro-Hungarian arms at Arangjelovac in December, 1914, lay so peacefully behind its frontiers that division after division had been withdrawn by the Austrians from their Balkan front to other theatres. Negotiations with Bulgaria, conducted in true oriental style with all the bargaining and chaffering of the *bazaar*, resulted early in September in the acquisition by the Central Powers of a valuable ally. Lieut.-Col. Glaise-Horstenau, in the opening chapter of this volume, entitled "The War-Situation of the Central Powers at the end of August," says that the Entente's offer to Bulgaria was Macedonia; and that in order to get Serbia to agree to this they were obliged to offer Serbia compensation in the shape of Bosnia, Herzegovina, Southern Dalmatia, Syrmia, and the Bacska, also Croatia, if the Croats would opt for them. The winning bid, however, was the offer of the Central Powers, which included the immediate cession by Turkey of Adrianople, and a strip along the Maritza to the Ægean, Eastern Serbia, a part of Rumania and a part of Greece, should these powers enter the war on the Entente side, a loan of 200 million francs, and the co-operation of 12 divisions, German and Austrian, in the offensive against Serbia. Amongst others, terms were included which were hardly flattering to the Austrians. For instance, the Bulgarians demanded that the supreme command against Serbia be held by a German general. To this Conrad, who had reckoned on an Austrian C.-in-C., had unwillingly to agree; and Mackensen was appointed. The Bulgarians were, however, still not satisfied, and a month later, and on the eve of signing, they demanded that Mackensen should receive his orders from German G.H.Q., and not from Austro-Hungarian G.H.Q. To this second humiliation Conrad could not agree, so that matters were at a standstill, until Gen. Cramon, the negotiator, genially produced a solution: orders for Mackensen to be the joint work of German G.H.Q. and Austro-Hungarian G.H.Q., and to be issued to him by the latter. The Germans, however, defeated this arrangement by sending Mackensen his instructions for the campaign direct, on the plea that they were personally addressed to him by the Kaiser. Whatever friction and unpleasantness the Austro-Hungarian C.G.S. had to put up with, the asset of the Bulgarian alliance remained.

The feature affording the most satisfaction to the Central Powers at the end of August, 1915, is still to be mentioned. The great victorious advance of that summer against the Russians had brought the Allies' front 230 km. east of Warsaw to a line running mainly north and south from the Baltic at Riga to Czernowitz, on the frontier of Rumania, at that time neutral. In driving the Russians thus far Falkenhayn had attained his immediate object. The Russians had been hard hit, their losses in men and equipment had been enormous, they had been driven back far towards the interior of their country, and to all appearances had been deprived, for a considerable time, of the power of bringing off any large-scale offensive. By the reduction of the Polish salient the line had become so much shortened as to permit the transfer of several corps to another theatre. The Balkans too were summoning to fresh deeds. In Bulgaria the Central Powers had gained an ally whose co-operation against Serbia would not only permit of an offensive being undertaken against that country, which should open up the long-desired direct railway route between Berlin and

Constantinople, but which, owing to the direction of the Bulgarian advance against Serbia's right rear, threatened to eliminate that country from the war once and for all. Falkenhayn told Conrad on August 3rd that he would look upon the offensive as over, as soon as the Grodno-Brest-Litovsk line was reached. Kovno was taken on the 17th, Kovel on the 24th, and Brest-Litovsk itself on August 26th. Conrad, however, had hoped for more from the drive than Falkenhayn. He considered as still too great the menace to Lemberg of the Russians' presence within two marches' distance of that city; but above all he eagerly desired to utilize the strategic opportunity offered by the diverging retirement of the Russian Western and South-western Groups of Armies. The vast area covered by the marshes of the Pripet and its tributaries had driven between these retreating Army Groups a wedge 150 km. broad, reaching from the Brest-Litovsk—Pinsk railway to the town of Luck. This gap also separated the Germans from the Austrians. Conrad's plan was to roll up the Russians opposite him by outflanking them from the north, *i.e.*, by thrusting between them and the marshes. Falkenhayn stood out against this further offensive for some time, but when Hindenberg urged to be allowed to undertake a similar movement from the German left, on Vilna and Minsk, he eventually gave in and agreed to both proposals. The result, as far as the Austrians were concerned, was the campaign of Rovno, the description of which by Capt. Wisshaupt occupies the next quarter of the book. It consists of a short introduction giving the strengths, positions and the railway conditions on both sides, followed by 120 pages of narrative, and finally a short retrospect. The narrative covers the operations of five Austrian armies in Volhynia and Eastern Galicia during the period of one month, 26th August to 25th September, and subsequent Russian attacks up to October 15th, when the line was stabilized. During this time activity was unceasing, as the narrative shows, and as facts, which can be selected without difficulty, testify. Thus, these five Austro-Hungarian armies out of a strength which was on 1st September, 1915, just under half a million men, lost during the month of September just under quarter of a million men. In view of the appalling percentage of casualties indicated, it is necessary to add that this loss was shared with the reinforcements received during the month, viz., 120,000 men. Thus, also, a division, the 3rd, which had taken part in all the fighting since Mackensen's breakthrough at Gorlice on May 4th, starting at Tarnow, just north of the gap, wound up at Olyka, halfway between Luck and Rovno, 320 km. east of its starting-point. In the five months that had elapsed the 3rd Division covered nearly 900 km., and had a grand total of four days' rest.

The author's subject was often sufficiently thrilling to be easy to write up, but under restrictions as to space he has been obliged to keep to bald narrative. Embellishments have been ruthlessly omitted. We are given in general only the bare facts, an account of the movements and doings of corps and divisions, seldom of brigades. The narrative is relieved by occasional short expositions of the courses open to the commanders, their decisions and plans, with enough of the Russian probable intentions to complete the picture. From such interludes the characters of the leaders begin to emerge. The reader learns something of Conrad and of Falkenhayn, of Brussilow and Ivanoff, and even of their subordinates like Dankl and Böhm-Ermolli. Beyond this the human touch is mostly confined to the unfortunately too often recurring statements that the troops were worn out, and that the weather was very bad. The industry and care which have gone to the making of "The Campaign of Rovno" are much to be praised. It is a misfortune that Capt. Wisshaupt could not be permitted to expand it.

The next great instalment is "The Conquest of Serbia," by Lieut.-Col. Mühlhofer. This appeared originally as the second double-number of Vol. III, when it was reviewed in the *M.M.* by Major-General Kerchnawe, *vide R.E. Journal*, September, 1932, p. 567. Other references to the same campaign occur in *The R.E. Journal*, December, 1933, p. 699, and September, 1934, p. 498. The largest single portion of the book follows in Lieut.-Colonel Brauner's "The Autumn Battles on the Italian

Front," the original appearance of which was noticed in *The R.E. Journal*, March, 1933, p. 186, under the title "The Close of the War Year 1915." It deals with the so-called "political" battles, the 3rd and 4th Isonzo. A final chapter by Lieut.-Col. Kiszling sums up brilliantly and deals with larger questions like the Dardanelles, Verdun, plans for 1916, and the lack of unity of command:

VOL. IV.

An important announcement is made with the issue of this volume. Owing to restrictions of space excluding from the *Official History* all tactical details and a vast amount of other relevant matter in the shape of administrative details, all account of supply and transport services, statistics, many instructive plans, and to a great extent of all critical remarks, the *M.M.* has decided to republish from its pages in pamphlet form articles singly, or two or three together, dealing with such subjects. These pamphlets are accordingly offered to the public—at 3 Austrian schillings each—as supplementary to the volumes of the *Official History*. The first batch of articles here announced were almost without exception noticed in *The R.E. Journal* from time to time as they appeared. In pamphlet form they may truly be regarded as complementary to the *Official History*, which is hardly complete without them.

Vol. IV itself follows on the same lines as its predecessors. It covers the events of the first seven months of 1916. The titles and authors of its sub-heads are :—"The New Year 1916 Battle against the Russians" (Capt. Wisshaupt), "The Conquest of Montenegro and Albania" (Lieut.-Col. Mühlhofer), "Austro-Hungary's Army from the winter in the Carpathians to the spring of 1916" (Major Franck), "The Three Theatres of War up to the middle of May, 1916" (Major-General Zöbl with three assistants), "The Spring, 1916, Offensive against Italy" (the same, with Lieut.-Col. Brauner and two assistants), "The Summer, 1916, Offensive against the Russians"—this takes up nearly half the book—(Col. Kiszling with three assistants), "The South-West Front and the Balkans to the end of July, 1916" (three officers), and "Problems of War-leadership during the first half of 1916" (Col. Kiszling).

The foregoing appeared first in three double-numbers, published at intervals, and were reviewed in the *M.M.* by Major-General Kerchnawe in articles entitled "Before the Turning-point" and "At the Zenith of the Great War" (*vide R.E. Journal*, March, 1934, p. 174, and June, 1934, p. 348). The idea in the reviewer's mind in bestowing these titles on the component parts of Vol. IV was clearly stated to be that the curve of the fortunes of the Central Powers during the war could be likened to the trajectory of a projectile, in that, having reached its culminating point, it begins slowly but surely to descend. The account of the events and campaigns of the period covered by Vol. IV, including as it does the breaking-off of the promising offensive against the Italians from S. Tyrol, and the subsequent disaster at Luck in the great Russian advance, when Brussilow broke through in the first days of June, suggests that a culminating point as regards Austro-Hungary's war-power was reached and passed about the 1st June, 1916. This idea is also strongly brought out in Col. Kiszling's final chapter. Austria's total manhood available for war had been decreasing for some months, as in the early days of the war it had been foretold to our comfort, that it would do, by writers like Col. Maude and especially by Hilaire Belloc. The same applies to the number of her front line troops, which fell from 1,158,000 on April 1st to 927,000 on August 1st. But in spite of the recent disaster to the Germans at Verdun, where their losses ran to a quarter of a million men, and in spite of the reverses to German arms which had been going on for a month on the Somme, it is not easy to concede that the highest point on the curve of fortune reached by the Central Powers during the war coincided with the point from which Austria's fortunes began to decline. The claim certainly furnishes evidence that in the opinion of her best military writers Austria's bolt was shot even before the brilliant campaign of Mackensen against Rumania brought up to a maximum the

amount of territory conquered by the Central Powers and gave them a much-needed accession of war-strength in vast quantities of oil and wheat. It was at this later date (actually on 12.12.16), and not during the period covered by Vol. IV, that the Kaiser judged the right psychological moment to have arrived for sending to the Allies his first offer of peace. The conflicting interests of Germany and Austria which *Oesterreich-Ungarns Letzter Krieg* constantly discloses are illustrated by the high-watermark of their joint fortunes being placed by the one party before Rumania declared war against them, and by the other party after Rumania had been most thoroughly conquered.

Vol. IV, like its predecessors, suffers from compression. As official history it has to take account of all operations, whatever their varying degree of importance. There are thus of necessity included in it many pages descriptive of fighting, of attacks by one side or the other, which had little or no effect upon the course of operations. A popular history, on the other hand, can pay more attention, *i.e.*, give more space, to one operation than to another, depending on their comparative importance, as affecting the issue of the campaign. It may even by such selection be able to give a better understanding of the war as a whole than the official history, which, especially when working under limitations as to space, has to a great extent to be satisfied with giving a faithful description of all events. And yet from so faithful a description the pictures also emerge—of the vastness of Austro-Hungary's effort and of the amount of its suffering; of the difficulties caused by its army being composed of various nationalities, so that many regiments had to be kept carefully away from their home-fronts for fear of there being too great sympathy between them and the enemy; of the difficulties of a war of coalition, especially those which were due to the misfortune of being looked upon as the inferior partner. Further and beyond, the joint authors of this volume have managed to work in an astonishing amount of reading-matter of a more general nature. Each portion of the war dealt with starts with a short résumé of the military and generally of the international situation, and ends with a short retrospect. Other questions discussed are: the consumption of man-power and its replacement; the increase of artillery; the supply of metals, and measures against shortage; the increase of m.g's; changes in the cavalry; the increased scope of technical troops; the manufacture of aircraft; extension of the engineers, and of signals; the value of wireless intercepts; railways; the military administration of conquered territories; changes in tactics, new methods of attack, new principles and experience of the defence in position warfare, fortification, trench-warfare, mountain-warfare; and morale. A book of very good value.

F.A.I.

RIVER CROSSINGS.

BEISPIELE VON FLUSSÜBERGANGEN.

By MAJOR-GENERAL KÖNIGSDORFER.

(Berlin. 1933.)

(Translated by Lieut.-Colonel A. S. Holme, O.B.E.)

Major-General Königsdorfer's *Beispiele von Flussübergangen* is a work of less than a hundred pages. Compressed into these, however, is a great deal of very interesting matter on the subject of the passage of rivers against opposition. Ten operations of this nature, taken from the mobile battles in 1914 and 1915, are described and commented upon by the author.

The crossings he deals with are:—

(1) Meuse, by the 3rd Army (August, 1914).
(2) Meuse, by the 4th Army (August, 1914).
(3) Meuse, by the 5th Army (August–September, 1914).
(4) Oise, during the battle of St. Quentin (August, 1914).

(5) Nethe and Scheldt, at the siege of Antwerp (October, 1914).
(6) Yser, by the 4th Army (October, 1914).
(7) Lower Bzura, by the III. Reserve Corps (December, 1914).
(8) Narew, by the 12th Army (July–August, 1915).
(9) Dniester, by the Southern Army (June, 1915).
(10) Vistula, by the Woyrsch Army (July–August, 1915).

They cover a wide range of conditions and furnish a number of useful lessons which may be grouped, in so far as their bridging aspects are concerned, under two heads, the equipment itself and its tactical handling.

Bridging Equipment.

Want of Assault Equipment.—In 1914 and during the war the Germans possessed no regulation assault bridge equipment. They depended on ferrying with pontoons and on assault bridges extemporised from barrels or floating sacks. The pontoons were too unwieldy for assault purposes. Their unhandiness tended either to tie the troops to sites near roads, which were usually less tactically suitable than the open country or, in the efforts to bring them as near as possible to the site with their transport, to attract attention and give away the impending operation. Equally unsuitable were the extemporised assault bridges. The barrel-pier type was the one that the German pioneers had practised with most in peace-time and that they now used more often than any other form. Its disadvantages were many. The barrels were troublesome to rope together and clumsy to handle. Their weight necessitated a large carrying party to bring along the bridge. Where barrels were scarce, as was apparently the case on the Eastern front, and took a long time to collect, there was usually a shortage of bridges.

The need for a light, adaptable and standard type of assault bridge was everywhere apparent.

Inadequacy of the Amount.—The German divisional bridging train had sufficient material for 115 ft. of bridge and their corps unit for 420 ft. Alternatively, used for ferrying, 108 men could be taken across at a time by the former and 468 by the latter. As there was no specific assault bridge equipment, the bridging train pontoons had, to a great extent, to serve for this purpose as well as for the subsequent bridge. The amounts available were clearly inadequate.

The Oise, Yser and Bzura were the narrowest of the rivers crossed; in the reaches used they were only some 100 ft. wide. The Meuse, Dniester and Narew were about 300 ft., the Nethe some 600 ft. and the Vistula considerably more. At the Yser one divisional bridging train or a quarter of the corps bridging train was just sufficient for bridging the gap. Each of the three divisions of the III. Reserve Corps had, therefore, enough equipment for two bridges. But this made no allowance for spares and there was no separate assault equipment. Casualties to the bridges from artillery fire proved heavy, two of the pontoon bridges being sunk, and it was evident that the four assault bridges per division that had been extemporised were too few.

The 36th Division, crossing the Narew at Rowy, had at its disposal its own bridging train and half the XVII. Corps bridging train. All this equipment was scarcely sufficient for a single bridge, yet it had to provide for the assault crossing as well. Actually, barely half the pontoons were employed for ferrying, the greater number being kept back for bridge construction. Their holding back meant that the ferrying took longer, the building of the bridge began later and the comparatively weak force on the enemy bank ran the risk of being overwhelmed in a counter-attack. During the building of the bridge nine pontoons were smashed by artillery fire and it was only with the help of additional material that the work was completed.

Mobility.—The want of mobility in the horse-drawn bridging trains made itself felt in many ways. At the passage of the Narew the XIII. Army Corps was unable to take advantage of the unexpected retirement of the Russians from Rozan, because

it could not get up its horse-drawn bridging columns in time. The same cause probably explains the numerous occasions on which the Germans accepted the losses in time and personnel involved in a frontal attack, rather than make a détour to find an unoccupied stretch of river.

Many casualties might have been saved the 5th Army on the Meuse and time gained in addition if a corps had been sent round Stenay, which was known to be clear of the enemy. Opportunities were neglected, too, of exploiting the success gained by one formation and opening the river to neighbouring units from a flank instead of letting these units continue with their frontal attacks. Such a manœuvre meant a change of the centre of gravity of the attack as well as additional crossing facilities where the passage had been secured. It called for a higher mobility in the bridging trains and more pioneer personnel than the German forces possessed.

On more than one occasion, but notably at the passage of the Vistula, crossing sites were disclosed prematurely by the too close approach of the bridging trains prior to the operation. This was in part due to the necessity for using the same equipment for both assault and bridge duties, but the poor mobility of the horse-drawn vehicles made it impossible to keep the material at any distance and bring it up at short notice.

TACTICAL POINTS.

Maintaining the Momentum of the Advance. Failure to maintain the momentum of the advance was a noticeable feature of many of the German operations and the evil effects were often far-reaching. The heavy fighting on the Yser, a river only 100 ft. wide, was largely due to the time allowed the enemy to prepare his defence. The Belgians only reached the lower Yser on the 14th October. Four days previously there were seven German cavalry divisions about Armentières, some 30 miles from Nieuport, and on the 15th the III. Reserve Corps was within 6–12 miles of the river. Yet the attack was not begun until the 22nd, by which time the defences were fully completed. The same situation occurred at the lower Bzura, where the crossing ended in failure. Here, if the III. Reserve Corps had been allowed to continue its pursuit of the Russians in the direction of the original attack, it is probable that it would not have struck a planned and carefully worked-out defence of the river as it did half a week later.

At the passage of the Meuse by the 3rd Army the possibility of surprise was given up by a day's delay for the preliminary bombardment. Much was lost and little, if anything, was gained by thus stopping the advance on the 22nd August. In point of fact, a fog, which prevented the opening of fire for several hours, could have been utilized to cover the crossing on that day. As it was the 22nd was a wasted day. Even the reconnaissances that were carried out probably achieved no more than could have been discovered in a short space on the 21st. The positions of defending machine-guns cannot, as a rule, be located by reconnaissance but only by an actual crossing. At the Oise again, the Germans were pursuing. Their cavalry reconnaissance to the river had been checked and Army H.Q. decided, on the evening of 27th August, on the precautionary measure of holding the troops back some distance from the river whilst further reconnaissances were being made to decide whether the pursuit should be continued or whether an attack were necessary to obtain possession of the river. This led to a halt on the Iron Stream and to the loss of half a day.

Surprise.—Attempts to secure surprise by means of feigned crossings were made at the passage of the Narew. One of them, the feigned passage of a regiment of the 25th Division at Binduska, some 2½ miles from a simultaneous crossing of the 36th Division at Rowy, did actually mislead the enemy and had a scattering effect. The feigned crossings by the I. Corps at Modzele and Ostrolenka, on the other hand, were rendered useless by a preliminary bombardment at the real crossing site at Matzki.

The original instructions to the Woyrsch Army for the passage of the Vistula were

for a crossing at Nowo Alexandria but they were changed, after the preparations had been made, to a site downstream of Ivangorod. The prepared but abandoned crossing proved an excellent blind to the actual attempt. In this case preliminary registration of the artillery was forbidden, as it would have betrayed the German intentions. Fire was opened with the unloading of the pontoons and even this seems to have been too early as it merely served to alarm the Russians. It would have been better if the artillery had only opened fire on request or after the enemy had opened fire. Disclosure of the impending attack through premature artillery bombardment occurred on several occasions. During the crossing of the Oise, which was a battle for existing bridges, premature shelling of the villages by some of the divisions gave the enemy timely warning.

Selection of Crossing Site.—A site favours the attacker if the near bank offers plenty of cover as well as high ground for artillery O.P's, whilst the far bank is low and open. Reverse conditions prevailed on nearly the whole of the I. Corps front at the passage of the Narew and contributed largely to the failure of its attempted crossings and to the crippling by artillery fire of the connection with the Matzki bridgehead.

The passage of the Dniester is another example of the difficulties caused by a river valley in which the ground on the enemy side is much higher than on the near side. In this case the Germans had a 2–1 superiority over the three Russian divisions opposed to them. Further, the passage was facilitated by the fact that the advance of the neighbouring armies on the left caused the Russians to leave the Dniester free for the left wing of the army. Nevertheless the passage of the river lasted four days and was full of critical situations. The main reason for the severity of the fighting was the tactically unfavourable nature of the crossing area. The latter was selected as best suiting the Austro-German plan of striking deeply into the flank of the retiring enemy. The loss of time and the numerous critical situations that resulted were such that it would probably have been more advantageous to have made the crossing where conditions were more favourable, even though this area did not fit in so well with the general plan.

In nearly every one of the operations described, crossings made clear of villages and towns succeeded much more quickly than those through them. This was particularly noticeable in the 3rd Army crossing of the Meuse and in the passage of the Oise. In the latter battle, apart from the delays of street and house fighting, there was hopeless confusion in the towns of Guise and Ribemont due to want of space and blocking of the roads, and much of the artillery could not be got through.

Number of Crossing-places.—Shortage of pioneers and bridging equipment was probably the explanation of the many instances of crossings attempted on too narrow a front. At the lower Bzura, in both the 5th and 6th Reserve Divisions, only one regiment was detailed for the initial passage and this, in the case of the former division, on a front of over 1,000 yards.

At the passage of the Narew five divisions made their initial attempt at one place only; every one of them failed.

Zero Hour.—Dawn was the time most frequently chosen to launch the assault. At the passage of the Dniester the four divisions on the right crossed at night, whilst the two on the left fixed their attack for the morning. Critical situations occurred in all these crossings independently of the time of day or night and mainly because the enemy could overlook the valley and was able to stop or greatly delay the continuation of the crossing that had not fully succeeded by day-time.

The crossing of the Yser was begun at dawn and this does not seem to have been early enough because, owing to the limited number of bridges, it was not possible to get all the troops detailed for the crossing on to the far bank before the hostile artillery could see to open fire.

Size of Bridgehead.—The danger of starting the construction of bridges too soon was illustrated on numerous occasions. At the 4th Army's crossing of the Meuse, the 12th Division was stopped for hours by shrapnel fire from using the bridge it had

built at Inor. The trouble was that the bridgehead had not been sufficiently advanced to deny the enemy observation for his artillery. The XIII. Corps of the 5th Army similarly found all its efforts to repair the demolished road bridge at Sassey frustrated by artillery fire so long as the enemy was left in possession of the commanding heights.

Several pontoon bridges were sunk by artillery fire at the Yser crossing. They were built while the bridgeheads that were intended to protect them against artillery fire were still too small, because the harassed infantry ahead were calling for artillery support.

At the Narew, bridges were begun too early with the result that the Russian artillery opened on them and they were shot to pieces. On the Dniester the enemy destroyed bridges by gun-fire in every case in which a sufficient number of troops had not got across and advanced far enough to interfere with the ground observation of the enemy's artillery.

COMMENTS.

Compared with the position during 1914–18 the mobile bridging equipment of the British Army to-day is both more suitable in type and more adequate in amount than it was. Instead of only one form of equipment which, assisted by such means as could be improvised, had to serve all purposes, there is now a range of types designed specifically to cater for the various tactical phases of a river crossing, for the passage first of individuals to seize a footing on the far bank, then for their close-support weapons and vehicles, after this to deal with divisional loads and finally to take all loads normally with the army in the field. In quantity there has been a marked increase. The division of 1914 had with it pontoon equipment for 150 ft. of medium bridge; behind this was the bridging train, an army unit, with 375 ft. To-day a more extensive scale of equipment is provided. The whole being carried in M.T. is much more mobile than the 1914 H.T. equipment and the organization generally is more flexible, allowing the material to be distributed to units and formations to suit the requirements of the particular operation.

But despite these advances, considerable though they are, it is a moot point whether the problem of forcing a river is to-day any easier than it was twenty years ago. If the difficulties of 1914–18 have been provided for there are many fresh ones to be taken into account.

The importance of maintaining the momentum of the advance which was exemplified in nearly every one of the operations described in *Beispiele von Flussübergangen* has become of even greater consequence to-day by reason of the rapidity with which a powerful defence can be established with modern weapons. Delays for the elaboration of plans, therefore, are even less admissible than they were. The only way to avoid them is by making preparations for the crossing before the river is actually reached, leaving only the final details to be settled on the bank. We have better means available to-day for obtaining information of what is ahead and, if the need is foreseen and the necessary measures taken, it should be possible to obtain sufficient details for a provisional distribution of the bridging equipment and an indication of the most likely crossing sites. The more the final reconnaissances can be restricted in scope, the less need be the delay in delivering the assault. Anticipation and all that it implies is clearly a prime function of the modern engineer commander.

Another problem concerns the zero hour for the assault. The traditional time is dawn, but in many of the German operations this was noticeably too late, the subsequent passage of troops during daylight being interrupted and in some instances stopped by artillery fire. In face of modern weapons a daylight passage whilst the enemy has ground observation on to the crossing site cannot be looked upon as practicable; it is likely to be precarious even under air observation. This being so, it would seem that the strength of the force to be passed over during darkness will have to be considerably greater than just the number necessary to secure a footing on the far bank. This calls for a start early, rather than late, in the night. We shall

have to accept night fighting on a serious scale and be prepared to complete our bridges so that troops can be passed over rapidly before daylight. Except under very favourable circumstances it may be difficult to maintain these bridges in the day-time. They cannot be artificially concealed. Smoke, for instance, would merely serve to attract the attention of hostile aircraft. The bridges have to be dismantled and recourse had to rafting which is relatively inconspicuous. There is no doubt that modern methods of warfare point to the increased importance of rapid night bridging by the divisional engineers and emphasize, too, the value of rafting, and in particular of the tracked raft which is not tied to fixed piers for use by day. These points affect both the design of the F.B.E. and the size of the set. Simplicity and lightness are qualities that we cannot afford to sacrifice and the more boats in the set the better.

H.P.W.H.

HEIGL'S TASCHENBUCH DER TANKS.

1935 Edition.

Revised and brought up to date by O. H. HACKER, R. J. ICKS, O. MERKER, G. P. v. ZEZSCHWITZ.

Part I.

(J. F. Lehmann, München. Price 10 marks.)

The 1930 edition of this book, which is a standard work describing the tanks and armoured cars of all nations, was reviewed in *The R.E. Journal* of March, 1931.

Major Heigl died in December, 1930. The work of revising his book and of bringing it up to date has been undertaken by four writers of different nationalities. The work takes up about twice the bulk of the last edition, and now consists of two volumes. The first volume, with which we are now dealing, is in two parts, the first treating of the characteristics of tanks and armoured cars in general, the second describing the armoured cars and vehicles of all countries, in alphabetical order, from Afghanistan to France. The book is fully illustrated. The second volume, dealing with the remaining countries, is expected to appear in the spring of 1935.

Armoured cars are usually divided into two classes, seven tons representing the dividing line between the heavy and the light types. Their main duty is reconnaissance, and the prevention of hostile reconnaissance. Tanks, on the other hand, are weapons of attack pure and simple. They are sub-divided into heavy (over 25 tons), medium (between 25 and 10 tons) and light tanks (under 10 tons).

Armoured cars are capable of high speed, but are practically restricted to roads; tanks will travel across country, but they must necessarily be comparatively slow. The manufacturers' task has been to make armoured cars and lorries more suitable for travelling across country, and to increase the speed of vehicles designed for cross-country work. This has led to a continual struggle between wheels and caterpillar tracks.

An ordinary car chassis can be utilized for military purposes, provided it is converted to run in reverse at full speed, and has a duplicate steering gear. The Swedish Landsverk armoured car M.185, built on a Ford chassis, is a type of this form of construction. There are a number of vehicles of the six-wheel type capable of moving across country within limits. Others are fully designed for cross-country work, *e.g.*, the French "Laffly" and "Berliet" cars, the British "Scammell," "Guy" and "A.E.C." cars, and the American "Christie." The latter has a chain in addition to its eight wheels.

There is an intermediate type with a caterpillar track in place of the hind-wheels. Examples of this type are the Citroën-Kégresse cars of the French motorized infantry (*dragons portés*). Their main advantage is that they can be constructed out of the ordinary chassis, but they are difficult to steer, and the writers think that they have

reached their maximum stage of development. The French have now gone over to the Carden-Loyd pattern.

Another type is the car with interchangeable wheels and caterpillar tracks. Of this, the Swedish "Landsverk 30" and the "medium Vickers Mk. II" are examples. The drawback to this type is the excessive width of the vehicle, and the obstruction to the view by the wheels when fully raised.

Finally, we come to cars with caterpillar tracks pure and simple. These vehicles have been developed very considerably since the war, both as regards speed, springing and wear of the chains. The life of a chain is now ten times what it was during the war, but it is still only a tenth of the life of a modern pneumatic tyre. The speed has been increased to 30 km./h. for medium and 50 km./h. for light tanks. The illustrations show us Japanese, Swedish, British, French and American types.

As regards engines, it is remarkable how their power has increased in recent years. Formerly Christie used his own motor-car engines of 90 to 100 h.p. His next development was the use of Liberty aeroplane engines of 343 h.p. and, finally, he introduced Hispano-Suiza aeroplane engines of 760 h.p. Air-cooled engines are increasing in favour. Petrol-electric drive, Diesel and steam engines have only a very limited scope.

With regard to armour, the electric welding of armour plates has permitted an appreciable saving in weight; on the other hand, in the latest Christie type, riveted plates have been reverted to, possibly to give better facilities for repair. Gun-fire is provided nowadays almost entirely in revolving turrets. Visual arrangements have been improved almost beyond recognition; the open slit is quite a relic of the past.

The writers consider that in future armoured vehicles will develop on five different lines:—

(1) High-speed reconnaissance cars for cross-country work, with four- or six-wheel drive.
(2) High-speed, cross-country fighting cars, with multiple-wheel chassis, with auxiliary chains or wheel and caterpillar-track drive.
(3) Small high-speed, well-armed tanks, with caterpillar tracks, for independent action against infantry and heavy infantry weapons.
(4) Larger high-speed tanks, to support the smaller ones in attack and to act against anti-tank guns.
(5) Slower tanks, with caterpillar tracks, either small and lightly armoured, or large and heavily armoured, for working in close contact with infantry (so far confined to France).

A brief reference is made to self-moving gun-carriages and to tractors.

Nearly 300 pages of the book are devoted to the armoured cars and tanks of different countries. 145 pages are devoted to Great Britain and 117 to France. Each type is fully described and illustrated, and the photographs and drawings are clear. A.S.H.

DIRECT CALCULATION OF COMMON STRUCTURES IN REINFORCED CONCRETE.

By GENERAL V. E. PALUMBO.

In one volume of 302 pages, with three main tables, and 11 subsidiary tables.
(Published by the *Rivista d'Artiglieria e Genio*. Price, Lire 30.)

General Palumbo has compiled this book with a view to assisting engineers and others engaged in the design of reinforced concrete structures. By utilizing his tables it will not be necessary, first, to assume a given section of beam, and to take its weight into account in the subsequent calculations. In the ordinary way, the consideration of the weight of a beam of assumed dimensions means that several attempts have to be made, by trial and error, before an accurate result can be obtained.

Part I contains notes on the characteristics of typical structures, on the conditions of loading, on external stresses, etc.

Part II deals with square or round columns, both under simple compressive stress and eccentrically loaded. For the former, two tables have been worked out, connecting the percentage area of steel reinforcement with the value of the co-efficients to be adopted in the resolving formulæ. For eccentrically loaded columns, Rankine's formula is converted into two others which give the required dimensions, without the necessity for trial and error.

We next come to beams, *i.e.*, slabs, simple beams, and combined beams and slabs, whose dimensions we can obtain without preliminary assumptions. The tables are so arranged that the results can be obtained rapidly by logarithms. They are worked out assuming a ratio of 10 to 1 in the moduli of elasticity of steel and concrete; and the depth of beams is taken to be twice their breadth, although other proportions can be worked out equally well.

The formulæ are extended to include slabs supported on all four sides.

Examples are given of each type of structure, showing the use of the formula and the method of working out the calculation in each case.

Part III is devoted to the detailed working out of calculations in a few examples.

In Part IV the fundamental formulæ are quoted, as well as the new formulæ that have been deduced from them in the text. Part V is a collection of the eleven original tables prepared for numerical calculations.

Table I gives the value of the coefficients appearing in the fundamental formulæ for calculating the useful thickness of slabs, the area of the steel reinforcement, and the distance of the neutral axis from the compression edge. Four other tables follow dealing with axially loaded columns. Tables V to VIII deal with beams under transverse stress. Table IX helps to calculate the width of strips of equivalent area in which the shear diagram is divided, to determine the reinforcement. Table X gives the baricentric distances of such strips from the centre of the beam. Table XI gives the combined area of 1 to 10 round steel rods, varying in diameter from 4 to 45 mm.

The tables and nomograms worked out by General Palumbo should be of great value to engineer officers and others engaged in designing reinforced concrete structures, and should save a considerable amount of time in calculation—that is, of course, in countries where the metric system is in use.

A.S.H.

A STUDY OF THE STRATEGY AND TACTICS OF THE MESOPOTAMIAN CAMPAIGN, 1914–1917.

By Lieut.-Colonel A. Kearsey, D.S.O., O.B.E.

(Gale & Polden, 5s. 6d.)

The author, in his introduction, points out the value of a study of this campaign to students of mobile warfare and minor tactics in an undeveloped territory.

He takes the reader, in some detail, from the pre-war policy and inception of the campaign to the capture and consolidation of Baghdad and shows how General Maude countered the effects of the Russian Revolution and dealt with the Turkish XIII. and XVIII. Corps north of Baghdad. The last five chapters deal with illustrations from the campaign of the principles of Economy of Force, Surprise, Security and Offensive Action.

The details of the minor tactical operations are difficult to follow on the maps provided, particularly those in the vicinity of Kut. The author would have greatly added to the value of his publication if a good map of the Kut area had been included.

C.D.M.

THE INFANTRY EXPERIMENT.

By MAJOR-GENERAL H. ROWAN ROBINSON, C.B., C.M.G., D.S.O.

(William Clowes. Price 3s.)

The experiment to be carried out by the 6th Infantry Brigade at Blackdown is given as the *raison d'être* of this publication.

The author disagrees with the trend of the experiment and puts forward a plea for a reorganization of our infantry, which involves a complete change in our military policy and military organization. His main arguments are based on the impotence of infantry in the attack and on the vulnerability of present-day armies to air attack in civilized war. He wishes, therefore, to relegate infantry to defensive operations only.

He would scrap the Cardwell System, thank it for its services and bow it out. He leaves it to the Adjutant-General to find a substitute and to overcome the recruiting and other difficulties inherent in the maintenance of two separate armies—a home service one and a foreign one.

He argues that the British field force should be based on mechanized forces; that Great Britain should refuse to take part in any form of position warfare on the Continent and that our military efforts in support of a Continental ally should be confined to this mechanized force, a strong air force and a powerful fleet.

With this in view he would reorganize the present Line and Guards battalions at home into two infantry (Guards) brigades, two infantry (Line) brigades and two mechanized brigades. In war, the four infantry brigades to double themselves.

One infantry battalion to form an integral part of each mechanized brigade and to be transported in armoured lorries. The infantry brigades to be transported in unarmoured lorries and their chief tasks to be the protection of aerodromes, tank harbours and so forth. Infantry weapons are to be limited to the rifle, portable light machine-gun, and, until a portable anti-tank gun is available, sixteen guns of the pom-pom type to be carried in lorries by brigade headquarters.

All first line transport to be pooled at brigade headquarters and to be decentralized when required.

He reluctantly concedes to the infantry, operating with mechanized forces, the task of forcing a river and seizing a bridgehead; but he would have them use improvised bridging equipment.

It is interesting to note, however, that, in spite of all the author's arguments against the employment of infantry in the attack, he would still leave them with this, the most difficult of offensive operations.

The infantry of the Territorial Army to be organized as follows:—

(*a*) Twenty battalions to relieve regular garrisons on our line of communications to the east. The organization of these battalions to be similar to the Home Service regular infantry.

(*b*) Thirty battalions for line of communication duties in the theatre of war. Anti-aircraft, anti-tank weapons and heavy machine-guns to be included in the organization of these units.

(*c*) Two infantry divisions, ready to relieve regular troops serving in India for service elsewhere.

(*d*) Certain battalions to be mechanized.

He proposes that the sixty-four line battalions and one guards battalion serving abroad should remain, except that one mechanized brigade and one or two battalions of heavy machine-guns should be formed in India and one mechanized battalion in Egypt.

He would reorganize the remaining infantry in India into "Hitter" battalions armed with small-bore rifles and light machine-guns. "Supporters" to include guns, tanks, heavy mortars and possibly heavy machine-guns.

He paints several pictures in his chapter on " Imperial Policing and Small Wars " to show the advantages of such an organization to India and for mountain warfare operations in particular.

The role of the " Hitters " is to be similar to that of the present-day " Scouts," but they are to be provided with information and supplies from the air. Night work is to predominate and the minimum independent " Hitter " force will be the platoon.

" Air Supply " may theoretically be an attractive idea; but in practice, the Air Force could not guarantee such supply under conditions prevailing on the North-West Frontier. Conditions here cannot be compared with those in Iraq. Moreover, the components of mobility are activity and the power to hit. The Scouts, as at present organized, are very active; but they lack adequate hitting power to overcome serious tribal opposition. The " Hitters " may suffer from the same disadvantage and be unable to hit.

The author recognizes that the defence of India (internal disorder and external aggression) is one of the main military problems of the Empire. Some of the arguments he puts forward, against the necessity for a general reserve at home ready to meet this problem, are not convincing; such as, for example, that Australia and New Zealand would be prepared to provide reinforcements in defence of India.

In one instance the author urges our military leaders not to take counsel of their fears, but to have a good think and then take up a definite line in what appears to be the soundest direction. In another instance he dashes to the ground his own high ideals by stating, " Moreover, the views here expressed may be wholly unsound " and a reversion to the methods of 1918 may be found necessary," and yet he disagrees with the proverbs " Slow and sure " and " Look before you leap." It is statements such as these that make the reader wonder if the author wishes to be taken seriously.

Many of his suggestions, even if desirable, would appear to lead to an impossibly complicated organization. He seems to have underestimated the importance of the principle that, " Our organization must be suited to average rather than to " exceptional conditions and be based, as far as possible, on a common standard " throughout the Empire." The reader can judge for himself the difficulties that arise once one fails to give this principle due consideration, and he can decide whether or not the author's policy is better than that of the War Office, which is admirably explained in a pamphlet *Notes on Infantry Experiments in* 1935.

C.D.M.

THE ROYAL ARTILLERY MESS, WOOLWICH, AND ITS SURROUNDINGS.

By Lieut.-Colonel A. H. Burne, D.S.O., R.A.

(W. H. Barrell, Ltd., Portsmouth. Price 2/6+6d. postage.)

All those interested in the Royal Regiment (and who in the Service is not?) will welcome this book. Colonel Burne's researches have covered a wide field and the reader feels that nothing of importance can have escaped him. But it is noteworthy that, even in this case, where conditions were most favourable for continuity, there is a gap of thirty years, for which no records of mess meetings are preserved; that the only complete set of mess rules, other than the present one, is for 1822; and that the history of the early days of the Mess depends on a notebook and sheet of foolscap, written by Major Thomas Scott, Mess Secretary, between 1832-4, and somewhat miraculously preserved by two butlers. This points a moral for all mess committees.

Colonel Burne commences by tracing the origin of the connection of the R.A. with Woolwich through the Dockyard and Arsenal, and fixes the occupation of the Mess in the present barracks in 1777. It was originally on the site of the R.A. Theatre. The present Mess, consisting originally of the mess room and a small ante-room

(now the outer hall), was built in 1803 and the annexations, alterations and extensions which have resulted in the present building are described, while other chapters deal with the mess plate, portraits, regimental institutions and the surroundings of the Mess. Many interesting sidelights are thrown on Army and mess life of the last century, and the militarization of the Mess from a purely voluntary and social arrangement to an institution of a compulsory nature, the history of "Regent's Allowance," the introduction of mess uniform, and the struggle for permission to smoke in mess, are all touched upon. But the reader will probably find most interest in the history of the Mess in roughly the four middle decades of last century. Woolwich was then the chief military centre of the country, the site of many Royal Reviews and similar displays for foreign notabilities. These were held on the Common, and included artillery practice with live rounds to the considerable danger of spectators and travellers on the Dover Road (on one occasion it is recorded that "only one person was injured"). These reviews were followed by lavish *déjeuners* and dinners at the Mess, while "publick dinners" for the Master-General of Ordnance and other high officers were common. At this period, the R.A. Mess was a national institution of high importance, and to be an Honorary Member was a high distinction, often solicited by notabilities but carefully guarded, though we note with pleasure that it was always accorded to the local Royal Engineers.

Those days are long past. In the words of an R.A. officer quoted in the book, "The Staff College and the Abolition of Purchase have ruined the Army"; hard training now occupies more of our time than the princely entertainments of eighty years ago, and the rise of Aldershot and other centres has drawn the bulk of the Regiment away from Woolwich. But the Headquarter Mess has still immense prestige, and in Colonel Burne it has found a worthy historian. May we hope that his example will stimulate someone to compile a similar history of our own Headquarter Mess?

E.V.B.

GORDON.

By DR. BERNARD ALLEN.

(Duckworth, 1935. No. 45 of "Great Lives" Series. Price 2s.)

In this short biography of Gordon, Dr. Allen has condensed his *Gordon on the Sudan* (1931), his *Gordon in China* (1933), and other researches. The result is a book of only 140 pages which can be perused in an hour and a half and costs only 2s. It can be recommended to all those who have not hitherto studied Gordon's career and whose interest has been awakened by the fiftieth anniversary of his death.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(*October*, 1934).—1. *Motorisation et cavalerie.*

General Rouquerol points out, not without regret, how motorization is gradually ousting cavalry from the organization of modern armies, and invites attention to the importance of adjusting our ideas to modern conditions.

Great Britain, the United States and France are creating large units, entirely motorized, to replace independent cavalry divisions. In Great Britain the tank has become a separate arm working in collaboration with the other arms, but not depending upon them. The German and Italian armies prefer collaboration of motorization and cavalry, but their cavalry is being equipped with an increasing number of motor vehicles.

The writer considers that changes should be made gradually. Cavalry is very vulnerable to gas attacks, but motor vehicles, being tied down to roads, are exposed to view from aeroplanes, and their movement may be restricted to the hours of darkness. A column of motor vehicles can be completely held up by a demolished bridge. Such blocks, of course, have always been liable to occur with an army on the march, but they were of less consequence when troops moved more slowly.

Signalling is of paramount importance nowadays, and, in the case of troops on the move, can only be done by wireless. The duties of engineers are more important than ever.

2. *Le nouvel armement de notre artillerie.*

Major Gonard gives a description of the new Swiss mountain gun that has been turned out by the Bofors factory in Sweden. The old Krupp mountain gun had defects that it was not possible to remove by improvements, and it was necessary to design an altogether new gun.

Some of the main points about the new gun are the following: The calibre is 75 mm., so that the ammunition is interchangeable with that of the field-gun. It has five different charges, which allow varying kinds of trajectories, from a short curved one to a maximum long range of 10,500 m. (about twice that of the old gun). This maximum range is attained with an angle of elevation of 42°, and a long projectile. The gun has a lateral field of fire of 6°, and can fire at any elevation between − 10° and + 50°. It is not necessary to dig a hole for the trail at the maximum elevations. For pack transport the gun forms nine mule loads, of which the heaviest is 110 kg., and the lightest about 100 kg. All the loads fit on the same pattern of saddle. The gun can also be drawn on wheels by a team of horses and mules, in tandem. This can be done in two ways: the whole gun may either be drawn by three horses, or it may be divided in two, each half being drawn by two horses. The latter arrangement will usually be adopted on mountain roads.

The new type of mountain gun has been settled, but nothing definite has been decided about the heavy field gun. It is probable that the latter will have a calibre of 105 mm., a maximum range of 17,000 m., and that it will be motor-drawn. The choice appears to lie between the Schneider and Bofors models.

(*November*, 1934).—1. *Le métier de chef.*

Lieut.-Colonel Mayer quotes from various books on the business of leadership. He compares leadership in civil life with that of an army commander. The qualifications for both are very similar. Command is a profession, subject to definite rules, which can be learnt. It is not necessary for a commander to have a perfect knowledge of tactics, or to be a technical expert, though it will doubtless be of help to him if he possesses these qualifications.

Napoleon was not above resorting to trickery to impress people with almost supernatural gifts that he did not really possess. He was not, however, afraid of admitting his incompetence in manœuvring to his generals. As a gunner, he was ignorant of infantry work. A comparison is made between Napoleon and Moltke, both great leaders. The former was constantly with his men on the battlefield and in bivouac, giving them encouragement, and following every detail of the battle in person. The latter, cold and silent, kept away from the troops, whom he did not know, and did not trouble to know. He did not follow the action on the ground, but waited, at a distance, for the battle to develop, and for news of victory or defeat.

Silence, in a chief, may be the sign of a strong will. A man in authority may refuse to discuss matters with his subordinates. Moltke, Kitchener, and Joffre were silent men: on the other hand, Napoleon and Foch were both freely talkative.

2. *Ravitaillement et administration des colonnes de train.*

Captain Buxcel discusses the question of the administration and revictualling of the baggage-train, with special reference to a mountain brigade, which consists of two infantry regiments and a mountain artillery group, together with parks and convoys. The administration of such a column is entrusted to a commissariat officer, attached to the brigade staff, who will have, to assist him, two regimental quartermaster-sergeants. In the latter part of the article the writer deals with the question as affecting the individual regiments and the artillery group.

3. *L'armée et les fronts.*

Lieut. A. S. gives his views on the subject of the army being dragged into political questions.

(*December*, 1934).—1. *Le passage de la Marne par la 200e division d'infanterie allemande, le 15 juillet 1918.* By Colonel Grasset.

On the 14th July, 1918, the 6th French Army, under General Degoutte, was holding the Marne between Château-Thierry and Troissy, a front of 35 km. It consisted of four army corps, and four divisions not attached to corps. One of these was an American division.

The French plan was to hold the river line lightly, with four divisions, but to arrest the enemy's attack, if he should succeed in forcing a passage, on the heights south of the Marne, and then, at a suitable moment, to counter-attack the enemy with the Marne at his back.

The German plan was to hold the river line with two divisions, and to attack during the night of the 14th/15th with twelve divisions, *i.e.*, a preponderance of 3 to 1. In guns the Germans had a preponderance of 5 to 1, with a practically unlimited supply of ammunition.

The Allies had expected an attack for some time, since it was known that out of the 206 German divisions on the western front, 72 were available in rear, ready to attack. On the 9th July, the French high command were aware that an attack was impending, and, during the next few days details were obtained from prisoners of the plans for attack, and of the zero hour (1.10—German time—on the 15th). Marshal Foch was able to make his plans accordingly.

The writer gives a detailed account of the attack, launched by four German divisions, on the front held by the 51st French division. He deals specifically with the attack made by the 200th German division, and the ten attempts made by this division before it succeeded in crossing the Marne. The 51st division was subjected to a most terrific artillery bombardment, but put up a gallant resistance, in the course of which it lost 115 officers and 3,800 men out of 5,000, and 37 guns out of 72. The upshot was that the first position of resistance was lost and that the enemy advanced 5 km. south of the Marne.

The result was, however, not decisive. A second position had been prepared on the high ground further back, but had not yet been wired. The allied artillery and air-force saved the situation. They concentrated a bombardment on the Marne bridges, destroying some, and making it impossible for guns or ammunition to get

across. A timely French counter-attack on the 18th July drove the German divisions back across the Marne, and thus began a series of allied successes which culminated with the armistice on the 11th November.

2. *Le château de Colombier.* By Rnr.

An account of the restoration of the historic castle of Colombier by the painter L'Eplattenier, thanks to the initiative of Colonel de Loys.

3. *Comment juger les réfractaires?* By F. Clerk.

The writer makes suggestions for the treatment by military courts of men who refuse to serve in the army. He pleads for greater leniency to genuine conscientious objectors, and suggests greater use of the punishment of exclusion from the army.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*October*, 1934).—1. *Possibilità dell'artiglieria divisionale.*

Colonel Berardi refers to the changes that have taken place during the last two years in the ideas about the employment of divisional artillery. He lays stress on the importance of close contact between divisional and corps commanders and their artillery commanders. In an attack in mobile warfare there will be three phases, which he calls, respectively, the megaphone phase (which begins as soon as all the guns are in battery), the telephone phase (in which group and battery commanders have pushed forward, and can see the targets more clearly), and, finally, the phase of preparation for fire manœuvre.

2. *Concetti di costruzione e di manovra per il gittamento di un ponte volante.*

General Maglietta, who had experience in the construction of extemporised suspension bridges on the Austro-Italian front during the World War, describes a form of bridge that he proposes for adoption as a standard type. The details of the bridge are as follows:—Maximum span 200 m., width of roadway 3·5 m., dip of cables 5 m., maximum concentrated load 10,000 kg., diameter of cables 37 mm., number of cables 10, breaking strain 97,000 kg., factor of safety 1/3.

The roadway is laid on top of the cables, the planks being clipped to the cables at intervals. The anchorage at each end consists of two trollies clamped down to wooden platforms, and furnished with drums round which the ends of the cables are wound. These trollies are buried in trenches 4 m. deep, and are weighted down with 300,000 kg. of excavated material.

The towers are a framework of tubular steel uprights, in sections, with wooden horizontals. The roadway is stiffened laterally by means of steel wire windguys. The ramps in the approaches can either be made of earthwork or by means of trestles that form part of the bridging equipment. If all the earthwork has been completed beforehand, it is estimated that a bridge could be erected in twelve hours.

The bridge, as designed, will carry either (1) infantry in file, or (2) a concentrated load of 10,000 kg., or (3) cavalry in single file, or (4) a column of 4-horse wagons at 20 m. interval. The cost of steel and woodwork is estimated at 170,000 lire.

3. *Sull' approssimazione dei dati desunti dalla preparazione balistica.* Captains Cavicchioli and Morricone.

4. *Calcoli relativi a ricoveri antigas muniti di impianti di filtrazione (ricoveri filtranti).*

Captain Giardino explains the theory of ventilating anti-gas shelters, and works out examples to show the amount of fresh air required to keep shelters ventilated during a gas attack.

5. *La produzione di armi e munizioni in Germania ed Austro-Ungheria nei primi due anni della guerra mondiale.*

General Bollati gives us details of the out-turn of arms and munitions in Germany and Austria during the first two years of the war. Germany had the advantage of possessing a large number of private firms as well as Government munition works. It is remarkable, perhaps, that in connection with the supply of arms, the greatest

difficulty was found in getting sufficient rifles to meet the expansion of the army. These had to be supplemented by rifles of obsolete pattern. The supply of machine-guns was maintained more easily. In connection with artillery, it was found difficult, at first, to keep pace with the increased demand, but big captures of field-guns soon relieved the strain. By a remarkable piece of improvidence, Germany had no mountain guns or howitzers in peace time, and these had to be constructed at short notice when the war began. As regards explosives, the shortage of prime materials, such as sulphuric acid and nitric acid and other essentials, might have had disastrous results for Germany if the fall of Antwerp had not released a large supply of material, and if the chemical industry had not come to the rescue with important discoveries.

Austria was more severely handicapped than Germany at the beginning of the war, particularly as regards rifles, but, in contrast to Germany, it was well provided with mountain artillery. With regard to machine-guns, field and heavy artillery and munitions, there was a great shortage at first. As in Germany, there was a shortage of raw material, such as nickel, copper, and lead. By the occupation of Serbia the Austrians were able to make good the shortage.

General Bollati points out the great advantage that accrued to the Allies by the entry of Italy into the war. Such a large proportion of munitions was required for the Italian front that the Austrians were compelled to use the strictest economy on the Russian front.

6 *I combustibili per i moderni motori per autoveicoli comunemente denominati "Diesel veloci."* By Lieut.-Colonel de Braud.

The high-speed Diesel engine has a cycle that differs considerably from that of the original low-speed Diesel engine worked by heavy oil, and has much in common with the motor-car engine. One of the most important problems that the constructor of a high-speed engine has to face is the selection of the most suitable fuel readily available in the market.

Colonel de Braud describes the different phases of the process of combustion, and the results of the researches made by Le Mesurier and Stansfield into this question. He then deals with the characteristics, chemical and physical, of various kinds of oil, and describes the experiments made by Pope and Murdoch in connection with the Co-operative Fuel Research in the U.S.A.

The article concludes with a list of the properties that a fuel suitable for a high-speed engine on the injection principle should possess.

(*November*, 1934).—1. *Nuove necessità dell' artiglieria divisionale.*

Colonel Biondi-Morra endeavours to show how the duties of divisional artillery have been affected by the changes of organization recently introduced in the other arms. The infantry of all modern armies is provided with an increased number of machine-guns, and also with "accompanying artillery." The introduction of these weapons throws extra duties on the divisional artillery, as does also the presence of tanks on the battlefield. A list, giving the strength of the divisional artillery in certain foreign armies, shows that the proportion of artillery to infantry is higher in France, Great Britain, Germany, and Yugo-Slavia than it is in Italy.

Under the present organization each army corps has at its disposal a group of light motorized artillery for the reinforcement of divisions. The writer considers that the strength of this light motorized artillery should be increased to a regiment.

2. *La fortificazione campale in copertura.*

Major Montanari discusses the question of filling in the gaps between permanent works on the frontier with suitable field fortification. It is important that a programme of the necessary field work should be worked out carefully in peace time. The article is illustrated by five sketches of typical groups of strong points.

3. *Contributo dell' osservazione e della fotografia aerea alla preparazione topografica del tiro.* By Lieut.-Colonel Liuzzi.

Aeroplane photographs have certain inherent defects: objects at a greater distance from the camera come out on a smaller scale than those nearer the camera, and the

fitting together of a mosaic of photographs is a matter in which absolute accuracy is impossible.

Lieut.-Colonel Liuzzi shows how the artillery command can best make use of aeroplane photographs, firstly, when large-scale topographical maps are available, and, secondly, when they are not available. It is advisable that artillery officers should be trained to observe from the air.

The best kind of aerial photographs are those giving a stereoscopic effect. The Santoni system in Italy, and the Nistri system, adopted in Brazil, are good types now in use. But they require a large amount of apparatus for laboratory work that is not available in the field. It is, however, on the lines of these systems that improvement may be looked for in the future.

4. *Studio sulle teleferiche.*

Lieut.-Colonel Cuocolo explains the methods of tracing the curves of equilibrium of cables of wire ropeways. In the first part he deals with cables with counterweights at one or both ends, and then with fixed cables, such as those of ropeways that form part of the standard equipment in the Italian army.

5. *Le prestazioni degli autoveicoli e la loro marcia in autocolonna.*

Major Amione shows, by a series of curves, the relative power of a motor-car engine, (1) on the bench, (2) on wheels in direct drive, (3) on wheels in low gear, (4) on wheels in reverse gear. He deals, specifically, with the Ceirano 50C heavy car (with semi-pneumatic tyres, a useful load of 5,000 kg. and a maximum speed of 27·5 km./hr.), and the Spa 25 C 10 light car (with pneumatic tyres, a useful load of 1,800 kg., and a maximum speed of 52 km./hr.). A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*September-October*, 1934).—1. *Le souvenir de Joffre au Soudan.*

Captain de Carbon-Ferrière gives an account of the inauguration of a memorial to Marshal Joffre, on the 18th February, 1934, in the Marcina district of the Niger, to commemorate Joffre's march to the conquest of Timbuktu forty years ago.

2. *Emploi du génie aux opérations du Maroc en* 1933.

General Naquet-Laroque gives the first instalment of an account of the work carried out by the Engineers in Morocco in 1933. The plans show the area in which the work was carried out, and eight photographs give a good idea of the nature of the country and the class of work executed.

The work was done in the mountainous country of the Grand-Atlas, inhabited by fanatical and well-armed tribesmen. Most of it consisted of properly graded roads, fit for motor-cycle traffic—portions being widened to carry cars. In addition, a number of mule tracks were constructed. Bridges were built, water supplies developed, a tunnel was driven, landing grounds levelled off. Civil, as well as military labour, was employed. " Spiros " compressors were largely used for rock cutting.

3. *Un nouvel appareil de téléphonie optique.*

Major Deny describes a new pattern of optical telephone that has been experimented with in Rumania, and is likely to be adopted for general use in the Rumanian army.

Under fairly favourable conditions a telephonic conversation can be carried on, with visible rays, over a distance of 6 km., or, with invisible rays, over a distance of 5 km. The apparatus can be packed into two haversacks, one containing the transmitter and the receiver, the other containing the amplifier.

4. *Exercise sur la carte (Sapeurs de chemin de fer) : une solution.*

This is a solution of a scheme set in the previous number of this review, relating to the duties of a battalion of railway sappers in a retreat. The solution consists, mainly, of the orders issued by the battalion commander, and the more detailed orders issued by the three company commanders, regarding the demolition of bridges, permanent way, and rolling stock. A.S.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*October*, 1934).—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *Combat de Papegoed.* (*11th September*, 1918.) Captain Geeroms.

An account of an attack, successfully carried out by the 24th and 23rd Regiments of the Line, on a portion of the German front line, which included the "Tranchée du Tour" and the Papegoed farm.

71 prisoners and 5 machine-guns were captured, with a loss to the Belgian force of 8 killed, 36 wounded, and 4 missing.

2. *Les combats sous bois.* (1). By J.L.H.

This article is intended to draw attention to the importance of fighting in woods, and to the necessity for training troops in this form of warfare.

In the first part, different kinds of woods are described, and the effect of projectiles bursting in them. The moral effect of shells is very great, and troops fighting in woods are liable to panics. Instances of heavy losses suffered in wood fighting during the Great War are those of the 20th French Infantry Regiment in the Luchy forest, who lost 550 men in a few hours, and the 157th German Infantry Regiment at Rossignol, who lost 890 men and 40 officers.

The employment of the various arms in wood fighting are next described, and instances from the Great War are quoted. The 18th Regiment of French artillery was surprised in the Luchy forest while in column of route and annihilated. The French failed to make proper use of their cavalry in wooded country, whereas the Germans made good use of theirs. Tanks will penetrate through woods if large trees are at least 4 m. apart.

The last part of the article is devoted to the defence of woods, *i.e.*, the best line of defence, and the placing of a wood in a state of defence.

3. *Détermination des aptitudes. Les "Army Mental Tests."* By Captain Yernaux.

When the United States of America joined the Allies during the war, her regular army and national guard combined consisted of 276,000 men. This number was increased to 1,200,000 in 1917, and to 3,600,000 by November, 1918. In order to select suitable candidates for the posts of officers and N.C.O's, and to employ men in the positions for which they were best fitted, certain simple mental tests were applied.

Dr. Roux de Montlebert has devised somewhat similar tests for French students. Other tests, based on these, have been tried in the 1st Carabiniers of the Belgian Army.

The writer explains the nature of the tests to which recruits have been subjected soon after joining. The recruits are divided into six classes, according to the percentage of marks obtained, but the result is kept confidential. It is, however, of great assistance to the commanding officer and the adjutant in judging the mental capacity of each man.

4. *Où en est la mécanisation des armées.*

A translation of an article in the American review *Army Ordnance* of May-June, 1934, in which the present state of mechanization in twenty-one armies is briefly described.

(*November*, 1934).—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *La contre-attaque à la Grand'Garde du Reigersvliet.* By General Jones and Lieut.-Colonel Jones.

On the morning of the 6th March, 1918, the Germans captured the Belgian post at Reigersvliet. On the same day, at 13 hours, a counter-attack was launched by the battalion of Chasseurs à Cheval under Major Jones, and the post and trenches were recaptured. The Belgians captured 11 machine-guns and 102 unwounded and 25 wounded prisoners, with comparatively small loss.

2. *Les combats sous bois.* (2). J.L.H.

In this second instalment the writer works out the details of a scheme in which a

regiment is entrusted with the organization, occupation, and defence of a portion of a position that lies in thickly wooded country.

3. *L'idée de manœuvre.*

Colonel Van Egroo begins this article by defining the "idea of manœuvre." He then goes on to quote historical examples to illustrate his meaning, referring first to larger units, and then to smaller ones. In dealing with an army, the general plan of campaign of the Belgian Army at the outset of the war in 1914 is quoted as an example; Grouchy at Waterloo serves as an example of the manœuvre of an army detachment. To take an instance of a corps, the writer refers to the employment of the 2nd Army Corps in the second sortie from Antwerp, and the action of the 7th Brigade in those operations serves to illustrate the manœuvre of a brigade.

Stress is laid on the necessity for clearness and simplicity in manœuvre. The Great War has illustrated the fallacy of the German theory of imposing a complete plan on the enemy, worked out to the minutest detail. Napoleon's method will always remain the true one: of having one's master idea, but of modelling its execution on the adversary's operations.

4. *Les croquis panoramiques de répérage.*

Captain Leseul has compiled a short set of instructions for panoramic sketching.

(*December*, 1934).—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *Deux coups de main sur Canopus trench, 25 juin et 28 juillet* 1918.

Captain Rousseaux describes two raids undertaken by the platoon under his command on a German trench known as Canopus trench. The first raid, undertaken on the 25th June, was a failure. The enemy had received ample warning through an elaborate artillery preparation, and the raiding troops were held up by a wire entanglement and machine-gun fire. They were, however, able to extricate themselves, and got back without any casualties.

In the second raid, undertaken a month later, the Belgians had an extraordinary piece of luck in selecting a time for their attack to correspond with the time of relief in the German trenches. The Germans were quite unprepared, and the Belgians got back with eleven prisoners.

2. *Les combats sous bois.* (3). By J.L.H.

In this last instalment, the writer works out a scheme for the defence of a wood, assuming that he has three days in which to carry out the work.

3. *Les possibilités actuelles de notre aéronautique militaire.*

After a brief reference to captive balloons, which he thinks are still capable of rendering good service, Lieut.-Colonel Hugon describes the many ways in which the air-force can be utilized in war time.

For observation, aeroplanes cannot obtain all the detail that a captive balloon can give, but they can cover a large area of ground and are far less vulnerable. Photographs will furnish information that the eye may miss. By means of flares a good deal of information can be obtained at night, and, by flying low, aeroplanes can cause considerable damage to troops marching along roads. In warding off an attack by low-flying planes, the rifle has been found more effective than a machine-gun.

Colonel Hugon next deals with fighting planes and discusses the relative merits of monoplanes and biplanes. Their great speed renders them comparatively safe from attack.

The bombing plane is a compromise between speed and carrying power; for the night bomber speed is less essential, and the carrying power is increased proportionately. A brief description is given of some of the German commercial planes, such as the Heinkel 70 B, the Junkers 52, 38, and Ju 60 L, all of which can easily be converted into bombers. The writer compares bombers with long-range artillery, but thinks that they would, as a rule, confine their attention to targets that cover a large area. He considers the "Electron" type of incendiary bomb to be extraordinarily effective.

Battle-planes are a type that Belgium does not possess. In 1918 the Germans had formed squadrons of armoured "Junkers" that took part in the battle of Mount Kemmel.

The main items that limit the action of aviation are (1) atmospheric conditions, (2) ground conditions, (3) re-filling stations and repair shops.

In the last part of the article the writer describes how Belgium might meet a possible aerial attack. The theory propounded by General Douhet that a war could be decided mainly by the air-force, leaving the army and navy to play only a secondary part, might apply to a country with natural defences, like Italy, but is quite inapplicable to Belgium.

4. *Règles d'emploi de l'observation terrestre dans les unités d'infanterie.*

Major Wanty divides his article into three parts. In the first, he deals with the tactical employment of ground observation, as it affects a regiment, a battalion, or a company. In the second part he describes the technicalities of observation, such as the choice and organization of observation posts, transmission of information, etc. In the third part he has worked out a general programme for the instruction of observers.

(*January*, 1935).—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. By V. F.

The writer gives an account of the advance of the 1st and 4th Chasseurs à pied from the Yser to the Scheldt in the autumn of 1918. The final advance in pursuit of the retiring German army began on the 28th September. The Germans made a firm stand on the "Flandern Stellung," where the Belgian advance was held up from the 30th September to the 14th October. On that date the German position was forced, and the Belgian advance continued until Gand was reached on the 11th November, when the armistice put a stop to further operations.

2. *La guerre de la succession d'Espagne et ses renseignements toujours vivants.*

Colonel Van Egroo runs through the history of the war of the Spanish Succession and deduces from it lessons that are still applicable to modern warfare. He limits himself to the operations in the north of Europe.

The war began with successes for the French, Villars winning the battle of Friedlingen in 1702. In 1704 Marlborough made his famous march to the Danube, where, in conjunction with Prince Eugene, he destroyed the French armies at Blenheim. The campaign of 1705 was uneventful. 1706 was a bad year for the French, and Marlborough inflicted a crushing defeat on Villeroi at Ramillies. 1708 was remarkable for Marlborough's victory over Vendôme at Oudenarde, and for the siege of Lille, at the end of which Marshal Boufflers surrendered to Marlborough and Eugene.

The war might have ended then, if the coalition had not offered unacceptable terms. In 1709 the fiercely contested battle of Malplaquet was fought between the combined forces of Marlborough and Eugene and the French forces under Villars. 1711 was Marlborough's last campaign, and he was recalled to England for political reasons. In 1712 Villars gained a victory at Denain over Eugene's army. The treaty of Rastett was signed in 1714.

The writer quotes Marshal Foch's remarks regarding Malplaquet and Denain, and the lessons taught by the campaign. A mistake made by the combatants was that of wasting time in besieging fortresses, the occupation of which had no decisive influence on the results of the campaign. The disadvantages of long lines, weakly held, became apparent; they inevitably led to disaster.

In spite of very different conditions, there is a distinct analogy between the campaigns of Villars and Marlborough and the Great War of two centuries later.

3. *Les procédés de combat de l'infanterie allemande.*

Major Wanty works out three tactical schemes on the lines of those set to German officers and N.C.O's, but transfers them to Belgian soil. The schemes are:—(1) a battalion of the advance guard in an encounter battle, (2) the relief of a battalion at night in view of an attack, (3) the rapid occupation of a defensive position.

4. *Vue d'ensemble de quelques applications possibles de la psychotechnique à l'armée.* In this first instalment Lieut. Mente gives examples of psychological tests that might be applied in selecting men for certain posts, such as artillery observers, drivers, machine-gunners, chauffeurs, aeroplane pilots and observers, etc. In some cases he proposes to adopt some form of apparatus to test the reaction to certain stimuli, in other cases, such as tests for eyesight, ordinary methods are applied.

A.S.H.

REVUE MILITAIRE FRANÇAISE.

(*October*, 1934.)—An interesting article, *Schlieffen et Moltke le Jeune*, by Lieut.-Colonel Pugens, begins this number. It describes the famous plan of campaign developed by Count Schlieffen during the 15 years he was at the head of the German General Staff, and the deviations from it which were made by Moltke the younger. The war on two fronts was Schlieffen's special study, and he had made up his mind to leave the minimum of forces to hold Russia while he brought overwhelming strength against France. The struggle with France would be brief, and then it would be Russia's turn. For this plan he proposed to have a very powerful right wing to sweep through Belgium. Moltke was forced to alter this, owing to the continued improvement in Russia's reorganization. He also altered the relative strengths of the right and left wings on the Western Front, owing to his growing fear of the French threat to the big industrial areas; so much so, that, whereas Schlieffen had intended to keep only one-seventh of his Western forces in Lorraine, Moltke increased the proportion to one-third. Schlieffen proposed to seek the decision between the upper Seine and the Marne; Moltke did not know where he would defeat the French. Schlieffen aimed at the envelopment of the French on both flanks; Moltke had to strengthen his own left because the French would probably take the initiative in Lorraine. It is therefore unfair to blame Moltke for watering down Schlieffen's plan, but it is certain that Schlieffen would have taken greater risks.

In the author's opinion, the German plan failed because it was too rigid and allowed for no possible variations. Neither Schlieffen nor Moltke were big enough for the war on two fronts.

The next article is entitled *La recherche et l'Utilisation des Renseignements dans une situation de Guerre. 9 Sept.* 1914, by Colonel Bernis. It recounts the military situation of the 9th of September, 1914, when von Kluck's Army was separated from the rest of the German forces by a gap 40 kilometres wide, into which the British Army and a French Cavalry Corps were beginning to thrust themselves. The author points out that, owing to the demolitions carried out by the Allies, the Germans had nothing for lateral communications but the line running from Metz through Aix-la-Chapelle and Brussels to Compiègne. This was their sole means of bringing round troops from Lorraine to help their right wing. The German armies had all out-distanced their supplies, and their railheads were anything from 120 to 150 kilometres from the front.

Joffre saw the dangerous situation von Kluck was in, and strove hard to press his advantage, but in the absence of precise information—such as the air service of to-day would have supplied—he failed to get his blows home. Moltke was powerless to send help; he could only send Hentsch to authorize retirement sufficiently far back to enable him to reunite his forces. The author discusses this situation in the light of present-day methods of obtaining information, and thinks that with modern air methods Joffre would have been able to do still further damage to the German railway communications and deprive the enemy of any chance of sending either supplies or reinforcements to the right wing armies. Joffre would thus have been able to widen the gap between Bulow and von Kluck and have carried the French victory to a dramatic conclusion. Certainly the situation on the 9th September had stupendous possibilities.

La Liaison Morale. Ce qu'est un tir d'artillerie is the title of an article by General Faugeron, emphasizing the importance of artillery co-operation with other arms. The writer recalls that up to quite recent times the artillery group was looked upon as a separate entity in the division, and when called upon for support was generally furnished with all too little information of the divisional plan. He quotes some specific instances of this from the Great War. The simple statement that the artillery will "support the infantry" will no longer suffice. The artillery commander must be informed in full detail so that he knows exactly what he is expected to do; when he has to open fire, for how long, what intensity, etc., etc. The article is a useful reminder to officers of other arms that the artillery commanders cannot be kept in the dark if the best use is to be made of their services.

There are only three articles in this number of the *Revue* instead of the usual four.

(*November*, 1934.)—Colonel Pugens begins an article, *La Manœuvre de Lorraine (Août–Septembre* 1914), which is interesting and clearly written. It describes Moltke's plans for the opening phase on the German left wing, and Prince Rupprecht's struggle to obtain his way and attack instead of retreat. Rupprecht was given the combined command of the Sixth and Seventh Armies while still retaining his own Sixth Army. This was a favourite device at the beginning of the war, when the system of forming armies into Groups had not yet been adopted. It led to misunderstanding and want of co-ordination, as was shown not only between Kluck and Bulow, but between Rupprecht and von Heeringen (Seventh Army).

Rupprecht was a staunch Bavarian and did not agree that his armies should let the French invade so long as he had a hope of beating them. Moltke's plan included a strategic withdrawal in Lorraine to entice the French right wing into a pocket. Rupprecht's armies were to fall back behind the Nied, the Saar and the Vosges, and then fall upon the French when they had come forward from their fortresses. Schlieffen had decided to abandon Alsace and Lorraine, but Moltke was not prepared to go so far; he was going to make a battle of it under conditions of his own choosing.

If the French remained on the defensive in Lorraine, Rupprecht's two armies were to attack in the direction of the Moselle below Frouard, and take Fort Manonviller, with the object of pinning down the French forces and preventing them from being transported to their left wing.

If, on the other hand, the French attacked with superior forces between Metz and the Vosges, then Rupprecht's armies were to yield ground and prevent the French from threatening the left flank of the main German forces.

Both these hypotheses required a full and accurate knowledge of the French action.

After considerable local success by the Sixth Army, Rupprecht considered the situation favourable for an attack with his two armies, but the Seventh Army was still behindhand. Moltke adhered to his plan, and ordered Rupprecht to fall back behind the Saar.

Then came a delegate from Moltke, a Lieut.-Colonel von Dommes, who, *à la* Hentsch, expounded the views of the Supreme Headquarters to Rupprecht and his Chief of Staff, von Krafft. The latter were vigorous in their opposition to the retirement. They pointed out that the French had but slowly followed up their retirement. Von Dommes reiterated Moltke's ideas, and left Rupprecht still burning to be free to act as he considered best. Finally, on the evening of August 18th, Stein, the Quartermaster-General at Luxemburg, telephoned that Supreme Headquarters did not veto Rupprecht's offensive, but that the responsibility must be on the latter's shoulders. Rupprecht made up his mind and attacked, although the battle-ground was not in his favour. Still, he managed to take 10,000 prisoners and 60 guns (battle of the Saar). This victory was greatly magnified at Headquarters, and led to considerable risks being taken.

Rupprecht now requested a further mission. This had not yet been considered at Headquarters, but, when on the 22nd August, Krafft telephoned for instructions, he

was told that the Sixth and Seventh Armies were to pursue in the direction of Épinal, and endeavour to drive the French southwards away from that fortress. This was a totally unexpected development for Rupprecht, but Moltke was anxious that as many French troops as possible should be held down in Lorraine.

Altogether too rosy a view of the situation was taken at the German Supreme Headquarters, and Moltke's staff would not listen to Rupprecht's urgent representations. The article, which is largely based on Rupprecht's war diary, is to be continued.

The series of articles, *Les Dernières Étapes de la Pacification dans le Grand Atlas Marocain*, by Lieut.-Colonel Lançon, is continued. The operations of 1933 are described in detail, and elaborate sketch-maps accompany the article.

An account of the Spanish possessions in Africa is given in *Les Possessions Espagnoles au Sud du Maroc*, by Capitaine De la Chapelle. The first Spanish control began in 1860 with a small establishment on the coast. It was a narrow strip 60 kms. long and 25 kms. wide, now known as the Ifni zone. It forms an enclave entirely surrounded by French territory. The rest of the Spanish territory is practically a desert country, inhabited by nomad tribes and supporting very little agriculture. These regions have lately assumed more importance as a link in the air services between Europe and South America; otherwise they must be extremely unattractive.

The last article in this number is entitled *La Petite Chapelle de l'École Militaire*, by Robert Laulan, the librarian of the École Supérieure de Guerre. The demolition of the school buildings has recently been under consideration, in order to extend the gardens of the Champ-de-Mars, but the little chapel has been spared and is to be preserved as a national historical monument. The chapel was built in 1754–55 by the celebrated architect Gabriel.

In the section devoted to foreign military news, there is an interesting account of the Italian military manœuvres of August, 1934. These were the largest and most important manœuvres held since the Fascist régime was introduced. Two army corps with four infantry divisions and 1 mobile division took part, and represented forces amounting to two armies, five army corps, fifteen divisions. The French Army was represented by a Mission composed of a General officer and two other senior officers. The manœuvres took place between Bologna and Florence.

(*December*, 1934.)—The *Manœuvre de Lorraine* (*August–September* 1914) is concluded in this number. The two articles are full of interest, and the comments are to the point. The over-confidence of the Germans brought about some dangerous situations, and the want of accurate intelligence shows up clearly on both sides. Rupprecht's right flank, opposite the fortified Nancy position, had become strung out, and out of the twelve divisions in the Sixth Army only three were left available to push southwards against the French rear. But to Rupprecht the situation appeared favourable, and he had almost willingly given up the 10th Ersatz division as a reinforcement to the Fifth Army. He was about to move his headquarters forward to Lunéville. But suddenly he learned that the French had launched an attack from Nancy against the IIIrd Bavarian Corps. The French attack was both well timed and well directed. It aimed at the most important of the communications on the right wing of the Sixth Army. Two Ersatz divisions retired in great disorder, and exposed the Lunéville–Arracourt road. Something like a panic set in, and Rupprecht had to use his reinforcements to bolster up his own line instead of attacking the French. The French attack did not get far, but it completely checked the right wing of Rupprecht's Army. At this inopportune moment, when the Sixth Army staff doubted whether they could hold on north of Lunéville or avoid being cut off from Metz, an instruction from Supreme Headquarters arrived, prescribing a breakthrough between Épinal and Toul, to join hands with the Fifth Army moving southwards. This order ran counter to the previous mission to the Sixth Army to avoid being separated from Metz. The initiative had passed to the French Second Army, and de Castelnau had reversed the position. No longer were the French pinned in the

Vosges: they were able to send troops across to their left wing. The Germans, on the other hand, became more tied to Lorraine. By the 27th August, there was more or less equilibrium between the two sides. An important effect of these events was that instead of withdrawing troops from Lorraine, which was intended to be a secondary theatre, to send to East Prussia, Moltke sent the two corps liberated by the fall of Namur, thus depriving the all-important right wing of handy reinforcements.

Moltke now believed that the French would withdraw from Lorraine, seek shelter within the fortified triangle Langres–Dijon–Besançon, and try to attack the flank of the Sixth and Seventh Armies while they marched to the centre of France; a very erroneous assumption.

By this time, the Sixth and Seventh Armies were thoroughly exhausted and needed several days' rest, but were unable to get it. Next, there arrived at Sixth Army Headquarters a Major Bauer, head of the heavy artillery section at Supreme Headquarters, a self-appointed delegate who took it upon himself to represent that a reduction of the Nancy fortress by the Sixth Army would speedily bring about decisive results. He so worked upon Rupprecht's staff that before the Army Commander could return from a tour of inspection and meet the newcomer, they were busy preparing plans to bring up heavy artillery. Thus it came about that the mission of the Sixth Army became further complicated; it was to pierce through between Toul and Épinal, and it was to reduce Nancy. It was to keep touch with Metz; and it badly needed rest. But at Supreme Headquarters, the project for attacking the Nancy position was not in the programme; and much misunderstanding arose. Finally Rupprecht had to compromise and embark upon the two tasks.

Some days had to elapse before the additional guns could be placed, and then came a munitions crisis. Supplies ran short, and by September 5th the artillery was practically silent. Meanwhile, events on the German right wing had gone badly, and the crisis of the Marne had fallen upon Moltke. On September 9th Rupprecht learned that the Sixth Army was to be transported to the right wing. The manœuvre of Lorraine was over.

This is a very interesting view of the operations in Lorraine, which should be studied in conjunction with the French accounts. The setback to the French First and Second Armies and their subsequent recovery are full of interest to a military student.

The series of articles entitled *Les Dernières Étapes de la Pacification dans le Grand Atlas Marocain*, by Lieut.-Colonel Lançon, is brought to a close. A tactical summary is given of the three successive campaigns in the closing chapter; and the practical lessons derived are well described. The operations were carried out from first to last with the constructive idea that the conquered tribes must be absorbed into a beneficial pacification and not wiped out of existence

The final article is entitled *Vieilles Histoires Alpines*, by Lieut.-Colonel Regnault. This describes three examples of the crossing of mountain passes in winter conditions. The examples selected are all from the nineteenth century: the passage of the Great St. Bernard in 1800, the crossing of the Splügen by the Army of the Grisons in the same year, and the passage of the Shipka Pass in January, 1878. Each example is very concisely described, and illustrated by sketch-maps. Even two hundred years before Bonaparte had broken away from the tradition that in winter all operations should cease, Lesdiguières had led a small column in the depth of winter and by night over the Mont-Genèvre; but this was a very minor operation. The passage of the St. Bernard was in the spring-time rather than the winter, but the example serves because of the full details left to us.

During the Great War there were large-scale operations in the mountains both in the Carpathians and in Armenia; and in all cases the troops engaged suffered terrible losses due to the cold and wintry conditions.

The author points out that whereas, in the three historical examples given, the operations were of brief duration, and led the troops rapidly from critical conditions to conditions of mildness and comfort, the operations in the Great War were prolonged, and the troops suffered intensely from the continual exposure, and the absence of healthy recuperation at the "other side." There was no other side in their case. Operations in the high mountains will continue: and the side which has to establish its troops in the snowy summits will suffer most.

W.H.K.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*October*, 1934.)—*The Consecration of the Austrian War-Memorial.* Without altering the style of a well-known landmark in the heart of Vienna, it has been possible to convert the buildings at the entrance to the Burg into a sort of Valhalla, containing large and handsomely got-up books, recording the names of those who died in the Great War. The buildings already bore before conversion two mottoes in large "bronze" letters, "Justitia regnorum fundamentum"—appropriate to the capital and seat of government of an empire—and "Laurum militibus lauro dignis," which was almost prophetic of the use to which the buildings have now been put.

To Major-General Materna, a serving soldier, has fallen the task of writing a speech suitable to such an occasion and ceremony, and it is here reproduced in black-faced type. The speech is stirring, without being overdone, well-sustained and not too long, a model of how to treat so difficult a subject.

The Development of the Austro-Hungarian Forces, 1900-1914, by Col. Kiszling. The object of this article, which has been reprinted from the *Berliner Monatshefte*, is by means of authenticated facts and figures to counter the reproach of increase of armaments in the last years before the Great War, made against Austro-Hungary in literature dealing with the subject of war-guilt.

Figures show that in the opening years of the twentieth century Austro-Hungary dropped farther and farther back in the race of armaments of the Great Powers. The causes of this were financial, but still more political. The political causes were due chiefly to difficulties made by Hungary. Since the latter country had obtained almost complete autonomy in 1867, the Hungarian upper classes had worked systematically to do away with the Austro-Hungarian army and to form a separate Hungarian army. In order to gain concessions the Hungarian parliament took to refusing to grant the annual contingent of recruits and to budget the annual contribution towards the armed forces of the Empire. Hence it was quite impossible to hope for Hungary's consent to any increase in the Austro-Hungarian army, or in the annual contingent of recruits which remained for some decades at 103,000 for army and navy together. It turned out fortunately for the Austro-Hungarian army that its second line, in Hungary known as the Honved, had been made purely territorial, and for this portion of it the parliament at Budapest was generous enough. The Austrian half of the Empire raised a similar second-line army, known as the Landwehr; and a healthy rivalry arose between these two, which eventually resulted in both coming more and more to resemble regulars. By 1907 the Landwehr had started to get its own artillery, while the Honved got as far as producing cavalry divisions. Thus it came about that up to 1908 Austro-Hungary was working on no concrete programme of developing its regular forces, although such a programme, drawn up in 1903, was still in existence. This envisaged the reduction of the time with the colours from three years to two, not because military circles favoured such a decrease, but as a popular measure, and a concession to parliament in return for the sanctioning of most necessary increases. In 1907 this plan was thrashed out again. The C.G.S. asked for heavy artillery for the field army, an increase in the mountain artillery, and in the S. and T. The Austrian Minister for Defence asked for an increase of Landwehr mountain-

troops, and an increase of peace establishment for the Landwehr company. The Honved Minister did the same as regards the Honved company. Parliament would not agree. Thus Austro-Hungary's armed forces in 1908 were in no way, in strength or equipment, in accordance with the political requirements of the Empire.

In this dangerous state of complete standstill it very nearly happened at the beginning of 1909 that the Empire had to call upon its armed forces. Alarmed at the successful revolution by the Young Turks at Constantinople in July, 1908, which might well spread to Bosnia and Herzegovina, still nominally under the Sultan, but occupied by Austria for nearly thirty years, the Austro-Hungarian Government decided to announce the annexation of these two states. Protests on all sides were loud, but the loudest came from Serbia, which saw its dreams of a larger Serbia brought to nought; and Montenegro seconded them. As it was evident that both Great Britain and Russia were aiding Serbia diplomatically, war parties in Belgrade and Cettinje got much support. Austria was compelled to take the military precaution of putting the commands adjacent to the frontier on a higher establishment, and of sending 15 battalions to the area south of the Save. Serbia answered by demanding autonomy for Bosnia and Herzegovina, and for itself a port on the Adriatic with a corridor leading thereto, to be taken from Austrian territory. Russia backed these demands. Austria made ready to answer with war, when Russia, which had not yet recovered from the effects of the Japanese War, suddenly weakened, and counselled moderation. To the general relief of Europe at the end of March, 1909, Serbia withdrew its demands. The profits accruing to the Austro-Hungarian army out of this crisis were valuable increases in artillery and machine-guns. On the other hand, 1910 and 1911 brought no improvement worth mentioning, as it was still not possible to get the Hungarian parliament to pass an increase in the annual contingent of recruits. At last, in July, 1912, after a struggle of eighteen months, a new Defence Act was passed, reducing the time with the colours from three years to two, and raising the annual contingent by 50%. This arrangement had not taken effect when, in the middle of October, war broke out in the Balkans. Turkey was defeated in a surprisingly short time, and by November 10th Serbian troops had appeared on the Adriatic at Alessio, while the Montenegrins were pressing hard on Scutari. The formation of an Albanian state, which had been planned by Austro-Hungary and Italy, was thus seriously compromised. Serbia and Montenegro were ordered to withdraw, but relying on Russia's support, neither of them complied. As Russia strengthened its troops on the Galician frontier Austria followed suit, and also brought two corps in Bosnia and Dalmatia on to a war footing. After long negotiations between Vienna and St. Petersburg an agreement was reached, and again a war was saved. The partial mobilization had, however, sufficed to show that, even under the new Defence Act, peace establishments were inadequate. A further increase of 32,400 men in the yearly contingent was passed by Parliament in 1914, but had not taken effect when the Great War broke out.

The writer's defence of Austro-Hungary against the charge of war guilt through excessive preparation for war is complete. When he winds up by saying that Austro-Hungary's unpreparedness for war in 1914 was certainly one inducement more for the Entente Powers to seek a decision that year, he begs a very large question.

Twenty Years Ago. There are two contributions this month to the series of articles under this title, dealing with the outbreak of the Great War (*vide The R.E. Journal*, December, 1934, p. 656), viz., "In N.E. Bosnia," by Lieut.-Col. Smola, and Major-General Klein's "At the Mouth of the Save." As the writers of this series have been selected in order that they shall be able to give their personal reminiscences of the situation and mobilization happenings in their respective areas, their accounts make popular reading.

The Battle of the Arges. A most instructive strategical study of the positions, possibilities, movements, the decisions of General Presan, commanding the Rumanian army before Bucharest, and their execution during the last three days of November,

1916, in fact, of all the factors leading up to what the author calls " the last encounter-battle of the Great War." The study is based upon the account given by General Pétin, Chief of the French Military Mission with the Rumanian Army, in his book, *The Drame Roumain*, 1916-18 (Payot, Paris). Of a very great achievement the article says " The flank-march of the 2/5 Rumanian Division through the patrols of Schmettow's Cavalry Corps and across the fronts of two advancing German infantry divisions is one of the most extraordinary undertakings in the history of war. In a march of 80 kilometres the division could not allow itself to be held up by the danger which threatened its flank throughout. The flank-marches of Turenne at Ensheim, of Frederick the Great at Leuthen, and of Radetzky from Verona on Mantua and from Milan on Pavia were secured against surprise by the terrain. Here there was no such security. For a parallel one would have to go back to the campaigns of Alexander and of Gengis Khan."—*(To be continued.)*

Motor-transport in a Hard Winter. Capt. Schmilauer gives many useful tips, which will be appreciated by officers other than those of the R.A.S.C. now that the tendency is for M.T. to pass increasingly under regimental charge. The subject falls under three heads :—(1) The causes of delay in being prepared to take the road in winter, and precautions necessary to overcome these ; especially, arrangements for having at hand day and night sufficient quantities of hot water ; (2) driving M.T. columns in winter ; and (3) clearing roads of snow by means of snow-ploughs (horse-drawn or Citroën Type C4, 30 H.P., weighing 1·2 tons) or by manual labour.

The following figures are given : 1 man with a shovel can clear in 1 hour a strip 20 metres long and 2 metres broad of snow 20 to 25 cm. deep ; a snow-plough with up to 6 horses can clear freshly-fallen snow 70 cm. deep 3 km. long and 3 metres broad in 1 hour. Mountain-roads are best cleared by a motor snow-plough, followed by a motor snow-scatterer which throws the piled-up snow clear of the road altogether. In very unfavourable snow conditions, drifts two metres deep and a steep winding road, a light Citroën snow-plough cleared 54 km. of road in 10 hours.

Field-Marshal Prince Windischgrätz. Revolution and Counter-revolution in Austria. Major-General Kerchnawe reviews Paul Müller's book (published by Braumüller, Vienna) with this title, and praises it as a very valuable contribution to the history of the period, 1849, and as a mine for searchers. Whether it is a history, or even *the* history of the period, and whether Dr. Müller has given a true picture of the man who has been designated " the saviour of the monarchy and even the saviour of Europe " (since after his success the conservative forces rallied in all countries) is less certain. For one thing, the reviewer finds, Windischgrätz's greatness as a soldier is insufficiently brought out. He finds his prototype in Seydlitz, who, at Zorndorf, sent a message back to Frederick, " His Majesty may have my head off after the battle, but during the battle he will have to put up with my making the best use of it I can on his behalf."

The Militia Question in Germany from 1848 *to* 1933, *by* G. Nickolaus, War Historical Department of the Friedrich Wilhelm University, reviewed by Colonel von Dragoni. This book deals with defence systems in general, and with the militia system in particular, by " militia " being understood the partially trained military force which results from a thorough application of the principle of universal service to the male population, such an application alone making possible the vast armies of modern warfare. The author decides that owing to its grave military deficiencies a militia alone could no longer be adopted by any country having a free choice. Progress in technics and progressive mechanization demand very highly trained professional soldiers. Success in the future, as it has been in the past, will still be " on the side of the strong battalions," but these " strong battalions " will consist of a small high-quality professional army with a mass-army, a militia, behind it.

The Protection of Food and Forage against Gas. Taken from the Russian by Capt. A. Divis. Meat, flour, hay, salt, sugar and tea are all very susceptible to mustard-gas and the arsenic compounds. The chief remedies are supply-depots to be placed as

far back as possible, supplies to be run up so quickly from the rear as to obviate any length of time of storage at the front, and tight and careful packing of all commodities, especially those mentioned, first in paper or in parchment and then in packing-cases with canvas covers or in double sacking, specially tightly woven.

The Marne Drama. General Ludendorff's egregious utterances (*vide The R.E Journal*, December, 1934, p. 660) have not escaped official notice. The German War Office takes up position against newspaper articles and pamphlets which, in a manner likely to foster racial animosity, derive " what was finally the political defeat of the German nation in the Great War " from the mysterious effect of powerful international organizations. According to the *Militaer Wochenblatt* it has laid down further that all that concerns the battle of the Marne has already been stated in full publicity in the *Official History*, and it is entirely beside the point to attribute the behaviour of the Head of the German General Staff to " occult influences."

The Training of the Infantry in Field Fortification, from the Hungarian of Lieut.-Col. Marko. The formation of strong points, which is the constant aim in battle, leads to the existence of weakened portions of the front, which can be held only by the aid of field fortification. Hence the infantry must be masters of temporary fortification. The following recommendations are made :—In every garrison a fortification model-garden to be laid out : which can be done cheaply enough. Officers and N.C.O's to be well trained in theory beforehand. In individual training the importance of field fortification to be constantly brought forward and practical work given. In the successive stages of collective training, positions and works may be traced and occupied, but at the end of company training, and again at the end of battalion training, a two to three days' exercise should be held in which all works are to be executed on full scale. In such exercises it will be an advantage for Engineers to assist.

Infantry will only be able to perform its battle tasks satisfactorily when it has been equally well trained in defence as in attack.

(*November*, 1934.)—*The Battle on the Arges.*—(*Continued*). Dr. Hereus brings out clearly the strategy leading up to this fight, and shows it to have been of extraordinary interest. The theatre is the Wallachian plain, 100 miles long and 100 miles broad, lying west of Bucharest between the Transylvanian Alps or Southern Carpathians on the north, and the Danube on the south. Two rivers traversing this plain, the Alt and the Arges, may be taken as its western and eastern boundaries. The position on the 23rd November is that the Rumanians have lost two of the mountain-passes in the north, necessitating their retirement in the west to the line of the Alt. They have a group of one cavalry division and one infantry division in the south watching the Danube. The Rumanian forces thus occupy the arc of a semi-circle of which Bucharest is the centre. The situation develops as follows :—Rumanian G.H.Q. forms a striking force of three divisions. Before they have decided where this force shall strike, they receive news that on the morning of the 23rd the Germans have started crossing the Danube, and indeed at a point 40 km. nearer the capital than the five divisions of the 1st Rumanian army, which are facing the enemy in the mountains and along the Alt. An army group is now formed under General Presan consisting of the 1st Army, the three divisions of the striking force, and the Danube Defence Group.

General Presan has now to decide whether he will (1) abandon Wallachia, and hence the capital. This his Russian allies advised. Or (2) retire all along the circumference of his front, and take up a defensive position in front of Bucharest. Or (3) hold the enemy in the north and west, and strike heavily at the German Danube Army (Germans, Bulgarians and Turks) advancing from the south-west : in other words, fight an encounter-battle.

General Presan decided on the third of these alternatives. In order to test the soundness of this decision it is necessary to investigate all the conditions and factors, and discover whether the plan had at least a reasonable chance of success ; that it

was not in the nature of a forlorn hope. This Dr. Hereus does, weighing strengths, working out distances and times, and comparing positions, the nature of the troops, their equipment and morale. He arrives at the conclusion that General Presan's decision was sound. It is all the more necessary to clear up this point, because the Rumanians eventually lost the battle of Arges, and with it their capital. The deciding factor was that the German Danube Army after being heavily struck was saved by the arrival of the next German army on its left, an arrival made possible by Schmettow's Cavalry Corps having been successful on November 25th in capturing the crossing of the lower Alt.

Commander and Staff. Major-General Paschek deals with the General Staff, not with special or departmental staffs. He gives us much that is interesting, much that is well said, but little that is new, beyond the fact that larger staffs are now an unfortunate necessity, and that with these larger staffs the necessary complete unity within the staff will be more difficult to attain. The intimate connection between the G.S. and the officers of Signals is mentioned. This obtains also in the British army where Signals is the child, the only child outside the staff, of G (Operations), but the connection is more intimate still in the German and Austrian armies, where Signals, instead of being purely executive, performs also the staff duties of G (Intelligence).

It was worth pointing out that a function of the army being the maintenance of the State the army must always be essentially conservative. For this it needs internal peace and stability. As contributing to these desiderata promotion by seniority, which may lead to tragedy in war, should be the general rule in peace. Armies tend to type and to externals. In a world of progress this conservatism in a long peace hinders the army's development. The only remedy is for its leaders to be all the keener and receptive of new ideas, and especially when the army's equipment is not of the latest, to be rather ahead of the times than behind them.

The 1934 Fleet Conference. Capt. Sokol here touches on the Washington Conference of 1922, and runs over the Five Powers' Agreement, the London 1930 Conference, the Paris 1931 Conference, and the London 1934 Conference, held as a preliminary to the great Fleet Conference proposed for 1935. The article thus furnishes an *aide-mémoire* for those who study the question, and for others it will fill up the gaps in their newspaper reading. It closes with a forecast of the questions with which the 1935 Conference (if any) will have to deal, cannot foresee how the multiplicity of diverging wishes, matters of dispute, and unfulfilable demands can be reduced to a common denominator satisfying to all, and prophesies that, like its predecessors, the next Fleet Conference will take place more under the star of armament than under that of disarmament. " A way could, however, be found if only the will was there ! "

1914. *The Military Problem of our War-commencement*, by Colonel Baron Pitreich, published at 56 Prinz Eugenstrasse, Vienna IV. General von Horsetzky reviews this book at some length, and with obvious pleasure. He finds that the historical development of the plans of operations of Austria-Hungary and of Germany against Russia, of Russia against the Central Powers, and of Austro-Hungary against Serbia have been brilliantly dealt with. There follow treatments of the operations against Serbia, 12th to 19th August, of Austro-Hungary's mobilization arrangements, of the introductory operations against Russia, of the first battles in Galicia and Poland, of the battle of Lemberg, and of the value of the Austro-Hungarian offensive between Vistula and Bug. This latter appreciation General von Horsetzky finds suitably couched, and parts company with the author only when the latter agrees with the dictum attributed to Count Schlieffen that " Austro-Hungary's fate would finally be decided not on the Bug, but on the Seine." This oracular utterance, the reviewer points out, was made in the winter of 1905-06 when no energetic action was to be expected from a Russia, weakened by the Japanese War. It did not apply to the

altered circumstances of 1914. It was no guiding star for the future, but "at most a shooting star."

The Austro-Hungarian Danube Flotilla, 1914-18, by Vice-Admiral Wulff, reviewed by Lieut. Handel-Mazzetti. A necessary and overdue chapter in the history of the Great War is furnished by this book, which contains accounts of three great actions in which the flotilla played a part, connected by a chain of minor incidents, covering a wide field of activity. The submarine mines and the booms of the North and South War were soon revived, and improved, but, curiously enough in all the years the war lasted there was no parallel to the fight between the *Merrimac* and the *Monitor*, even though the Rumanians possessed on the Danube similar craft. In the face of the latter the Austro-Hungarian flotilla cleared the Danube to the Black Sea, and even sent a detachment to Odessa and the mouths of the great Russian rivers, an adventure in which navigation added its thrills to those of war.

Tank Warfare. General Eimannsberger's book (*vide The R.E. Journal*, September, 1934, p. 459) is here reviewed by General Ratzenhofer, and, on account of the fundamental problems with which it deals, it is warmly recommended to all officers for thorough study. The points which are raised in this work have apparently not yet been settled even in those countries which are leading in mechanization, since, although there is everywhere activity in perfecting tanks and in studying their possibilities, in no country have really large sums of money yet been voted for tank production, or to create the higher tank formations.

Considerations on machine-gun fire as a defence against low-flying aeroplanes. Taken from an article by Lieut.-Colonel Garrone in the *Rivista Militare Italiana*. The importance of this subject is manifest: it concerns not only all those who march across bridges, but especially those who make them. Calm, disciplined ground-troops, well trained in A.A. defence, confident in their weapons, and in their ability to defend themselves, are the best answer to the low-flying bomber or machine-gunner. In other words the troops must look after themselves. They will do best when they have got a little accustomed to surprises. The value of the automatic rifle, full or half, is here indicated, and a warning added that the low-flying aeroplane instead of being deterred by bad weather, may even take advantage of it.

A Machine-gun on a New Principle. It is reported on the authority of an infantry journal in Madrid that a Japanese inventor, Jositharo Shimizu, has patented the principle of a machine-gun which fires bullets centrifugally from the periphery of a disc driven by an internal-combustion engine. The trial weapon is reported to have fired at a rate of over 9,000 rounds a minute. The muzzle-velocity is four times that of an ordinary machine-gun, and penetration four times as great. The gun weighs 90 lb., and its mounting in aircraft is being tried out.

(*December*, 1934.)—*The Tyrolese Imperial Rifles on the San*, 1914-15, by General von Fabini. This is regimental history of a fine fighting corps, of which from nine to twelve battalions served in, in the latter case composed, the 8th Division of the XIVth Corps in the Fourth Army. The operations on the San have been chosen as belonging to the hardest and most costly fighting in the whole war. On the 15th and 16th October the division managed to get 4½ battalions across by ferrying, no bridging being possible. Bridgehead was then abandoned upon the Austrians going over to the defensive. From October 20th to 26th the river line was held against repeated Russian attacks. On October 27th a general retirement took place, starting from the left with Mackensen's Group and the 9th German Army. Six months later, taking part in Mackensen's great breakthrough at Gorlice, the 8th Division was back on the San at precisely the spot they had left in October—Novosielec. Here they were heavily counter-attacked from the 22nd May to 3rd June. On the 4th June one regiment of three battalions was formed into one battalion of three companies. They could muster only 290 rifles and 3 machine-guns. The San had already been forced by the Prussian Guards, and a fortnight later the Russians retired from the river line.

Moltke and Conrad, the respective Chiefs of the General Staff of the two allied armies

at the commencement of the Great War, by Lieut.-Colonel Dettmer, reprinted by permission from *Deutsche Wehr*. The author starts with a comparison of the situations in France and in Galicia in September, 1914, in both cases the armies of the Central Powers conducting a general retirement, in France without having fought their battle out, in Galicia only after a hard struggle for success. He then asks, "Would the German armies have been withdrawn from the Marne if they had been under Conrad von Hötzendorf, instead of under Moltke, or would the battle have been fought out to its probably victorious end?" In order that every reader may be able to judge on these points for himself, Col. Dettmer then runs over the main happenings in Galicia on the assumption that they will be less well known than the events in France. He thinks that the disaster to the Third Austro-Hungarian Army on August 27th would have brought about a general retirement to behind the line of the San, if Moltke had been C.G.S. on the eastern front instead of Conrad. The method that the latter adopted of dealing with this new and adverse development was typical of the man. Instead of retiring his two victorious armies of the left, the First and Fourth, he sent the Fourth Army to the aid of the Third, a distance of 70 kilometres, leaving only two corps to hold the Russians, to cover its rear, and to keep touch with the right of the First Army. This was a strategic manœuvre of great boldness. It accorded with Conrad's ideal of attacking, and, although it did not bring success, it enabled the Austrians to fight on until every prospect of success had disappeared.

To his own question the author replies, "I find only the answer 'The retreat on the Marne would not have taken place.' The battle would have been fought out.'" It will not escape the observant reader that Col. Dettmer, in his answer, perhaps wisely, avoids using the pregnant words in his question "probably victorious."

Clear Thinking in Leadership and the Clear Wording of Orders. Major-General Paschek follows up his last article. He develops on broad lines a method of thinking things out, but is at pains that this method should not become a scheme or plan. On the contrary it is intended to show that what is essential and of the greatest importance can always be discovered by clear and ordered thinking, and is then to be used as the governing idea for the giving of orders. The genius may follow his own light, but since military leadership, like every other purposeful form of mental activity, is subject to the eternal laws of logic, a plan, if only for educational purposes, would appear to be necessary for the average leader.

The Full Incorporation of the Militia into the Framework of Italy's Armed Forces. This is the story of a great—to soldiers it would appear almost impossible—achievement. To start with, the word "militia" is somewhat misleading, since it will be generally understood to mean a military force of a lower category than the regular army, less well trained and less well equipped. The Blackshirts, or Fascists, to whom the reference is, were, however, not raised as a military, but as a political force. Their military training was scanty. They did not aim at being soldiers. Their duties were to do all those things for the new Fascist state which the State would not willingly ask the army or even the police to do, but for which uniformed bands of enthusiastic political supporters formed an admirable instrument. That the armed forces of the Crown should look anything but askance at a new armed force in their midst would be too much to expect. There was little love lost between the army and the Fascists ten years ago. *Nous avons changé tout cela.* The successive stages by which this wonder has been brought to pass are:—

(1) In 1924 the political army known as the Fascist Militia is nominated to be "a constituent of Italy's armed power."

(2) Mussolini the next year takes over himself the portfolios of the Army, of the Navy and (a new one) of the Air. He appoints three under-secretaries of state to assist, choosing a Fascist, Balbo, as under-secretary for the Air. He is himself also "General Commandant" of the Fascist Militia.

(3) Blackshirt battalions are formed within the Fascist Militia, consisting only of soldiers who have completed their regular army service. These are exempted from their Army Reserve service by a ten years' engagement in the Blackshirts. These battalions, composed of reservists carefully picked, become *élite*-troops. They are posted, one or two, to every regular division, train with that division and are designated for tactical use as "storm-battalions." The importance of this move, considering its effect upon the attitude of the army in general towards the militia, can hardly be over-estimated.

(4) At the end of 1930 a new Act introduces compulsory military training for all males capable of bearing arms of the ages 19 and 20. This military training to be carried out by the Fascist Militia, who will at the same time educate in the Fascist sense. The Militia thus became intimately connected with the Navy and Air Force as well as with the Army.

(5) On the 18th September, 1934, the draft of a new Act is published, which provides for "the military preparation of the nation." Its introductory axiom is "The activities of the citizen and the soldier are in the Fascist State inseparably connected." It ordains pre-military training for all boys "capable of defence" from the age of 8 to the age of 18, the same to be carried out under the Fascist Militia. The ages of 19 and 20 had already been catered for. In addition all schools have to give 20 hours' training a year in military subjects for five years.

It orders also post-military training for all who have completed their service in the Army, Navy or Air Force. The training will last ten years and be carried out principally on Sundays and holidays. The responsibility for this training lies with the Fascist Militia, although the programmes will be drawn up by the ministries concerned.

According to the anonymous writer of the article, it is this last measure which completes the complete fusion of the Militia formerly entirely and now mainly a political army, with the rest of Italy's armed forces. That anything on the face of it so very unlikely should come to pass shows what can be effected by the powerful combination of dictatorship, genius, and a very long time.

The French Air Manœuvres, 1934. The underlying idea of these manœuvres, in which a record number of 500 aeroplanes took part, was that the capital of the Red Forces, Paris, was attacked in a time of political tension, without the declaration of war, by the superior air forces of an eastern neighbour, Blue. The frontier between Red and Blue ran south from a neutral state through Longuyon, Commercy, Langres, and Dôle, to Geneva, thus providing Blue with eight good French aerodromes. Considering the bad weather experienced, flying performances were reported as "very good." The experiences of the manœuvres are naturally being exploited for propaganda purposes. The fact is emphasized that the new types of machines shown were only single specimens, while the mass of the air fleet is five years old and out-of-date. The successful attacks by Blue are represented as revealing a severe menace to France, whereas they really show how well equipped France is for offence.

The Air Threat to Hungary, by Major Szentnemedy, G.S. There are in this article lists of figures which have been compiled with the idea of showing the vulnerability to the air of a number of European countries. This is to be deduced from each country's total population, its population living in large towns, number of large towns (over 300,000 and over 100,000 inhabitants), area, number of inhabitants per sq. km., percentage area under cultivation, percentage area uncultivated, percentage of population engaged in industry, and percentage of population engaged in agriculture. Another factor in vulnerability, which the lists do not indicate, is the number of large towns, which are industrial centres, lying close to the frontiers. That the number of these in the case of Hungary is particularly high is shown by a map

wherein are seen to lie along Hungary's northern (against Czecho-Slovakia) frontier all those industries, etc., mines, coal, iron and ores, oil refineries, chemical and machinery works, which are *most* susceptible to air attack. The other frontiers are far less exposed, but are opposite Austria, Jugo-Slavia and Rumania, who are less dangerous. From a study of his tables the author deduces that England, Germany and Hungary would commit real suicide if they did not in time devote greater attention to air defence measures.

F.A.I.

WEHR UND WAFFEN.

(*October*, 1934.)—*The Departure Errors of a Projectile due to the Motion of a Ship.* Having dealt with the effects of rolling and pitching on gunnery, Dr. Hanert here investigates mathematically the effects of altering course.

Peace Training and War Experience. General Marx continues his artillery reminiscences, the object of which is by instances to show where peace training was inadequate or even wrong. His memory of detail, and of the smallest happenings in 1914 and 1915, when he was commanding a field battery, is at times almost uncanny, but it makes the pictures vivid. Every incident, every fire order goes down. He remembers the gun horses by name. He recalls everything, from the sight of the B.M. passing the battery in action at full-split " with his invariable crumpled cigarette," to the thrill of seeing a French line of skirmishers debouch from a wood and advance directly towards his guns, at a time when the infantry escort to the latter had not yet arrived, and there happened to be no German infantry in front. He points out the inaccuracies in the maps. He sees all and knows all, in fact, as the Germans themselves say, " he hears the grass grow." The human side also comes out strongly in these adventures, *e.g.*, when, in noting errors or omissions of the French artillery, the writer softens his criticism by referring to the French battery-commander opposite as " my colleague." Another instance occurred in the Argonne, when, having established through a captured F.O.O.'s party the identity of a particular French battery, it was decided on the 22nd August, 1915, to mark the first anniversary of the two batteries meeting in action, by sending greetings. After much consultation as to the best method of keeping a live shell from bursting, an intended dud was fired bearing the message, *Salutations de vos voisins de Joppécourt*, 1914—22/8—1915.

Technics and Tactics of the Gun-carrying Aeroplane. The French technical press has been occupied for some time with this subject, and opinions vary, always excepting one point of universal agreement, and that is that for any use of the aeroplane-gun except firing in the direction of flight, owing to the great effect upon the trajectory which is due to the aeroplane's motion, we are not yet sufficiently prepared. The whole question has been handed over to a Technical Commission to work out, but meanwhile practical trials with fighters having a forward gun built in under the limitation mentioned have been successful. The gun and engine are therefore organically connected. The best such combination is said to be the Hispano-Suiza, 860 H.P. at 4,000 metres (775 at ground-level), 12-cylinder, weight with gun and ammunition ½-ton. The gun is a 20 mm. Q.F., firing all kinds of projectiles, *e.g.*, incendiary shell, rate of fire similar to that of m.g's also firing through the nave of the propeller. The gun with 60 rounds of ammunition weighs the same as two Vickers-Maxims with their normal load of ammunition. For that, however, the gun takes up less space than the two Vickers, and hence is specially suitable for small 'planes like fighters. Tracer ammunition is used for fire correction. Fire can thus be opened at 800 metres, instead of at 300 metres, at which range it first becomes effective with the latest Vickers-Maxim m.g. pair. This is the gun's chief advantage. Even a moderate pilot in a single-seater fighter with a gun should be able to chase a heavy-bomber and get off 30 rounds at it while outside m.g. range.

The Development of the Railways behind the British front in the Great War. Under this promising title appears no technical article, and no history, hardly even an account, of the development of the railways behind the British Army in France, but many passages on the Transport question which are flattering to Mr. Lloyd George and to Sir Eric Geddes, but to no one else. The source of these passages is given as the former's *War Memoirs*, Vol. II. This book has something to answer for if it can mislead a foreign reader into saying " Sir Eric Geddes succeeded in convincing G.H.Q. of the importance of railways to the conduct of modern war."

The Air Forces of the different Nations. An appropriate quotation from General von Seeckt's " Thoughts of a Soldier " serves as an introduction to this series :—" In, and to a great extent only since the Great War the air arm has stepped into a position of equality alongside the land and sea arms, the principles of war remaining unchanged. It would be frivolous to deny or palliate the dangers and horrors of air attacks behind the front, especially in conjunction with the use of gas. War will start with the attack by the air fleets of both sides, because they are the forces which are quickest to be ready for use and quickest to reach the enemy. A wealth of problems, military and economic, arises when we think out these questions."

The first country to be dealt with is Great Britain. Here new types of military aeroplanes are being ordered in such numbers as to necessitate great extensions of factories, *e.g.*, when Hawker Aircraft Ltd. acquired the large concern of the Gloster Aircraft Coy. This firm alone has produced eight different types of aeroplane during the past year, besides fulfilling orders for the Gloster Gauntlets, single-seater fighters with Bristol Mercury VI S2 engines of 575 to 605 H.P. Various units have been equipped with Hawker Demon two-seater fighters, having Rolls-Royce Kestrel engines, with Hawker Harts, Hawker Ospreys or with the Hawker Hardy, a general-purposes 'plane, evolved from the Hawker Hart day-bomber, and specially suitable for the Colonies. Another general-purposes 'plane (fighter, reconnaissance and bomber) deriving from the Demon is the Australian Demon, of which eighteen have been ordered by the Australian Government, average speed 160 m.p.h. For army and navy co-operation two more Hawker types have been issued, the Audax reconnaissance two-seater and the Nimrod single-seater.

Typical of the British aeroplane industry of to-day is the tendency for the same firm to produce the whole machine instead of body, engine and propeller being produced by different firms. Thus, de Havilland first made aeroplane chassis and then extended to making their own Gipsy engines. Siddeleys, who made automobile engines before the war, expanded during the war to the making of aircraft engines, then at the instigation of the British Government to the manufacture of aeroplanes, at first with Armstrongs, and now independently. This rationalization started with the Bristol Coy. which joined up with the Cosmos at the end of the war, a combination which produced the Jupiter, Mercury, Pegasus, Perseus and Phœnix engines. Thus in the aeroplane industry are seen a similar situation and lines of development to those of the car industry. A recent example is furnished in the purchase of the Circus engines by Philipps and Powis of Reading. Where complete amalgamation of firms has not taken place, large purchases of shares or other financial measures are the forerunner of such amalgamation, *e.g.*, between Rochester Popjoy Airmotors and Short Brothers. A recent case of fusion is that of Blackburn taking over the Cirrus Hermes Engineering Coy., and transferring it to Brough.

Also to be reckoned as part of the rationalization of the aircraft industry is Great Britain's endeavour to obtain aeroplane motor spirit out of its large resources of coal. During 1933 one R.A.F. squadron operated solely upon petrol produced from British coal by the process of the Low Temperature Carbonization Coy. with results so satisfactory that the Air Ministry decided to extend the trials to include seven more squadrons. This company has produced up to now 100,000 tons of petrol out of a million tons of coal. When its two new factories are complete the company will be in a position to produce more than twice the requirements of British military aviation.

As is the case with fuel, so in England the greatest attention is paid to the engine-question. Thus the favourable results in military aviation obtained with Armstrong-Siddeley engines have led to the latter being continually further improved. Especially in 'planes for training purposes their seven-cylinder engines, Genet-Major, Lynx and Cheetah, are in use. All three patterns have electric hand-starters, as have the more powerful Panther and Tiger (at present 14-cylinder 640 h.p.). All these engines have the new, light, simple membrane petrol-pump with automatic regulation. Notable progress has also been made by the Bristol Works with their Pegasus and Mercury engines, the latter running on the new fuel DTD230 with Lead Ethyl.

Another department to which the English pay attention is that of new materials for aeroplane-construction. Here are deserving of mention Tungum, sold by Wilbraham and Smith, for pipes and containers of all sorts, and a new light alloy produced by High Duty Alloys Ltd. called Hiduminium.—(*To be continued.*)

Reliability Trials of Motor Transport with home-produced Fuel and artificial rubber Tyres. These trials of the Union of German Engineers and the Automobile and Aircraft Technical Society, with Government support, will take place in the spring of 1935. Their object is to show what has already been achieved, but also to prove that as regards motor transport Germany's independence of supplies from abroad can be regarded as secured.

Germany's Raw Materials. The R.T.A. (National Society of Technical Scientific Work) passed a resolution on 18.9.34 that German economics should be based upon German raw materials. The presiding body of the Standards Committee and all unions and societies interested in standardization have unanimously voted for the same object. The work to start immediately.

Measurements of the Amount of Moisture in Wood. Siemens and Halske have produced a portable apparatus for determining the moisture content of wood. Direct current, produced by means of a hand-generator, passes between tinfoil electrodes on rubber pads through the sample of wood until a condenser is charged and a glow-lamp lights up. The time taken to charge the condenser depends upon the ohmic resistance of the wood, which again is a measure of the moisture it contains. The percentage of water is read off the scale corresponding to the time taken. The moisture range of the instrument is 5% to 22%. The degree of accuracy claimed is $\pm 1\%$ from 5% to 12% of moisture, and $\pm 2\%$ from 12% to 22% of moisture.

(*November*, 1934.)—*The Use of Artillery against Tank Attacks.* The writer is an artillery officer with war experience against tanks. His conclusion is: The direct fire of single guns will not stop tanks but at most make them change direction and drive faster. Hence, where a tank attack becomes visible a barrage must be laid in its way, in which all batteries take part, for which this is ballistically possible. This means dispersed fire, oscillating fire (*tir fauchant*), very rapid fire and—much ammunition.

French and American Methods of A.T. Defence. The difference between these two methods arises from the nature of the A.T. weapon used, the assumed speed of the tank (France, not more than 8 m.p.h., U.S.A. 24 m.p.h.), and differing ideas of the reliability of the human factor. The American method stands and falls by the high degree of training and other high qualities of the gun-layer, who has to observe at 1,500 metres the burst of his first round, work out and apply the necessary correction, so as to be able to "aim on" for the next round. The French method makes less claim upon the individual. It is based upon key-ranges, dropping 200 metres at a time. This "mechanized" shooting is more wasteful of ammunition, as the first round fired at a tank as it passes from one zone into the next will always be short. These methods are of special importance because tanks and A.T. guns will always be found at the very centre of where the decision takes place.

Aeroplane Guns. The question is no longer discussed whether aeroplanes are to be armed with guns, but only with what guns, and how. Colonel Blümner here runs

over the whole subject: the aeroplane gun's inception in the Great War; its development dropped at return to peace; the subject re-raised owing to the air manœuvres in Great Britain, France and Italy having shown that there was no satisfactory answer to the attacks by large bombers; hence the necessity for the single-seater fighter to carry a gun firing an explosive shell, thus becoming, as *Les Ailes*, says, "the unlimited ruler day and night of the space through which it flies"; the consequent extension of the gun to all aeroplanes, except perhaps reconnaissance machines; the present state, patterns and details of the aeroplane gun amongst the leading countries, especially in France and England.

The Problem of the Wide Shot. Lieut.-General Rohne, who is an Hon. D.Eng., says he has been almost exclusively occupied with this problem for three years. Cranz, in his *Ballistics*, p. 420, mentions no less than eight mathematical lights who have studied the question. He himself gives six different rules which, he admits, only partially accord with each other. General Rohne's definition is that generally accepted in musketry, viz., the wide shot is that hit the neglect of which leaves the remaining hits more in agreement with the laws of probability. He shows here how he arrived empirically at an expression for testing this fact, viz., it is a wide shot when

$$\frac{K}{w} \text{ is } > \frac{n-1}{\sqrt{n}}.$$

K being maximum deviation, w being the most probable deviation, and n the number of observations. Whether this is capable of purely scientific proof he does not know.

Strategic Demolitions Carried Out by the British Fifth Army during the Battle of the 21st to 27th March, 1918. Taken from the late General Buckland's account of the same in *The R.E. Journal*, March, June and September, 1933, but entirely re-written. Comparisons are unavoidable, the writer finds, with preparations for similar demolitions made before the German retirement the previous spring to the Alberich Line. He recognizes, however, the great difference in that the 1917 retirement was voluntary, limited in extent, and took place at an appointed time. Regarding the Fifth Army Orders of 10th February, Colonel Wabnitz asks several pertinent questions and points out the confusion caused by their lack of clearness. He considers that, given clear orders and good organization, there would, by concentrating as much as possible on the important jobs, have been just about sufficient time for the available R.E. to make the necessary preparations between February 15th, when A.H.Q. ordered "preliminary measures," and March 21st when the attack came.

The Air Forces of the Different Nations gives a comparative table of air force strengths, material and personnel, of 15 powers, and concludes the account of British activity by mentioning new types like the autogiro "La Cierva C.30," of which Roe and Coy., of Manchester, are delivering ten for army co-operation, and innovations like Exactor control, invented by Hele-Shaw and Beacham, and Goodyear spur-wheels.

Figures are also given of France's expenditure on air power in 1934 and a forecast of expenditure for 1935, under six different headings, of which the leading item, "new equipment," rises from 170 to 450 millions of francs.

(*December*, 1934.)—*Thoughts about the Development of Artillery.* Considering the various new tasks which the artillery of the future will have to perform, and the lack of war experience with the much improved weapons of to-day, a certain restraint in providing new armament for the artillery is justified. The most important tactical demands, like great speed and cross-country powers, high state of fire-preparedness and rapidity of fire, must not be gained at the expense of fire effect and accuracy. Every solution will thus be of the nature of a compromise. Capt. Vieser gives a list of the types composing the U.S. artillery of to-day as showing better the trend of

modern artillery development than those composing the artillery of any European power.

Anti-Tank Defence. Major Schneider thinks that the neglect of this subject contributed to a great extent to Germany's defeat in the last war, and that anti-tank defence is perhaps the most important branch of Germany's future weapon technics. He examines the conditions of a field artillery barrage laid down at 3,000 metres and, allowing 20 metres of front to each gun, he finds that the tanks will pass through this barrage in exactly 30 seconds, so that the chance of any one tank being hit is ·2%, or ·8% if four rounds per gun are got off in the time. He concludes that the only effective A.T. defence lies in aimed and observed fire.

[*Note.*—The contrary opinion held by a writer in the last number was arrived at, not by calculation of the tank's chance of passing unscathed through the barrage, but from observation of the moral effect of a barrage by light and heavy howitzers at Berry au Bac upon the drivers of the French tanks. On approaching the barrage tank after tank baulked, and the crews abandoned ship. The prospect of being burnt alive as a result of a direct hit was more than the drivers' nerves could stand. Confirmation of this was obtained when, after the successful Chemin des Dames offensive, the Germans were able to examine the numerous abandoned tanks.]

Fifth (British) Army Demolitions, March, 1918. Colonel Wabnitz continues his account up to and including "Orders for the destruction of the bridges." In his study he has compiled separate lists of bridges, one for each corps, IIIrd, XVIIIth, XIXth and VIIth, giving for each bridge, by whom it was prepared, to whom handed over, by whom and when charges were fired, and the result. He compares, but without rubbing it in, our hurried, confused and sometimes contradictory arrangements with those of the Alberich operation, the bridge demolitions of which took place "without friction and without hesitation."

A "Sentinel" Eight-wheeler, Steam-driven. A short note with photographs of a product of the Sentinel Wagon Works, Shrewsbury. This lorry, driven by a 120 h.p. four-cylinder steam-engine, is chiefly remarkable for two things: the enormous load carried, 13 tons, and the construction of its two front axles carrying four steering wheels.

The Air Forces of the Different Nations. These notes consist chiefly of gleanings from *The Aeroplane* and from *Aviation*, with a strong bias to the statistical. They would be called in the army "Intelligence Summary" or "Comic Cuts," depending upon the company and speaker. Selected items are:—the French Air Ministry has bought, from the American firm Lockheed, a two-engined Electra aeroplane for 150,000 francs, and the licence to manufacture this type in France for over two million francs. A scheme has been started for the removal from the neighbourhood of Paris of all factories producing aeroplanes, kite balloons and aircraft engines. France has budgeted 50 million francs for the A.A. defence of the north coast of Africa, and 17½ millions for seven new hydroplanes of different types. The British Air Ministry estimates at 1½ million pounds the cost of the new air base on the Indian route at Dhiban on the Euphrates. The increase of 40 squadrons in the R.A.F. (460 machines, mostly bombers) will be carried out at the rate of four squadrons in 1934, and nine a year until completion in 1938.

F.A.I.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*August*, 1934.)—A photograph of the late Field-Marshal von Hindenburg, studying a map, divider in hand, is the frontispiece, facing appropriate messages by the Army Minister to the army in general, and by the Inspector of Pioneers and Fortresses to his own corps.

Frederick the Great on Attack and Defence. Five maxims from Frederick's writings dealing with the pure defensive, the true defensive, the art of fortification, choice of a position, and attack of a position. They are printed here as texts in black-letter type.

The Belgian Inundations of 1914. The story is told here prosaically, but it is dramatic enough. On the 20th October the German Fourth and Sixth Armies were advancing parallel to the coast, bent on destroying the remnants of the Belgian Army. The line of the Yser was taken and the Belgians had retired to behind the Nieuport–Dixmude railway embankment when, on the 31st October, the German advance suddenly turned into a retirement, the troops being knee-deep in water. Whoever was responsible for this far-reaching strategic measure—and the point is by no means clear, since many authorities claim the honour—there is no doubt as to who did the work, viz., the engineers of the Belgian Army. The officer responsible, Major Thys, has published his experiences in a book *Nieuport*, 1914–1918, which is the principal source of this account.

L'organisation du terrain. Introduces a series of articles dealing with the defensive in general, and with field fortification in particular, the whole being treated from a characteristically French point of view, as laid down in *L'instruction provisoire sur l'organisation du terrain.* The first article deals with tactical considerations, the principles of leadership and training, thus corresponding with Part I (1927) of the regulations mentioned.

Co-operation or Subordination. In other words, are the Pioneers (Divisional Engineers) to work for the infantry under the infantry commander's orders, or are they to be given their tasks by other authority, with instructions to co-operate? The writer inclines to the latter view, but his article shows that the last word has not been said on the subject.

Training of the Pioneer Company. Movement on the Water without Engine-power. The object of this part of recruit training should be to turn the land-lubber into a waterman. There is in water work a double training. Besides the military training in the effecting of river-crossings, there is the training of the individual in handiness, endurance, and independence. The writer's criterion for the waterwork of the company is the number of recruits who can really punt single-handed. He says that the company which is good on the water will be reliable everywhere.

The remaining articles in this number are:—An Exercise in Field Fortification; the Spirit of the Field Pioneer; the Drainage of a Position; facsimile of the preface of a handbook for "officers who wish to become field engineers, or to serve in campaigns with profit," with examples from the last war (1756–1762) and the necessary plans, by Captain Tielke, Electoral Saxon Artillery; an Inundation Exercise; the Crossing of a Terrain of Shell-craters; Pioneers in Locality Fighting, 1914; Gas Pioneers in the Great War; Nobiling's Patrol (destruction of the railway south of Verdun); The Patron Saints of the Artillery and Engineers (a reproduction of Gobelins from the staircase of the officers' mess of the former Guards Pioneer Battalion); Repair of a Broken Dyke; A trip on the Danube; Sailing; Diesel Engines without Compressors; the Bosch-Dewandre Under-pressure Brake.

The photographs, maps, illustrations and get-up are admirable.

(*November*, 1934.)—A photograph of Major-General Unverzagt, Pioneer General in the 7th Army, who was killed at Dormans in July, 1918, is the frontispiece, faced by extracts from his last letters.

Great Leaders on the Value of Fortresses. Two pages of extracts from the writings of Frederick the Great, Clausewitz, Napoleon, Moltke and Count Schlieffen.

The French South-Eastern Fortifications in 1914. An investigation of what purpose these fortresses were intended to fulfil, and of the part they actually played in 1914. The writer shows that, while holding up the German 6th and 7th Armies, the fortresses enabled one after another three French corps and two cavalry divisions

to be withdrawn to reinforce the left and centre. Further, he deduces from their various effects upon the course of operations nine different points which fortresses can fulfil, provided they are sited in accordance with the commander's strategic intention. He agrees with the French opinion that Belfort, Epinal, Nancy and Toul fully justified their existence by the part they played in 1914 alone.

L'organisation du terrain (continued).—Deals with the fire plan and with technical details of fire positions, m.g. posts, shelters, dug-outs and obstacles.

The Question of Armour. The rapid fall of the Belgian fortresses appeared to indicate a decisive superiority of the projectile over armour. This was not borne out by subsequent examination of the damaged forts, nor by the experience of Verdun. Hits by shells up to 16·8 in. on the armoured turrets of Douaumont and other forts caused only damage that could soon be repaired. This article shows, by means of photographs, cupolas put out of action when the fault lay chiefly with bad design or inferior concrete, especially examples of "under-hitting" when turrets stood, but their concrete bases were shattered. Such cupolas had mostly not been designed to withstand high-angle fire. A section of a cupola is given here as it should be, deeply bedded and well bolted down, with a broad base resting on (the best) concrete, floated in (the best) P.C. mortar, the cupola shored up on a steel cylinder which serves as lining to the shaft.

Training of the Pioneer Company. According to the A.V.G. (Training Manual for Mountain Troops) the making of paths, footbridges and fire positions is to be done by the troops concerned, the pioneers of mountain troops being reserved for more difficult tasks, roads, bridges, rock-boring, erection of ropeways, provision of shelters in rock and ice. Four weeks in the winter and ten days in summer are all that can be allotted for high altitude training. As the trained pioneer must be used to rock climbing roped, and be able to negotiate snow slopes on skis, carrying a good weight, it is best only to take men who have been brought up in the mountains.

The remaining articles include:—Manonviller Fort, the covering fort of the *Trouée de Charmes*, its story and capture; the French and Belgian Eastern Fortifications (with a map); Douaumont; Reinforced Concrete as Armouring; the Provision of Protection against Gas in the Building of Fortifications; the Fortress of Berlin; and a description with photograph of the Mercedes-Benz cross-country, six-wheeler, type G3a, 65 h.p., useful load 1 ton across country, 1½ tons on the road.

F.A.I.

THE INDIAN FORESTER.

(October and November, 1934.)—Life in a Himalayan Valley occupies a considerable space in these numbers. The valley in question is the Northern Tons, in the extreme north of the United Provinces; it is well out of the beaten track, and hence the manners and customs of the inhabitants are all the more interesting. The article is well written and illustrated with excellent photos.

Poisoned Waters, in the October number, propounds the interesting theory that the drinking of water contaminated by certain salts brings out latent malaria in a patient, without the intervention of the *anopheles* mosquito. The salts in question exist in the water of wells dug in laterite, and chlorination has no beneficial effect. After a week's drinking of such water, and it should be added after considerable experience of similar water in other parts of India and in East Africa, the author found that he had to start choking off incipient malaria, and "came to the welcome conclusion that the only safe water to drink was"—whisky.

There is as well a note on the partial destruction of a railway carriage by white ants, causing Rs. 3,000 worth of damage. We are not told if the carriage was running during that period, but the railway staff might be excused for regarding the wheels and rails as giving sufficient insulation.

The most interesting article, in the November number, is one by F. W. Champion on the preservation of wild life in the United Provinces. The increase in the number of cars and rifles within the last few years has, according to the writer, led to a very serious depletion of game in that province, and, says he, in a few decades there may be nothing but jackals and monkeys left. His suggestions for remedying this state of affairs are sound and worthy of consideration by the authorities. Forest officers are, it must be remembered, the game wardens of the districts for which they are responsible, and their views on the preservation of wild animals particularly valuable.

(*December*, 1934.)—The December number contains two excellent big game stories which will bear repeating. One is of a tiger, which, during the recent heavy floods in Assam, took refuge in the Divisional Forest Officer's office, and remained there all night rather than face the wet outside, in spite of an attempt by the Forest Guard to drive it out with blank cartridges. The other is of the chase and destruction of a full-grown panther by a pack of wild dogs.

The Monas game sanctuary, Assam, is another interesting article. It is sad to relate that the rhinoceros is fast disappearing in that part of the world, owing to the depredations of poachers. Rhinoceros horn is used by Indian and Chinese, especially the latter, as an aphrodisiac; it is said that a horn will fetch Rs. 15 per *tola* (nearly £3 per ounce) in Calcutta. As horns run up to 20 inches in length by 24 inches in basal circumference, the value of a horn to a drug-seller is almost fabulous. No wonder, then, that organized poaching is rife and that on one occasion a detachment of the Assam Rifles (military police) was called out against the gangs.

Mr. Muir, an officer of the I.C.S., contributes an article, with photos, on the abnormal growth of a cypress tree, on the steep slopes of Cheena, the hill overlooking Naini Tal. Some 40 or 50 years ago, apparently, the tree in question suffered the loss of its trunk by an accident, leaving a horizontal branch about 10 feet long sprouting from the stump almost at ground level. Its tip then proceeded to grow vertically, when the branch became a cantilever with an increasing load at the unsupported end. Normally, a horizontal branch grows by increasing its diameter equally all round, so retaining its circular section, but this cantilever branch acted exactly as if it were working out an engineering problem, and, ceasing its growth on the upper or tension side, developed enormously on the lower side, until its section became, as it is now, that of a rather elongated egg, with the small end uppermost. The author searched round for further examples and discovered at least one. The explanation he offers is that compression stimulates the formation of wood, while tension, or perhaps the absence of compression, inhibits it.

Mr. Trotter describes the substitution of special pneumatic tyres, provided by the Dunlop Rubber Co., India, for the familiar iron tyres on bullock and camel carts. The result is a great gain in efficiency—loads at least 50% greater can be carried at a faster pace with the same tractive effort. It is also claimed that very much less damage is done to the road surface below—a claim of great interest to Sappers with experience of road maintenance in India. The cost is, of course, greater than that of an ordinary bullock or camel *gari*, but a quotation of Rs. 102 for complete wheels for an axle load of 1,340 lb. cannot be called excessive. Unfortunately, the Indian bullock cart proprietor is seldom sufficient of a capitalist to be able to afford this sum.

This number closes the sixtieth annual volume.

F.C.M.

CORRESPONDENCE.

To the Editor, *R.E. Journal.*

THE LYDD MILITARY RAILWAY.

DEAR SIR,

I have read with great interest the article by O. J. Morris in *The Locomotive* of August 15th, 1934, a review of which appeared in *The Royal Engineers Journal* for December. It takes me back to the summer of 1893, when I was a subaltern in the 9th Fortress Company.

This Company was sent from Chatham to perform Royal Engineer duties at the Siege Artillery Camp. The arrangement was that it should be commanded by the Division officer there, at that time Captain (now Colonel) E. F. Taylor. A detachment of the 8th Railway Company from Chattenden was attached for the working of the Military Railway.

In the previous year a subaltern of that Company was attached also. On leaving the S.M.E. in the autumn I was attached to the 8th Company for two months, and presumably was considered fit to undertake the necessary railway supervision.

Mr. Morris states that only two of the old Suakin Berber Railway locomotives had been re-shipped to England, and were used at Lydd from 1885 to 1906 and 1907. At least one more must have been brought back.

After a short time in 1893 I reported unfavourably on one of the two locomotives, a report endorsed after expert examination. A third, therefore, was sent from Plumstead Marshes. It had stood there for eight years and was dispatched on its own wheels, without being lifted. Rain had dripped into the lubrication holes in the bearings and had rusted patches on the axles.

Consequently, when the engine arrived at Lydd, some of the brass axle-boxes had "run," owing to the friction developed. Further delay occurred, but the engine was taken into service during the summer.

There were no gun trucks among the rolling-stock, as Mr. Morris presumes, because the guns and howitzers were fired from the near end of the range. On arrival in the Mess, I looked through the window and remarked to Taylor that I did not know the firing took place over the sea. It was my first sight of a "mirage," caused by the heated air rising off the shingle. A morning's work raised a

magnificent thirst, rather hard to satisfy when the mess was crowded by a course of attached officers, including Australians.

Experimental guns were fired from a splinter-proof by electricity. The first Lyddite shell ruined a howitzer by bursting in the bore and bulging the jacket. I heard that a protective iron disc had not been removed on fusing the shell.

That summer, also, Colonel Cowan carried out experiments to ascertain the extreme range of the Lee-Metford rifle. At the extreme range his observers failed to hear a single bullet drop out of fifty fired one after the other. He asked me what could have happened to the bullets, but I could not explain.

The Military Railway took off the South-Eastern Railway, with a physical connection at Lydd Station. It ran over waste land and between cottages until the shingle was reached. Over this length of a mile or more there was a strict speed restriction to four miles an hour.

At the far end of the range there was a wicked curve to the right to serve the various targets. A train was run four times a day to take down markers and working parties and bring them back to dinner. This curve I re-aligned, the work also involving a shift of a turn-out. For this remodelling I made my first theoretical calculations in permanent way work. We extended the railway, with a trestle bridge over one of the innumerable ditches of Romney Marsh.

The speed limit I have mentioned was once greatly exceeded by myself under orders. A committee had come down and their deliberations were so prolonged that their intention to drive to the station to catch the last train had to be altered. Taylor ordered me to drive them by train, as he could trust me not to take undue risks.

The engine was not attached to the carriage, and my haste to couple up resulted in a bad bump ; in fact, only at the third attempt did I succeed. I was told afterwards that the committee were dancing with rage, with a good prospect of having to spend the night at Lydd after all.

When we were still a mile from the station I could see the South-Eastern train just about as far away on the other side. Both trains arrived simultaneously. My passengers tumbled out and rushed across to the platform. Not one turned his head and shouted "Thank you." I fear that appreciation of the work of the Royal Engineers has never been a failing of the British Army.

Yours faithfully,

GORDON HEARN.

52, Woodbourne Avenue, S.W.16.
15th December, 1934.