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SURVEY IN FRANCE DURING THE WAR.

(Based on a Lecture given at the S.M.E. on the 10th April, 1919).

By Lieut.-Colonel E. M. Jack, C.M.G., D.S.O., R.E.

The following account of the Survey organization in France during the war will, I hope, be of interest to R.E. officers. The work done was of some importance, and was controlled entirely by R.E. officers; but little is known about it in the Corps.

The article deals in a general way with the main aspects of our work, and is divided as follows:—

I. A brief historical account of the development of Survey units.

II. A description of the organization of a Field Survey Battalion as it existed at the termination of hostilities.

III. An account of the development, from the technical point of view, of the various branches of the work.

I. General History.

The only provision in the original Expeditionary Force for topographical work was as follows. At G.H.Q. there was the Topographical Sub-section of the General Staff, known officially as I.(c), but more commonly as "Maps G.H.Q.", and consisting of one officer (G.S.O.3) and a clerk. On the L. of C. there was one officer and a clerk; and divided between L. of C. and the Army was the Printing Co., R.E. The Printing Co. was organized in four sections; one for G.H.Q., one for L. of C., and two mobile sections for work with Corps (which at that date consisted of two Divisions).

The Topographical Sub-section, or Maps G.H.Q. as it will hereafter be called, was augmented in the first month of the war by one clerk and a box-car. The L. of C. Map Section was increased before the end of 1914 to five clerks and storekeepers, and a map depôt established, first at Abbeville and later at Rouen. The Printing Co., with the exception of a small letter-press printing section which was left on the L. of C., was concentrated wholly at G.H.Q. in September, 1914, the Corps sections having been withdrawn from the Corps, who said they did not require them.

Towards the end of 1914 the need of better provision for large scale maps became apparent, and advantage was taken of the presence in France of the 1st Ranging Section (consisting of 1 officer and 4 other ranks, all surveyors) to start Survey work in the field.

The ranging section was an R.E. unit which was formed at the Ordnance Survey, Southampton, in response to a demand for some means of identifying hidden targets. The idea was that an aeroplane should, when vertically over the target, let fall a smoke bomb or other easily visible signal. The ranging section, with two theodolite observers at either end of a measured base, would fix the position of the aeroplane at the moment of signalling, and thus the position of the target. The survey part of this scheme was simple, but the part of the aeroplane presented various practical difficulties which were not easily overcome. Finally the development of wireless communication between aeroplane and battery provided a more certain means of identifying targets and the Ranging Section was no longer required.

The section was augmented by 12 topographers obtained from the Ordnance Survey, and others from Field Cos. and other R.E. units in France, and was finally, in April, 1915, attached to Maps G.H.Q. as the 1st Ranging and Survey Section, and undertook survey in the field for the whole Expeditionary Force.

In 1915 armies were formed, and in March of that year a "Maps and Printing Section," consisting of an officer, a small staff, and a detachment of the Printing Co., was formed for each of the two armies then in being.

With extensions of the front the task of survey for the whole Expeditionary Force became too great for one section to carry out; consequently in the autumn of 1915 the personnel of the Ranging and Survey Section was divided into three, forming "Topographical Sections" for the First, Second and the newly formed Third Army.

In the meantime the problem of fixing the positions of enemy batteries had been taken up in various ways, and the system developed was finally incorporated in the Survey organization, on the formation of the Field Survey Cos. in 1916.

Concurrently the system of fixing the positions of enemy guns by recording the sound of their discharge (known as Sound Ranging) was being developed. The first British section was formed in November, 1915.

By the beginning of 1916 survey work had increased to such an extent that a considerable increase in establishment was found necessary, and in February the Topographical Sections were converted to Field Survey Cos. These Cos. included a staff for survey, map compilation and drawing, battery compilation, and printing, as

well as the Observation Groups and Sound Ranging Sections. The Printing Co. personnel became definitely part of the Field Survey Cos., and ceased to be detachments from the Printing Co.

By the summer of 1916 there were five Field Survey Cos., formed on this model, for the five British armies.

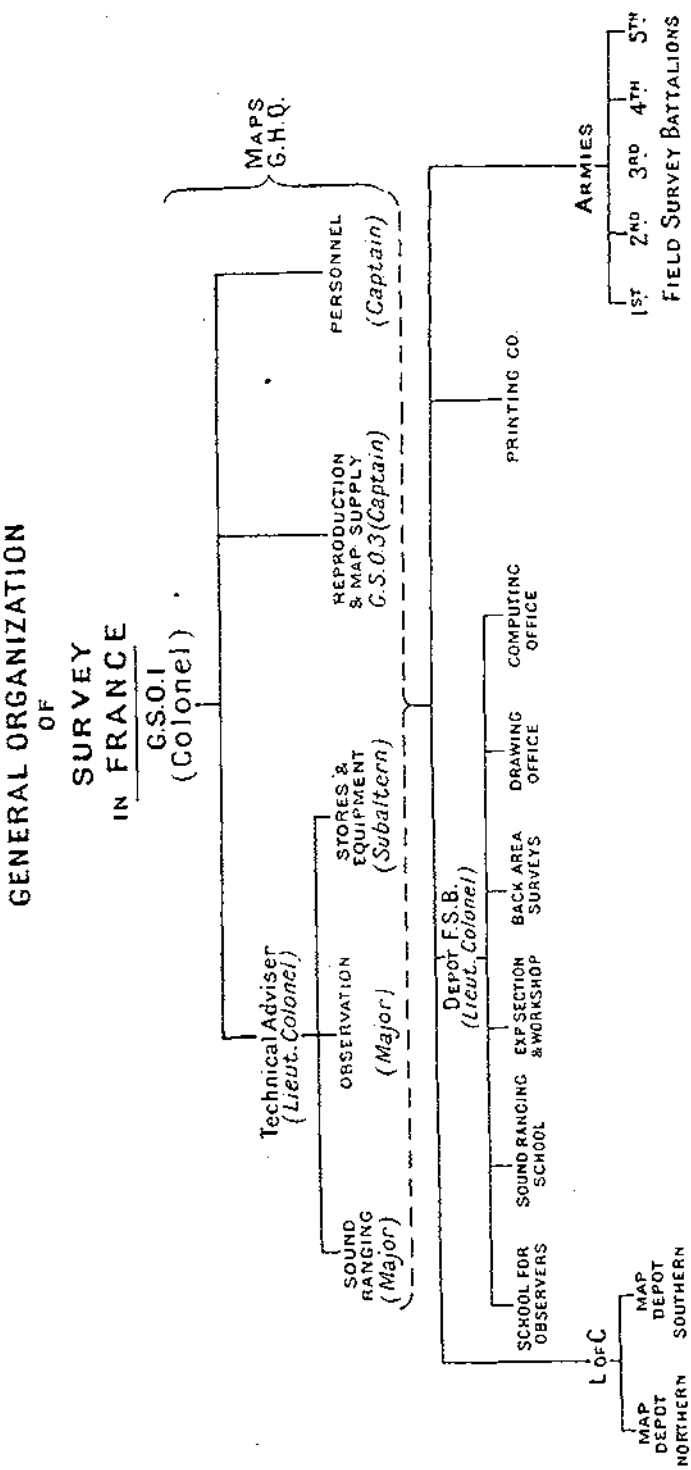
With the continued increase of the British forces, and of the front and area to be dealt with, the Corps began to feel the need of a small organization to provide for its local mapping requirements. Consequently Corps Topographical Sections were authorized in February, 1917. These sections formed a part of the Field Survey Co. of the Army to which the Corps belonged.

As the work of the Survey units expanded it became necessary to make provision for instruction and training. The Experimental Sound Ranging Section was formed in August, 1916, and transferred from the front to G.H.Q. early in 1917. At the same time the nucleus of a workshop for the maintenance of Sound Ranging apparatus was collected. In April, 1917, the School of Instruction for Flash Observation, which had been formed in the 3rd Field Survey Co., was taken over by G.H.Q. To co-ordinate these units and to superintend generally the training and supply of personnel for the Field Survey Cos., the Depôt Field Survey Co. was formed in April, 1917.

No other material change in the organization of the Field Survey units was made, but the continual growth of the work necessitated further increases in establishment, the first of which was authorized in October, 1916.

In September, 1917, authority was given for the conversion of the Companies into Field Survey Battalions, with Lieut.-Colonels in command. Further proposals for enlarging the establishment were made, but the military situation in the early part of 1918 rendered any increase impossible. In the autumn of 1918 the strength of the H.Q. Sections was increased, but at the expense of certain Observation Groups and S.R. Sections which had to be disbanded. This was the situation at the termination of hostilities in November.

In the meantime the establishment of Maps G.H.Q. had been altered and increased to meet the growing needs of the situation. The importance of the work was recognized by the advancement of the officer in charge to G.S.O. 2nd grade in March, 1915; and again, in May, 1917, to G.S.O. 1st grade, with (from June, 1918) the temporary rank of Colonel. The staff was increased in May, 1917, by one G.S.O.3, for map reproduction and supply; and in June, 1918, by the following addition, though with one exception these had been working at G.H.Q. for some months before that date: 1 lieut.-colonel (technical assistant), 2 majors (advisers on Sound Ranging and Flash Observation), 1 captain (personnel) and 1 lieutenant (equipment).


GENERAL ORGANIZATION
OF
SURVEY
IN FRANCE
G.S.O.1
(Colonel)
MAPS
G.H.Q.
PERSONNEL
(Captain)
REPRODUCTION
& MAP SUPPLY
G.S.O.3(Captain)
PRINTING CO.
ARMIES
1ST 2ND 3RD 4TH 5TH
FIELD SURVEY BATTALIONS
Technical Adviser
(Lieut.-Colonel)
OBSERVATION
(Major)
STORES &
EQUIPMENT
(Subaltern)
Depot F.S.B.
(Lieut.-Colonel)
COMPUTING
OFFICE
DRAWING
OFFICE
BACK AREA
SURVEYS
EXP SECTION
& WORKSHOP
SOUND RANGING
SCHOOL
SCHOOL FOR
OBSERVERS
SOUND
RANGING
(Major)
L OF C
MAP
DEPOT
SOUTHERN
MAP
DEPOT
NORTHERN

On the L. of C., the officer in charge, Lieut. (now Major) O. E. Wynne, R.E., having completed the organization of the work, left in November, 1914, and the Base supply was thereafter in charge of a W.O., S.M. Clemons, R.E. A large Base depôt was established at Rouen, with an advanced depôt at Abbeville. Subsequently, on the reorganization of the L. of C. into L. of C. North and South, a depôt for the northern system of supply was formed at Calais, in charge of Q.M.S. Spelman, R.E., while the depôt at Abbeville was enlarged and supplied formations on the southern system. At the same time the depôt at Rouen was abolished.

The Printing Co. at G.H.Q., having originally provided detachments for the armies, and these detachments having been absorbed into the Field Survey Cos. on the formation of the latter, remained as a separate unit responsible for letter press printing and map reproduction for G.H.Q. Its establishment was increased on two occasions. On the formation of the Depôt Field Survey Co. in April, 1917, the Printing Co. was absorbed into that unit, becoming a Printing "Section"; but on the formation of the Depôt Field Survey Batt. (October, 1917) it was restored to its former status of an independent unit.

Besides the survey units in France there were certain others that were formed mainly on our model, and for which Observation Groups and S.R. Sections were supplied from France. On the dispatch of British forces to Italy a nucleus of survey personnel was sent, which later was formed into the 6th F.S. Co. In Egypt the 7th F.S. Co. was formed, and in Salonika the 8th F.S. Co.

The following officers commanded the Survey units up to the termination of hostilities.

1st Ranging & Survey Section..	Major H. St.J. L. Winterbotham, R.E.
1st Army Maps & Printing Section	Lieut. C. Romer, R.E.
2nd ,, ,, ,,	Lieut. B. Lightfoot, R.E.
1st Army Topographical Section	Capt. W. H. Tapp, Queen's Bays.
2nd ,, ,, ,,	Major C. S. Reid, R.E.
3rd ,, ,, ,,	Major H. St. J. L. Winterbotham, R.E.
1st F.S. Co. and Batt.	Lt.-Col. H. Wood, R.E., succeeded on transfer to Salonika by Lt.-Col. B. H. Wilbraham, R.E.
2nd ,, ,, ...	Lt.-Col. C. S. Reid, R.E.

3rd F.S. Co. and Batt.	Lt.-Col. H. St. J. L. Winterbotham, R.E., succeeded on transfer to G.H.Q., by Lt.-Col. B. F. E. Keeling, R.E.
4th ,, ,, ...	Lt.-Col. M. N. MacLeod, R.E.
5th ,, ,, ...	Lt.-Col. B. F. E. Keeling, R.E., succeeded, on being wounded, by Lt.-Col. F. B. Legh, R.E.
Depôt F.S. Co. and Batt. ...	Lt.-Col. B. F. E. Keeling, R.E., succeeded by Lt.-Col. L. N. F. I. King, R.E.
Printing Co.	Capt. B. H. Wilbraham, R.E., Capt. E. E. Field, R.E., Major W. Stanford, R.F.A., Capt. T. Curr, A. & S. Hrs.
6th F.S. Co.. (Italy)	Major C. S. Reid, R.E., succeeded by Major G. F. Jones, R.E.
7th F.S. Co. (Egypt)	Major W. J. Maule, R.E.
8th F.S. Co. (Salonika)	Lt.-Col. H. Wood, R.E.

Lt.-Col. Jack was in charge of Maps G.H.Q. throughout the war, and on the termination of hostilities his staff was as follows:

Technical Assistant	Lt.-Col. H. St. J. L. Winterbotham, R.E.
Adviser on Sound Ranging ...	Major W. L. Bragg, Leic. R.H.A.
,, Flash Observation ...	Major H. H. Hemming, R.F.A.
Officer i/c Map Supply	Capt. E. E. Field, R.E.
,, Personnel	Capt. G. Carlyle, R.E.
,, Equipment	Lieut. G. Allingham, R.E.

II. Organization of the Field Survey Battalion.

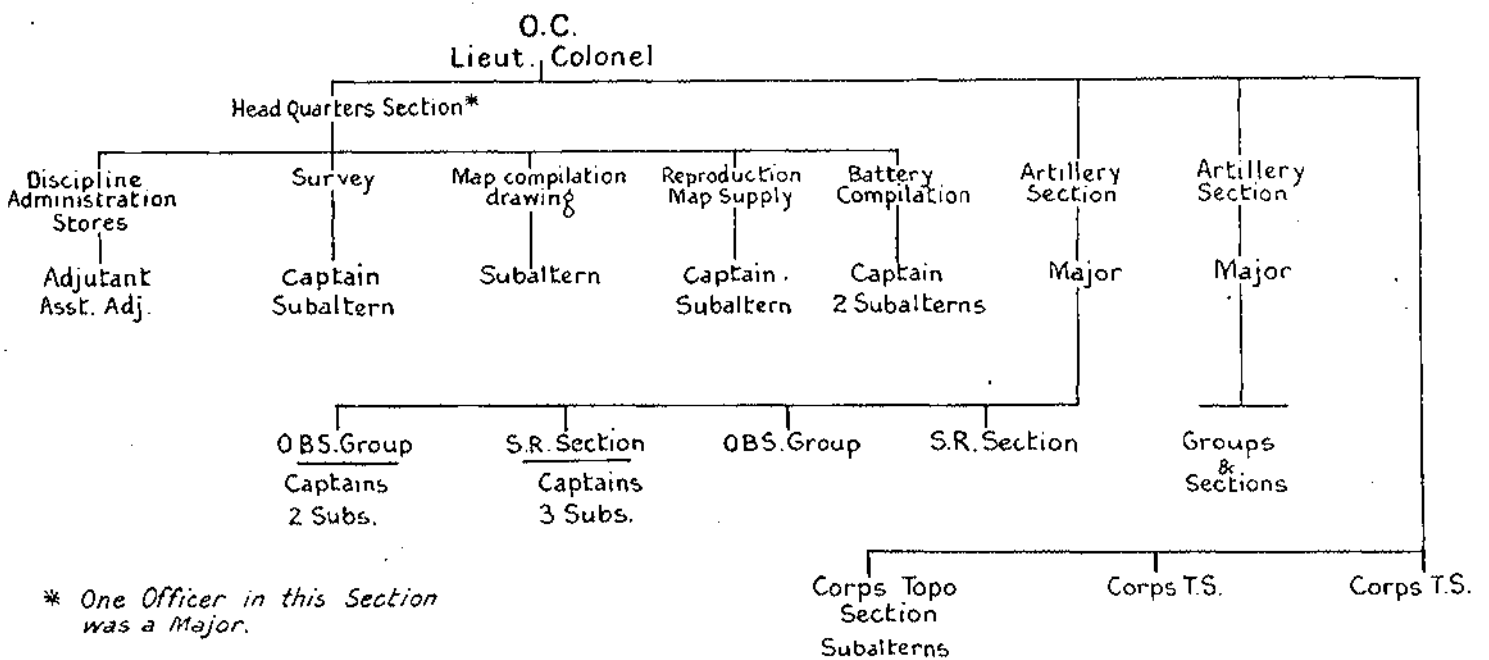
The Field Survey Batt. was organized as a H.Q. Section, and a variable number of Corps Topographical Sections, Sound Ranging Sections and Observation Groups.

The numbers given below are those on the W.E. Actually they were nearly always exceeded in practice by the addition of supernumeraries. The organization of duties differed slightly in different battalions.

The H.Q. Section (13 officers and 175 other ranks) included staffs for survey, mapping, printing, map supply and battery compilation; besides the usual work of discipline and administration required for a military unit.

ORGANIZATION OF FIELD SURVEY BATTALION

AT END OF WAR



* *One Officer in this Section was a Major.*

Survey.—The Officer i/c Survey had a staff of 6 trig. observers and assistants, 10 topographers and about 6 draughtsmen. He was responsible for all trigonometrical and topographical work, for fixing (British) battery positions, and for making and supplying artillery boards.

Mapping.—This work consisted of the compilation and drawing of topographical detail, and the drawing of trenches from air photos. It was usually in charge of one officer, with from 30 to 40 draughtsmen.

Printing.—There were 2 printing officers, with a staff of 46 tradesmen, which included lithographers, provers and transferrers, machine minders and feeders, photographers, tradesmen for the Helio-zinc, Vandyke and Ordoverax processes, and engine drivers.

Battery Compilation.—This was the work of compiling the results obtained from the Observation Groups and Sound Ranging Sections, and occupied 2 or 3 officers and about 4 clerks and draughtsmen.

The Corps Topographical Sections included 1 officer with 5 draughtsmen and 3 topographers. They prepared small local maps for the Corps on backgrounds prepared by the F.S.B., and reproduced them on the Ellam Duplicator. The topographers' duty was to fix the positions of field batteries. These sections were Corps Troops and always moved with the Corps H.Q.

Sound Ranging Sections (4 officers and 37 other ranks) were responsible for fixing the position of enemy guns by recording their sound of discharge.

Observation Groups (3 officers and 62 other ranks) were responsible for fixing the position of enemy guns and other targets by cross observation, and for generally watching the front.

Artillery Sections.—Sound Ranging Sections and Observation Groups were allotted according to the front to be held and the nature of the operations, and it was impossible to lay down any definite number for a F.S.B. The number occasionally became unwieldy, and, during operations especially, it became difficult for one O.C. to look after the whole. In order to decentralize control and relieve the O.C. the establishment was increased by two majors, who were responsible under the O.C. for the supervision of half of the groups and sections in the battalion, under the title of an "Artillery Section."

III. Technical Development.

Artillery Survey.—With survey in the general sense I shall not deal in this article. There were many problems to be solved, but no new developments, except that trigonometrical resection assumed an importance that it had never done before in our experience. Several

methods of resection were employed that are not in common use, and there is no doubt that this subject deserves particular attention in the future teaching of survey.

What is of particular interest, however, is the survey that was done specially for the artillery, and which we now call "Artillery Survey."

When Winterbotham was in charge of the Ranging Section, he was asked to lay out an arc for the first 15-in. howitzer that reached the country, and which happened to be located near him. This he did with marked success, and it led to numerous similar requests. It gradually became one of the duties of the observers and topographers of the Survey units to fix the positions of heavy guns and batteries. This was usually done by theodolite resection; occasionally by plane table; and later when the work was extended to field artillery the plane table was always used for their batteries. It will be remembered that the map in the early days was imperfect, and the detail often considerably out of position. The only way to ensure accuracy all round was to refer everything to the trigonometrical framework. Hence all targets and all gun and battery positions were fixed directly from trigonometrical points. As the battery usually took up its position in a concealed spot, this was as a rule carried out by resecting near the required position, and making a short traverse to it. To be successful this had to be done by expert surveyors.

This work developed greatly, but in the later stages of the war rather less attention was paid to the fixing of position than to the giving of correct direction or "line." For this purpose an elaborate system of "bearing pickets" was developed. These were pickets fixed by the F.S.B., marked with a flag or disc, and numbered. The R.A. were provided with a printed list of these pickets, giving the bearings from each to a number of surrounding conspicuous points. The battery commander could place his guns in any convenient site near a picket, and by setting up a director over the picket, could give parallel line in any required direction to his guns.

In all the later battles, when bombardments were begun without any previous registration, this matter of having line accurately fixed became of the highest importance; and the great success of these surprise bombardments may be attributed in no small degree to the work done by the surveyors. This was acknowledged on many occasions. After the battle of Cambrai (Nov., 1917) the Third Army Commander sent his personal thanks to the 3rd F.S.B. for the excellent work they had done; in Italy the G.O.C. the British Forces mentioned the work of the 6th F.S.C. in orders; and recently Sir Douglas Haig has made special mention in his final dispatch of the work of the Field Survey Batts. in this connection.

Besides giving line, the provision of artillery boards entailed heavy work on the F.S.B. The gunner began the war by measuring his range and bearing with a six-inch protractor and a bit of string, on a map that had been folded, and which he tried in vain to spread flat on a table. He finished it with an elaborate board, made of 3-ply wood, or sometimes zinc covered, on which his map was pasted down in small sections placed accurately in position. On this board his gun positions were exactly marked, and a paper arc for each position was pasted, of large radius, and reading to 10 mins. This arrangement was termed an "Artillery Board."

These boards were manufactured partly in France (by the F.S.B. carpenters) but mainly by the Ordnance Survey. They were prepared and supplied entirely by the F.S.B. Some idea of the numbers involved may be gained by the fact that every battery required one spare board, besides others prepared for reserve positions.

Towards the end of the war an official pattern of artillery board was designed, having a metal arc and a pivoted metal scale which could be fixed to suit any battery position. As these were only supplied at the rate of one per battery, the F.S.B. were not relieved to any appreciable extent.

All this work should undoubtedly have been done by the R.A. themselves, but they had had no training for it. In any future war they will no doubt be independent in these matters. In the meantime, when the excellent work of the artillery is mentioned, it will I hope be remembered that the R.E. surveyor had no small share in contributing to their success.

MAPPING.

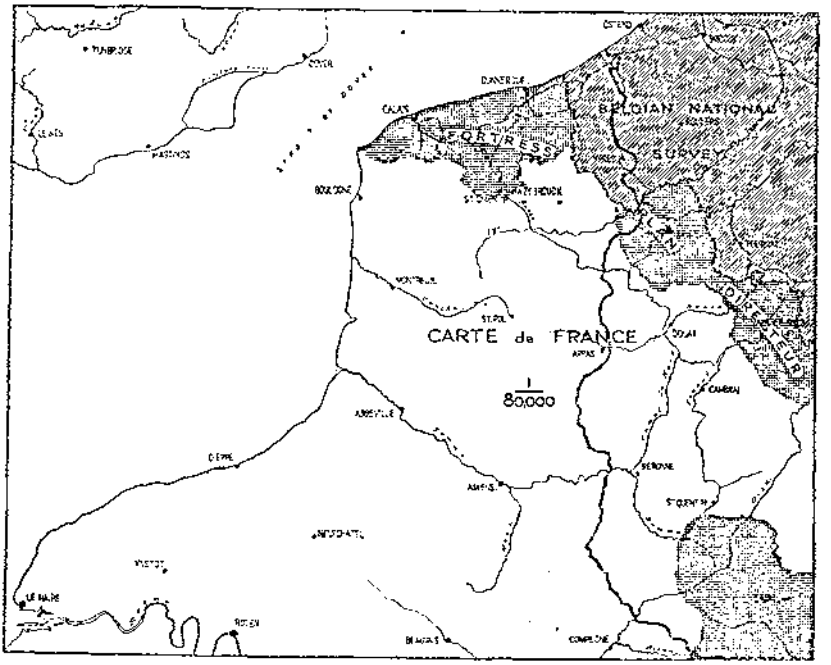
To understand the mapping problem and how it was solved it is necessary to have some idea of the material already existing in the country.

Belgium.—The whole of Belgium is covered by a very fair topographical map, published on the 1/40,000 and 1/20,000 scales. We had the plates of these maps and could print what we liked.

France.—In France no large scale maps had been published. The Fortress Plans Directeurs had been prepared in peace time, for the areas around fortresses and along the frontier, as a secret map. These were topographical maps on the 1/20,000 scale, of good quality, but not always up to date For the rest of the area with which we were concerned no maps were readily available except the French General Staff map on 1/80,000 scale.

A cadastral survey of France had, however, been carried out

early in the nineteenth century (mostly between the years 1830 and 1850), but it was never published. The manuscript drawings of this survey exist in triplicate, and are kept at the Mairies of Communes, and in the chief towns of Departments. This survey is mostly of good quality, but each commune was done independently, and there was no trigonometrical framework. The documents consist of an enormous number of small drawings on 1/2,500 scale, with a number of MS. compilations or index diagrams on the reduced scale of 1/10,000.



Material Existing before the War.

The material available was thus, for Belgium and a strip along the frontier, a topographical map that was good but not altogether up to date; and for the rest of the area nothing but the small scale 1/80,000 and the old cadastral survey existing in manuscript only.

In 1914, when it became evident that larger scale maps were a necessity, we were puzzled to know what to do. It seemed almost folly to start detailed survey in the field. No one realized how long the war was going to last, and everyone had the idea that a "break through" was possible, and that the line might move at any moment.

An attempt was made to use photographic enlargements (to 1/20,000 scale) of the 1/80,000 map. This was almost immediately found to be useless. The errors in the original map, and the mag-

nification of the generalized detail of a small scale map, made such an enlargement out of the question for accurate work. An effort was then made to revise the map, and correct its errors, using as a basis the photographic enlargement. This proved equally useless. It was therefore decided to start a topographical survey *ab initio*.

I have already mentioned the Ranging Section, which was working under Winterbotham. This formed a nucleus of expert surveyors, and Winterbotham had much experience of supervising survey in the field. He was put in charge of the work, and his section augmented by observers and topographers obtained from the O.S. Southampton, and recovered from various units in the field. The survey was done at great speed, for fear it should be too late to be of use. The basis was the existing French triangulation, the positions of whose points were obtained from the Service Geographique. The front then extended from Ypres to La Bassée, and the area surveyed was up to some 40 kilometres to the rear, excluding portions covered by Belgian maps or French Fortress Plans Directeurs. Work was begun on 25th January, 1915, and on 28th February the field work was complete and was sent to the Ordnance Survey for reproduction. This survey, though owing to the haste with which it was done it was not perfect, was an enormous advance on anything previously available, and for the first time our artillery had a reliable map on which to work.

Subsequent surveys were carried out at less speed and consequently with greater refinement and accuracy. With each extension of our line it became necessary to survey the country on our side and produce a reliable map.

Some of the difficulties encountered in this kind of work in the field have their interest. The first surveyor who appeared with a theodolite was arrested as a spy, on the ground that no one but a German would be likely to use such an instrument in our area. These difficulties were enhanced when our men were working in or near an area occupied by French troops, and it became a common experience for topographers to be taken into custody. Eventually we had to provide every man with an elaborate passport, bearing as many signatures and office stamps as it was possible to crowd on the the sheet; after which they were able to do their work with less interruption. It has been said with some truth that in this, as in other services, the difficulties of contending with the enemy were insignificant compared with the obstacles placed in the way by our own friends. One F.S.B. Commander stated that his three chief enemies were rumours, tanks and Australians. The first caused unauthorized movements; the second picked up and carried away all telephone cables; and the third took anything they saw. In one

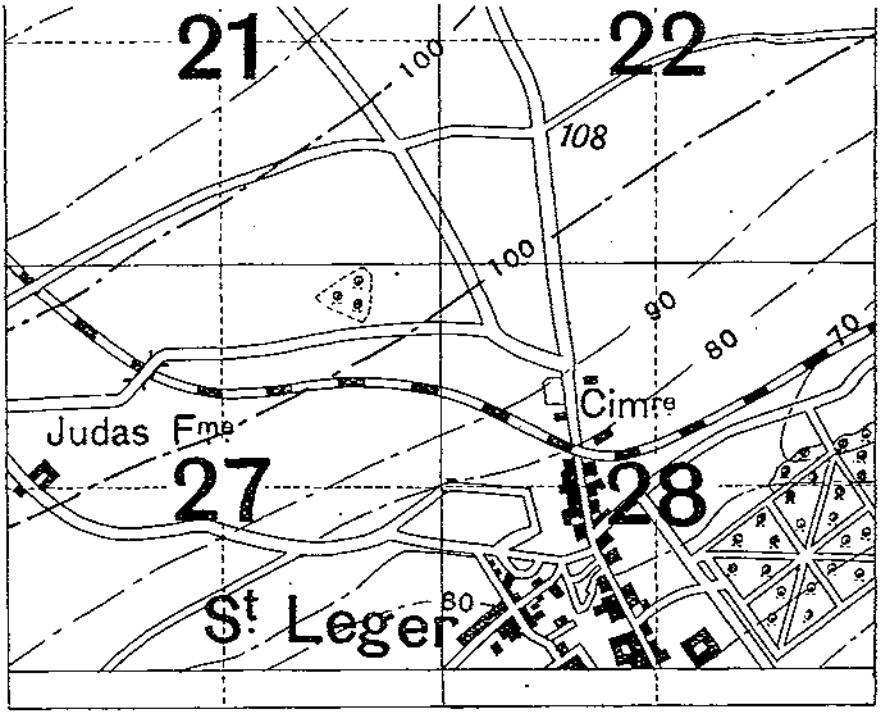
area the greatest difficulty was experienced in preserving any kind of trigonometrical signal or picket. It was found that there was only one kind of monument that was respected, and thereafter every trigonometrical point was made secure by marking it "Grave of an unl nown soldier of the —th Field Survey Battalion."

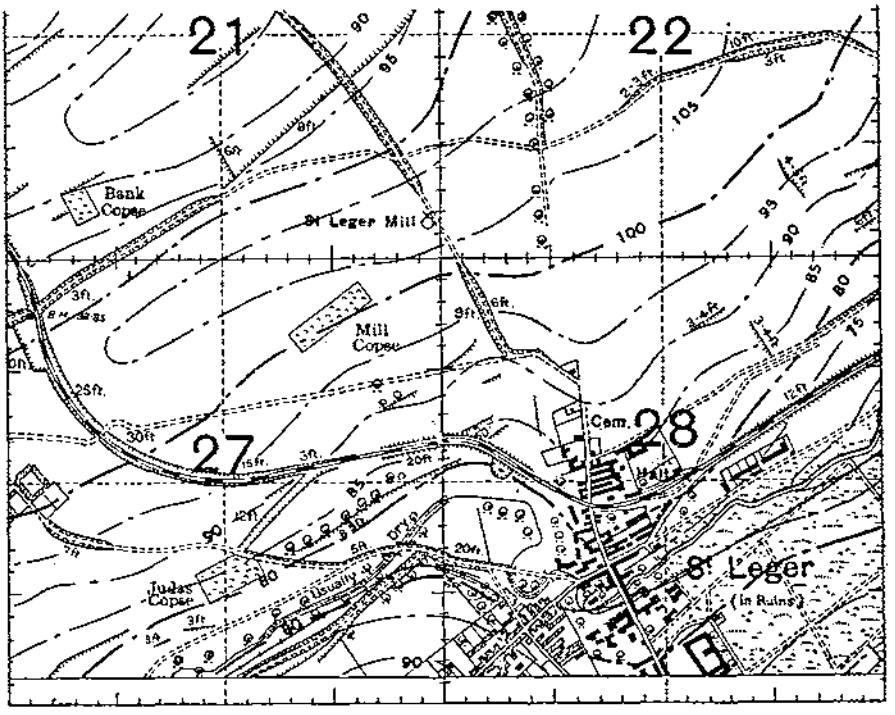
Pressure of work was so great that it was never possible to survey more than a fairly wide strip behind our line. Consequently, when the great German attack in March, 1918, drove us back to Amiens, we found ourselves without any large scale map in rear. The work of survey was immediately put in hand, and carried out with great speed; but fortunately it was not required for use against the enemy. The methods employed on this survey of back areas are extremely interesting from the survey point of view, but to describe them would occupy too much space for this article.

The above account relates to survey behind the front line, where we could get on to the ground. But we had also to produce maps of the other side, of country we could not reach, and this presented a totally different problem. At first the only material we had on which to base our work was the French triangulation points and such points as we could fix ourselves; and for detail, air photographs. But the French trigonometrical points were often unreliable, partly owing to their destruction by the war; partly to removal of signals (such as church towers) during peace, and their re-erection on adjacent, but different, sites; and partly to arithmetical and other errors in the positions given. Air photos were also often unreliable, owing to the errors and distortions to which they were subject. Consequently a map constructed from distorted air photos based on few and uncertain trigonometrical points did not meet the requirements of the case. Fortunately we learned of the existence of the old cadastral plans which I have mentioned. These provided a good topographical framework, on to which the air photos could be fitted, and formed a most valuable control. It is true that these cadastrals were 80 years old, and that in some cases detail had altered or disappeared; but it is astonishing to find how little on the whole detail does change, and how old boundaries, hedges and topographical features persist in spite of modern innovations.

The maps of the forward areas were therefore constructed on a framework of old cadastrals, controlled by such trigonometrical points as could be fixed, and with detail corrected and brought up to date by air photos, and also by such mine plans, and railway and canal plans and sections as were available.

In this way we were able to produce a map that was reliable in plan; but the problem of contouring remained an extremely difficult one. Use was made of the levels of the French Nivellement General, and of all railway and canal plans and sections that could be obtained;





Comparison between the early and late maps.

Sheet 51*b*, S.W. Scale 1/20,000.
(1) First edition, enlarged from 1/80,000 and re-drawn. Printed by O.S., 1915.
(2). Eighth (final) edition. Printed by O.B.O.S., June 1918.

and contours were drawn with the aid of these, and following the hachures of the 1/80,000 map when no other information was available. The contouring of the forward maps remained, however, of necessity their weakest point.

It only remains to add that the mapping of trenches was done from air photos. Once you had your sound framework of topographical detail, the plotting of trenches was a simple matter. If your topographical detail was not accurate, sooner or later you had trouble in fitting in your trenches. The conclusion is evident that it always pays in the long run to make your map as accurate as you can in the first instance, as it is then a reliable basis for all subsequent work.

Reproduction.

The only means of reproducing maps provided for the original Expeditionary Force was the equipment of the Printing Co., R.E. This equipment consisted of small hand litho presses, of demy and foolscap size. All work was done on tracing transfer paper, and put by hand on to the stone or plate. Zinc plates were carried, but were not in favour, and were never used if stones were available. Besides the litho presses, there was a Zygad multiplicator, which is a convenient machine for printing small work on to absorbent paper by means of a wax stencil. There were also Boston hand letter-press printing machines, and one treadle press.

The scheme was that all reproduction and printing on a large scale would be done in England, and for a long time this was done. Trench drawings were prepared, sent home by King's Messenger, reproduced at Southampton, and an edition of several thousand printed and sent to France in from a week to a fortnight from the dispatch of the drawings. The Ordnance Survey, under Colonel Sir Charles Close, R.E., performed prodigies, but as the war advanced, trench editions became more frequent, maps were wanted in a greater hurry, and it became evident that no establishment on the other side of the channel could cope with the work. Eventually therefore all F.S.B. were equipped with machines and reproducing plant of their own ; and in addition the Ordnance Survey established an Overseas branch in France. This was in charge of Lieut.-Colonel W. J. Johnston, R.E.

The reproduction equipment of the F.S.B. at the end of the war was as follows :—

Flat-bed Litho Machines.—One demy, one double demy, with proving presses.

Two of the battalions had two double demy machines (as well as a demy) in use at the end.

Helio-zinc Process.—One camera, demy or double demy size; developing baths, etc.

Vandyke Process.—Printing frame, whirler, developing baths, etc.

**Ordovcrax Process.*—Special table, and gear for melting composition.

†*Ellam Multiplicator.*—Complete outfit.

Lighting.—Mercury vapour tube outfit, and electric light for all ordinary work.

Miscellaneous Apparatus.—Guillotines for trimming paper; graining machines, etc.

Power.—Lighting plant was in most cases supplied as a complete unit by the Signal Service. Power for machines was given by an oil engine and transmitted by shafting.

Map Supply.

It was the business of the F.S.B. to supply the troops with maps, and they were provided with transport for this purpose, but the amount allotted was never sufficient.

In most armies the F.S.B. delivered direct to divisions; but in one army delivery was made to the Corps, and the Corps Staff made themselves responsible for transmission to lower formations. Our experience was that it was better for the troops if the F.S.B. undertook the whole responsibility.

Map supply is entirely a matter of organization and transport. In the early days of the war it was thought that, if a division wanted 500 maps, the delivery of the maps in bulk to the Divisional H.Q. was all that was required. It was found, however, that divisions had no staff or facilities for opening cases and making up maps for distribution to units; so this work was undertaken first by Maps G.H.Q., and later by the Field Survey units. All maps were made up into convenient packages, properly addressed. Thus for a division there would be one packet for Divisional H.Q., one for each infantry brigade, one for the artillery, one for the R.E., and so on. This procedure made it reasonably sure that the various units would get the maps to which they were entitled.

The work of distribution was always a great strain on the transport, especially during operations. Distances were long, roads bad, transport always inadequate and often broken down. In most battalions advanced map depôts were formed to relieve the strain,

* A very convenient process for printing up to about 60 copies. An undeveloped blue print of the drawing is pressed for a few minutes on to a special composition, after which the composition can be inked up in the same way as a lithographic stone.

† Similar to the Zygad.

but these, though valuable for ordinary maps, could not help much in the case of trench maps which had to be printed at the F.S.B.H.Q.

Map supply to the troops was controlled by the authorized scales of issue, and governed by the general principle that all reasonable demands should be met at once without question; that all losses should be replaced without delay and without query; and that in general there should be no red tape in the business. The repeated testimonies to the excellence of the map supply were, I think, a proof that this system bore good results.

Observation Groups.

The method of fixing objects by means of intersecting bearings is too obvious to R.E. officers to need any elaboration here. The artillery, to whom the question is of prime importance for the fixing of their targets, had made some provision for locating batteries, and had observers who were well trained for the duty; but their methods depended on intervisibility of the observation posts, and made no provision for the difficulties of flash spotting in times of great artillery activity.

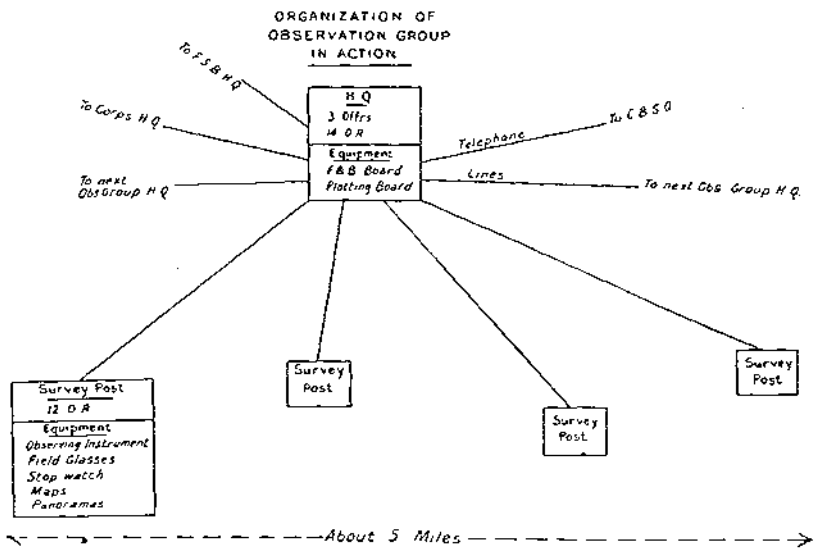
The importance of the question speedily came into prominence, and various unorganized attempts were made in 1914 to deal with the problem of battery fixing. When it is remembered that the maps at that date were inaccurate, that the observation posts were fixed in the vaguest manner, and that bearings were often magnetic, it will be readily understood that the results of these early attempts were wanting in accuracy.

The first properly organized Observation unit was formed in October, 1915, in the Third Army, and was called the Artillery Survey Detachment. It was trained and controlled by Winterbotham, then O.C. Third Army Topographical Section.

Other armies followed on the same lines, in some cases under the supervision of the R.A., in others under that of the survey units. The growing importance of the latter, and the necessity for co-ordinating and organizing observation on scientific lines, led eventually to the inclusion of "Observation Groups" in the Field Survey organization.

An Observation Group is organized as a H.Q. and four survey posts. The H.Q. includes 3 officers and 14 other ranks, including drivers and batmen, and is responsible for supervision and co-ordination. Each survey post is manned by 11 survey post observers, and has a 2-wheeled cart with driver—total, 12 other ranks.

Survey Post Observer is one of the several new trades we had to devise for our work. These men were carefully selected from likely



material from all arms, and were given a thoroughly sound practical training at the School for Observers. They were taught the use of the instrument, flash observation on a dummy range, map reading, something of the construction of a map, and use of the stop watch, and were generally trained to use their wits and become useful, intelligent observers.

An Observation Group is a unit organized and trained for the purpose of fixing objects by cross-observation; and especially of fixing the position of guns by observation of their flashes. The duties of Observation Groups included watching all ground to their front, and fixing and reporting the positions of any target or unusual occurrence; but by far their most important and difficult duty was that of fixing guns, or "flash-spotting."

The problem of flash spotting may be said to consist in training observers to observe flashes, and directing them on to the same flash. This is a difficult matter, when, as usually happens, a number of guns are firing in the area under observation.

Various methods were tried to secure observation of the same flash, which was ensured only when the observations were simultaneous. At first the time (to the nearest second) of every observation was booked. This meant frequent and careful synchronization of watches, and subsequent comparison of the timed observations; a laborious process, which produced some, but not many results. Other methods were tried, and valuable ideas were obtained from a French flash spotting group. Finally the "Flash and Buzzer Board" was evolved, the design being due to Major (then Lieut.) Hemming, a young Canadian holding a temporary

commission in the R.A., and one of our most capable observation officers.

The flash and buzzer board is a small telephone exchange, by which the operator can speak to any or all of the four survey posts as required. It has four* small electric lights, and four buzzers; and it can be arranged that the observers either show a light, or sound a buzzer, by pressing a key at the Survey Post. The procedure in flash spotting is usually that one observer leads, observing the flashes of a certain gun. Each time he observes the flash he presses the key at his post, and the corresponding light appears on the F. and B. board. A second observer is directed on to what is believed to be the flash, observes, and presses his button each time he sees it. If he is on the same flash the two lights appear together. Similarly the other observers are put on, and if the observation is successful all four lights will appear together; three being, of course, the minimum necessary for certainty. As soon as the operator is satisfied that the observers are on the same flash he tells them to book their readings. These are reported to H.Q., the bearings are laid out on a specially prepared board, and the position of the flash fixed.

An obvious development of this system is to fix the position of the burst of our own shell, and hence to observe for "ranging" our own fire. This developed to such an extent in the later phases of the war that in several cases the M.G.R.A. of the Army considered it of more importance than the fixing of gun positions. Ranging by this method is evidently far more accurate than the usual method, whereby a single observer reports "short" or "over," and estimates the amount.

A further development is to fix the position of the shell when bursting in the air, and so to range on to an invisible target. This is simpler in practice than it sounds, and became part of the regular procedure.

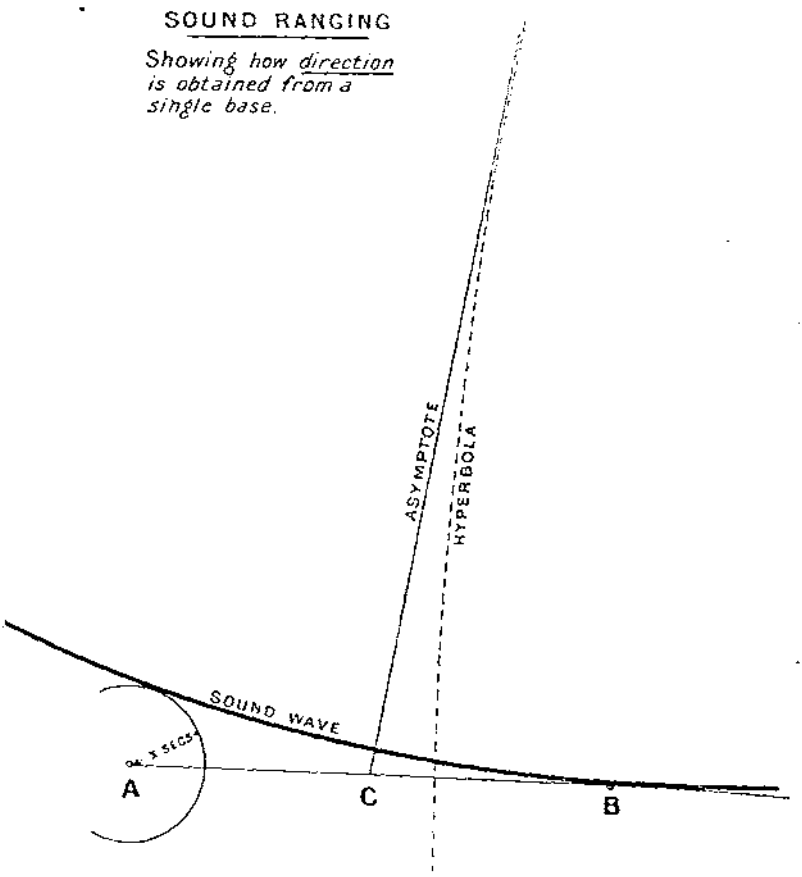
Sound Ranging.

The problem of locating the position of the point of origin of a sound depends on the well-known fact that sound travels at a uniform velocity, subject to slight variations due to temperature and atmospheric conditions. Thus if you can determine the interval of time between the arrival of the sound wave at two fixed points you have the data necessary to enable you to fix the *direction* of the sound.

Thus in the diagram, A and B are two fixed points, and the sound wave reaches B x seconds before it reaches A. Describe a circle

* In the latest pattern there are six.

with A as centre, and radius equal to the distance travelled by sound in x seconds. Describe any circle which passes through the point B, and is tangential to the small circle described round A. Then the centre of the big circle is a possible position for the origin of sound, say a gun. An infinite number of circles may evidently be described passing through B and touching the small circle. Actually the locus of the origin of sound is a hyperbola whose foci are the points A and B, and this hyperbola gives the direction of the sound. In practice



instead of the hyperbola we use the asymptote, the error for points not in the neighbourhood of the base AB being small and easily corrected. It is easy to see that for a given base AB a time scale can be constructed, having its zero on the perpendicular passing through the mid-point of AB, and having time divisions, corresponding say to hundredths of a second, to the right and left of this zero. Then if instruments at A and B record the time of arrival of the sound at each point, one has only to set a fine string pivoted at C

(the mid point of the base) at the scale division corresponding to the time interval, to get the direction of the sound with reference to AB. In other words a single base, with a recording instrument at either end, gives you a bearing to the sound.

The possibility of locating gun sounds in this manner had been discussed some years before the war, but no practical application of the idea had been made. The French took up the question immediately after the outbreak of war, and at first devised a system of a measured base, with three human observers, each with a stop watch, who would record the instant the sound reached them. This human observer method continued in use, with considerable success, for a long period, and was used by the Germans throughout the war. Later experiments evolved automatic apparatus of various kinds.

French sound ranging soon attracted attention in the British Army, and Colonel Blandy, R.E. (Signals), wrote a report on it. In April, 1915, Colonel Hedley, R.E. (Geographical Section, G.S. War Office), was so impressed by what he saw and heard on a visit to Paris, that he came straight back to G.H.Q. and reported on the subject to various senior officers. The result of this was the dispatch of a Committee of three to report on French sound ranging. The Committee consisted of Major Winterbotham, R.E. (survey expert), Captain Lefroy, R.E. (electrical expert), and an R.A. officer. The R.A. officer, after the first day in Paris, returned to G.H.Q., and thereafter dissociated himself from the reports of the Committee. I mention this merely as a matter of historical interest, because the matter was one which, if it was to be of any use at all, was of paramount importance to the artillery. The two Sappers continued their investigations, and made a report which was a model of its kind. Considering how little was known of sound ranging at that time, and in what a crude state the French system was, it is a great testimony to the ability and foresight of these two officers that the report and recommendations they made hold good to this day, and have been amply justified by the event. The gist of their report was that—

(1) Sound ranging though in its infancy was a practicable proposition, and would give valuable results.

(2). The Bull system was the best.

On receipt of this report the Committee was sent on a second visit to see the working of a French sound ranging section at the front. Their second report confirmed the first.

At G.H.Q. there was much apathy, and some opposition. The matter was put before the Experiments Committee at G.H.Q., and they decided against ordering any apparatus. It fell to my lot to combat this decision, and after some discussion I got it rescinded,

and one set of apparatus was ordered, and was delivered from Paris in October, 1915.

In the meantime Colonel Hedley had secured the services of W. L. Bragg, at that time a lieutenant in the Leicestershire R.H.A. Bragg is one of the most brilliant of our younger scientists, and is also a very sound practical man, and we were fortunate in securing his services. He remained with us throughout the war as our chief sound ranging expert, and was later on my staff at G.H.Q. He, with two other officers and half a dozen men, constituted the first S.R. Section.

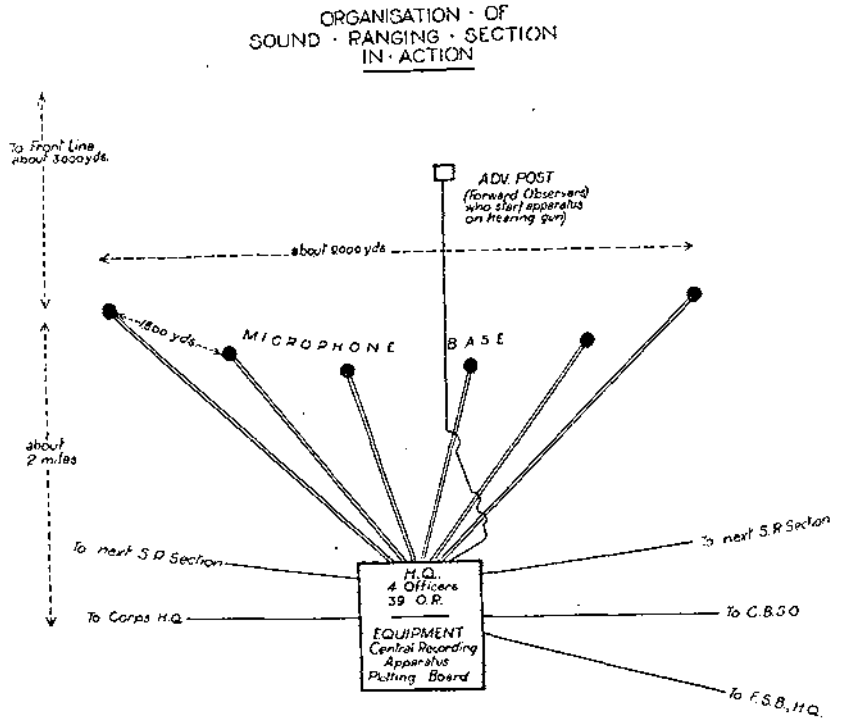
This section suffered under every kind of handicap. It had to try and produce practical results, while at the same time carrying out research. Mistakes of all kinds were made; in the survey, in the length of base, and in methods. It seemed indeed doubtful if it would be possible to produce those results which the authorities required as a justification for the existence of the section. However, results that just satisfied requirements were obtained, and in December it was decided to form seven more sections, making two for each of the four armies then in the field.

From that time sound ranging advanced. As soon as the eight sections were working the call came for more, and in the end the artillery recognized that sound ranging was an essential part of their equipment.

A Sound Ranging Section in action consists of the microphone base, the forward observer, and the central recording apparatus. The base consists of six microphones, each pair of which constitutes a sub-base which gives a bearing as shown in the explanation given above. Thus if all six microphones respond, five bearings are obtained to the gun. The length of the base is about 9,000 yds. and it is our practice to space the microphones equally and regularly either in a straight line or more commonly on the arc of a circle.

The microphone is a most important part of the apparatus. Much trouble was experienced with the early microphones, partly because they responded to any casual noise, and partly because of the difficulties caused by the shell wave (*onde de choc*). The shell wave is the sound made by the shell travelling through the air, and in the case of a high velocity gun it travels in advance of the true sound of the gun discharge, and produces a false record. What was wanted was a microphone that responded only to sound waves of larger amplitude, such as those produced by a gun discharge, and that was very well damped. Such a microphone would not be affected by rifle firing or casual sounds, and would also readily take up sounds at short intervals and so distinguish between guns firing rapidly, and also as a rule between the shell wave and the gun discharge. Lieut. (now Capt.) Tucker, R.E., devised a microphone which satis-

fied these conditions almost perfectly, and the invention of this microphone constituted the biggest stride made in sound ranging since the introduction of the graphic recording apparatus.



The forward observer is situated sufficiently far in advance of the microphone base to give him time to press a button and set the recording apparatus in motion after hearing a gun which he wishes to record. This usually means about 1,000 yds. in front. The forward observer's task is by no means mechanical. He requires an expert knowledge of gun sounds, including nature, direction and probable position, as well as an intimate acquaintance with his portion of the front. A good forward observer is essential to the successful practical working of the section. There are ten forward observers in a section, to allow for reliefs, and it is common practice to have two forward observing posts.

The recording apparatus used by us is that designed by Mr. L. Bull, a British subject resident in Paris. The principle is that of the Einthoven galvanometer, which consists of an electro-magnet between whose poles pass fine wires. An electric current passing through any of these wires produces in it a deflection. In the Bull

apparatus there are six wires, each connected with one of the microphones in the field The shadows of these wires are projected by a suitable lantern on to a cinematographic film, on which at the same time cross divisions are marked, representing short intervals of time. So long as the wires are unaffected they appear on the film as straight lines, but when a microphone responds to a sound a current passes through the corresponding wire, and it twitches and the line on the film is broken. The record thus forms a ready means whereby the required time intervals can be measured with great accuracy. *(See Plate).*

As in the case of flash spotting, an obvious extension of the system of sound ranging is to determine the position of our own shell bursts and so to range our own guns. This can be done with the greatest effect when ranging on to a battery that has just fired. The two determinations of position (of hostile battery and our shell burst) being made within a short interval are subject to the same errors caused by wind, temperature, etc., and these errors cancel out. The difference between the two records represents the error of the position of the shell-burst with reference to that of the battery, and all that is required is to bring the record of the shell-burst to agree with that of the battery, to ensure that the shell is falling on or close to the target. The method is in fact a differential one, and it is not necessary to know where the hostile battery is—it may be one that has never fired before. An ingenious mechanical plotter was devised by Bragg whereby the necessary corrections could be supplied to our gunners in a very short time, in terms of yards short or over, minutes right or left.

BATTERY. COMPILATION SECTION.

This was the logical outcome of the work of the observation groups and sound ranging sections. Some one had to co-ordinate the work and collate the results obtained, and this was naturally done in the F.S.B. who were responsible for obtaining the results. A further reason was that, in the early days especially, a decision as to true position was intimately bound up with a knowledge of the local value of the map. The work was, however, so closely connected with Artillery Intelligence that, as the latter became an organized service, the desire on the part of the R.A. to incorporate the compilation section in the office of the M.G.R.A. grew; and towards the end of the war the compilation section was in all cases located in or close to the R.A. Office.

Compilation of battery fixings demands considerable experience, sound judgment, and an intimate knowledge of air photos. The various fixings usually indicate a small area in which the battery lies;

and the air photo is practically always taken as the final evidence of position. It may be mentioned, however, that there have been occasions when the air photo appeared to disagree with the results of the group and section fixings, and the latter were discarded; and that it was found later that the fixings were right, but that the photo had failed to reveal the presence of the battery.

The division of responsibility agreed upon was that the F.S.B. decided position, and the R.A. activity. (*See Plate*).

These two systems of gun fixing—by visual observation and by sound ranging—are complementary, and neither is complete without the other. It is necessary to enter a caution about this, because sound ranging has attracted so much attention that it is often spoken of as if it were the one and only method of fixing guns, or at any rate the most important. It is, however, impossible to say that one is more important than the other. Each can do what the other cannot. Flash spotting is unaffected by wind; but, for fixing enemy guns, it is less effective by day than by night. Sound ranging is unaffected by rain or fog, and is equally effective by day or night, but an adverse wind will put it quite out of action. Sound ranging is more economical than flash spotting, as it occupies fewer men and, given favourable conditions, gets far more locations; on the other hand the flash spotting locations are more precise.

Another point that may be mentioned is the question of the mobility of these units. It is incorrect to say that their methods are suitable only for absolutely stationary warfare. Both are of great value in semi-mobile warfare, the degree to which they can be used depending naturally on the rapidity of movement. The proper way to gauge their value in this respect is to consider their mobility in comparison with their objectives, and it may be said without hesitation that, given the necessary transport and personnel, a S.R. Section can move from an old position and get into a new one at least as quickly as heavy artillery, while an Observation Group can do so a great deal more quickly.

We were naturally very anxious to check, by actual examination on the ground, the results of battery fixing by these methods. Various opportunities occurred; after the German retreat on the Somme, after the battles of Arras, Vimy Ridge, Messines, etc. The results were in every case highly satisfactory. Of German batteries actually identified on the ground it was found that about 90 per cent. had been accurately located. Of reports of battery positions sent to the R.A. it was proved that the proportion of inaccurate or non-existent positions was very low, something under 5 per cent. In other words the F.S.B. succeeded in locating nearly all the German batteries, and the information given by them to the

Artillery was accurate and reliable. One could hardly ask for better testimony.

I have tried in this somewhat brief account to give some idea of the work of the survey organization in France. There are many aspects of that work which I have not touched; such as the trigonometrical and levelling problems, magnetic survey, screen calibration in the field with the aid of the sound ranging apparatus, air photography in relation to survey, the preparation of maps bearing special information, and so forth. Anyone who is interested in these and kindred developments of our work will be able to read about them in the detailed official account which is now in preparation.

I have also barely referred to the work done by the S.M.E. in providing the original Printing Co. and various personnel and stores during the war, nor to the tremendous amount of help received from the Geographical Section at the War Office and from the Ordnance Survey, Southampton; but this is not because I am not conscious of the great debt we owe to these institutions.

A point that has puzzled many people, especially R.E. officers, and about which I have often been questioned, is why we mixed ourselves up so much with Artillery work. The answer is that if we had not done it, it would in many cases not have been done at all, and the Army and the nation would have suffered in consequence. Certain obvious needs came to our notice, which our training enabled us to tackle, and for which the gunners had not been trained. I can say with truth, and in no offensive spirit, that the surveyors were able to teach the gunners a good deal about their job; so much so that it is now recognized that survey is a necessary part of the gunner's training, and the future gunner will be taught to look after himself in these matters.

One last word on survey from the R.E. point of view. Before this war survey was looked upon as a legitimate and valuable occupation for the Engineer officer in time of peace, but it was considered that active survey work would cease on the outbreak of war. The surveyor's work was thought to lie mainly in map making before the war, and after its commencement he was expected to turn his attention to more important matters. The proof of this is in the arrangements made for the disposal of the Ordnance Survey personnel on mobilization. All were allotted to Field and Army Troops Cos., with the result that when we wanted them it was extremely difficult to get hold of many of these valuable men.

The war has, however, shown that Survey has a very decided military value in the field. When we take into account the smallness of our numbers (our total strength being just under 4,000) and when

we consider all that Survey did in the war; whether we think of the accurate direction of our own guns, or the fixing of enemy batteries, or the provision of reliable maps of all kinds; I think we are justified in questioning whether there is any branch of the Army which in proportion to the numbers engaged had a greater effect on operations.

The net result is that we have started a new branch of Artillery work, which I am certain is destined to have great developments; and, as far as the R.E. are concerned, I think that it will be recognized in future establishments that no formation should ever take the field without its proper equipment of survey personnel.

HISTORY OF THE RAILWAYS AND ROADS TRAINING CENTRE, R.E., LONGMOOR.

By COLONEL H. M. SINCLAIR, C.B., C.M.G., C.B.E. (LATE R.E.).

BEFORE the War Longmoor was the Headquarters of the Railway Companies, R.E., which consisted of the 8th and 10th Regular Companies. Three Special Reserve Companies (two Monmouth and one Anglesey) also came to Longmoor annually for training, which was carried out technically on the Woolmer Instructional Military Railway.

On the outbreak of War in August, 1914, the above five Companies were mobilized, and the 8th Company proceeded at once to France. In October, 1914, Lieut.-Colonel J. H. Twiss, R.E., Commanding Royal Engineer, Longmoor, left for France as Director of Railways, and Colonel H. M. Sinclair, C.B., was appointed in his place as O.C., Railway Troops.

It was decided to raise four Constructional Companies, each with a strength of six officers and 250 other ranks, as early as possible, for service in France. Officers and men for these Companies began to arrive in October. Both officers and men had to be trained simultaneously, with the aid of officers of regular companies still at Longmoor, and old R.E. warrant and non-commissioned officers called up for the purpose. At first it was intended to send these companies out in a fortnight; but the exigencies of inoculation, vaccination, drill and musketry soon showed that this could not be done. Nor were the demands from France sufficiently pressing.

RAILWAY CONSTRUCTION TROOPS DEPÔT, R.E.

In December, 1914, it became apparent that the existing nucleus of a Depôt must be enlarged for the receipt and training of recruits, the preservation of documents, and generally dealing with the rapidly increasing *personnel* of the Railway Troops. This was organized first under Capt. J. M. Burn, R.E., afterwards Capt. G. J. Watt Smyth, R.E., and other officers in succession. Lieut.-Colonel May, R.E., has been in Command since 21st May, 1917. As the numbers of men at Longmoor steadily increased it became necessary to obtain a recognized establishment for this Depôt, which had to be modified from time to time till it has assumed the *personnel* now given in "War Establishment" 1196, Part V., of 3rd May, 1918. The following is a summary of the organization and history of the Railway Construction Troops Depôt, R.E.:—

Formed December, 1914.—Establishment 300 all ranks.—Revised 624 all ranks on 19th June, 1915, including Headquarters, Railway

Troops, R.E.—Revised 814 all ranks on 1st August, 1916.—Revised 1139 all ranks on 3rd May, 1918, exclusive of Headquarters, Railways and Roads Training Centre, R.E.

Title.—Changed from Railway Troops Depôt, R.E., to Railway Construction Troops Depôt, R.E., on 14th December, 1917.

Number of men sent overseas :—

1914	...	...	750	1917	...	...	6,212
1915	...	...	2,250	1918	...	...	3,188
1916	...	...	4,252	1919	...	...	71

Average strength :—

1914	...	...	200	1917	...	...	1,800
1915	...	...	750	1918	...	...	2,082
1916	...	...	1,200	1919	...	...	1,655

Disposition.—Depôt run as one company until April, 1916, and becoming too unwieldy under these conditions (1,000 strong) was split into four companies :—

Headquarters...		(Administrative).
A and B	...	(Recruits and Draft producing).
C	... ...	(Miscellaneous ; also Draft producing).

In October, 1916, the functions of the companies were organized as follows :—

Headquarters...		(Administrative).
A	... ...	(Recruits and Training).
B	... ...	(Miscellaneous).
C	... ...	(Draft Producing).

The Railway Construction Troops Depôt, R.E., finds all reinforcements for Construction Companies, 30th Railway Labour Battalion, 270th and 271st Railway Labour Companies, Railway Store Park, Railway Transport Establishment, such as Mediterranean Lines of Communication, etc.

During 1914—1915, owing to lack of experienced staff, and speed with which drafts had to be despatched to Expeditionary Forces, the organization of the Depôt was unavoidably far from perfect.

The average time required for a recruit to complete his training including musketry and gas, and to be granted overseas leave, was ultimately from 7 to 8 weeks.

During March, 1916, when a great blizzard swept the country, from three to four hundred men were loaned to various Railway Companies for several months to repair damage done to telegraphic wires, etc. A letter of appreciation and thanks for the assistance given by the Railway Troops in this connection was afterwards received from the General Manager of the Great Western Railway, through the War Office.

Meanwhile the demand for new Construction Companies and reinforcements for those already abroad continued to increase. When

a sufficient number of recruits had been assembled in the Railway Construction Troops Depôt, R.E., one new company could be formed full fledged from the Depôt ; but others were obtained complete, with a proportion of officers, direct from the British Railway Companies.

It will suffice to give Appendix A which is a list of the Construction Companies formed at Longmoor from 1914 to March, 1919.

Two Railway Labour Companies of men over military age, and voluntarily enlisted, were formed at Longmoor during 1915 (Nos. 270 and 271). Early in 1916 authority was given for the enlistment of a Labour Battalion on similar lines by Major Peake, in and about Gloucestershire, consisting of four companies of 250 each. This Unit formed and trained at Longmoor, and left by companies as shown in Appendix A.

It may be mentioned that at first C.S.Ms. and C.Q.M.Ss. for all Construction Companies, Inland Water Transport, and Railway Operating Division Sections, were found from such old Army N.C.Os. as were available. Later all C.S.Ms., C.Q.M.Ss., Pay Corporals, etc., were provided from men specially trained at Longmoor, or when transfers from other arms were authorized, from the best men of any origin.

Inland Water Transport, R.E.

In January, 1915, the Inland Water Transport branch of the Royal Engineers was started, and officers and men engaged for it began to arrive at Longmoor under the command of Major Luck, R.E. This formed a separate unit under the O.C., Railway Troops, and was quartered at the Applepie Huts, then approaching completion. It was organized in sections of two officers and 250 other ranks each, and the training carried out under its own officers, assisted by such warrant and non-commissioned officers of the old R.E. as were available.

This Unit remained at Longmoor until May, 1916, and during the time it was here 138 officers and 4,064 other ranks were sent overseas. As the numbers were becoming too great for the accommodation at Longmoor, the unit was removed to Richborough, where large works were in contemplation.

It will thus be seen that the early training of the Inland Water Transport, R.E., including many officers, non-commissioned officers and men who have since risen by rapid promotion to high rank was received at Longmoor.

Canadian Overseas Railway Construction Corps.

In June, 1915, the Canadian Overseas Railway Construction Corps, numbering 20 officers and 500 other ranks, reached Longmoor from Canada with some 650 tons of Canadian construction material, tools, and machinery, under the command of Lieut.-Colonel Ramsey of the Canadian Pacific Railway.

This Unit completed its training under the O.C., Railway Troops as a separate unit, went to France on 28th August, 1915, but returned again to Longmoor on 6th October, 1915, and finally left on 1st November, 1915.

It was reviewed by His Majesty the King, on the 18th July, 1915, with the other Railway Troops.

Railway Operating Troops Depôt, R.E.

In April, 1915, another unit, the Railway Operating Division, R.E., began to form at Longmoor. Hitherto Construction Companies and small bodies of Railway Transport Establishment, Railway Store Park and Military Forwarding Establishments, had been formed. It had now become necessary to provide for the working and operation of railways overseas as well as construction and maintenance.

This unit was organized in sections of 266 men with no specific number of officers, the various operation trades being in fixed proportion. As this unit was at first to be unarmed, the training was simple drill, and the men could be passed through rapidly. It resulted that as the authorized trades could not always be provided in proper proportions, the sections went out incomplete in trade-numbers, and the requirements of each section were never fully met, until the time when, owing to the reorganization of the Railway Troops, R.E., in the autumn of 1916, the system was changed, and the companies of various composition were organized at Longmoor and sent out, as far as possible, complete.

Consequent on the reorganization and expansion of the Railway Troops undertaken in the autumn of 1916 by Major-General Sir E. Geddes, the Railway Operating Division was reorganized, and it was decided in January, 1917, to send out complete companies under the following titles, as well as keeping up the supply of reinforcements:

	No. sent out.
Broad Gauge Operating	3
Light Railway Operating	11¼
Broad Gauge Train Crew	0
Light Railway Train Crew	6
Broad Gauge Workshops	3
Light Railway Workshops	3
Broad Gauge Misc. Trades	4
Light Railway Do.	2
Broad Gauge Wagon Erecting	3
Electrical Sections	3
Engine Crew Companies	4
Transportation Stores Co.	¼
	42½

It was decided that these companies should be armed in the same proportion—10 per cent.—as the Railway Construction Troops, so musketry had to be added to their training, as well as instruction in anti-gas measures.

The total number of officers and men sent out from the Railway Operating Troops Depôt, R.E., between April, 1915, and 11th March, 1919, is as follows:—

Officers	494
Other Ranks	26,089

Appendix B gives the list of Railway Operating Division Companies and the dates on which they were sent out.

The Railway Operating Troops Depôt, R.E., was first given a definite establishment in January, 1917, and has been commanded by the undermentioned officers since its formation:—Lieut. Ince, R.E., from April, 1915, to October, 1915. Lieut. (later Captain and A/Major) L. B. Shoppee, R.E., from October, 1915, to August, 1917. Major (now Lieut.-Colonel) P. D. Michod, O.B.E., R.E., from August, 1917, to date.

Title.—Changed from Railway Operating Division, R.E., to Railway Operating Troops Depôt, R.E., on 14th December, 1917.

In June, 1915, the Quarter-Master-General inspected the Railway Troops and C.O.R.C.C. It was arranged that this should take the form of a review and march past in Blackmoor Park. About 400 men of the R.O.D., took part, more than half of whom had only been enlisted about a week. Each unit marched past in column, with a creditable alignment. But the 2nd Company of R.O.D., 200 strong, consisting entirely of men who had only drilled for a week, passed the saluting point in an absolutely wall-like line, as good as any company of Guards. On Col. Sinclair's informing General Cowans of their length of service, he remarked, "Well, Sinclair, I cannot understand how you do it!" No doubt it was a happy accident, but it shows what can be done by men of intelligence under experienced guidance.

Military Camp Railways.

Railways to various camps had been laid during their construction for the convenience of contractors. Most of these camps were approaching completion early in 1916, when it was determined to keep the railways working for the supply, etc., of the camps.

Already the O.C., Railway Troops, had been called upon to make surveys and estimates for certain proposed military railways on Salisbury Plain, at Witley Camp, etc. It was decided to entrust the maintenance and working of the railways to the O.C., Railway Troops, R.E., with a military organization for the purpose.

The following table shows the lines taken over, and the dates on which they came on charge :—

Command.	Designation.	Main Line Connection.	Mileage.	Date taken over.
Southern ...	Larkhill ...	Amesbury, L. & S.W. ...	9 miles	25. 5. 16
do. ...	Fovant ...	Dinton, L. & S.W. ...	3½ miles	20. 5. 16
do. ...	Codford ...	Codford, G.W.R. ...	4¼ miles	3. 6. 16
do. ...	Sutton Veny ...	Heytesbury, G.W.R. ...	5 miles	3. 6. 16
Northern ...	Catterick ...	Catterick Bdge., N.E.R.	21 miles	29. 7. 16
do. ...	Ripon	Ripon, N.E.R.	7¾ miles	30. 5. 16
do. ...	Cannock Chase	Milford and Brocton, L. & N.W.R.	13¼ miles	11. 6. 16
do. ...	Clipstone ...	Mansfield, G.C.R. ...	4 miles	25. 7. 16
do. ...	Grantham ...	Grantham, G.N.R. ...	6¾ miles	1. 6. 16
Western ...	Kinmel Park ...	Foryd, L. & N.W.R. ...	6¾ miles	7. 8. 16
do. ...	Prees Heath ...	Whitchurch, L. & N.W.R.	1 mile	25. 5. 16
do. ...	Oswestry ...	Oswestry	3½ miles	8. 8. 16

To these must be added the Woolmer Instructional Military Railway, which has always been worked from Longmoor, the Bisley, Deepcut and Blackdown Railway, constructed and maintained from Longmoor in 1916—1917, the Altrincham Depôt Railway, and the line from Westenhanger to Lympne Aerodrome. In addition lines were constructed from Farnborough to the Aldershot Aircraft Factory, to the Ascot Flying Corps Stores, and for sidings at Abbey Mills, mainly by labour, and under the direction of Longmoor. The number of officers and men permanently employed on these Military Camp Railways was at first five officers and 448 other ranks, and rose to six officers and 673 other ranks. Lieut.-Colonel R. G. Aston, O.B.E., R.E., was placed in charge of these railways.

Besides the permanent Establishment large numbers of men on loan from Longmoor have from time to time been employed on the construction, improvement, balasting and maintenance of these railways. Those taken over were merely contractors' lines which required a serious amount of labour and expenditure to bring them up to a reasonable and safe standard, including repair and renewal of bridges, realignment of track, deviations, balasting, lifting and provision of extra sidings, platforms and signalling systems.

The Military Camp Railways were taken over by the Director of Movements, War Office, in April, 1918, and have since been administered from his office with *personnel* provided from Longmoor.

Road Troops.

The Road Troops began to form at Longmoor in December, 1916, under the Command of Major Michod, R.E. In February, 1917, they were removed to Aldershot owing to lack of accommodation and remained there until November, 1917, when they were brought back to Bordon to fill up accommodation available there. They were again moved to Aldershot in October, 1918, thence to Woking and returned to Longmoor in February, 1919.

The Road Construction Companies had an average Establishment of 4 officers and 256 other ranks, and a depôt was authorized consisting of headquarters, and two companies, later increased to four. The number of companies formed and despatched overseas is shown in Appendix C. On Major Michod being transferred to command of the R.O.T.D., R.E., Major Haughton, D.S.O., Ox. and Bucks Yeomanry, took command of this depôt on 1st January, 1918. The total number of men received is 12,650, of whom about 15 per cent. were rejected as unfit. 232 officers have gone overseas.

As these troops at first required but little training, and no musketry, but had merely to be clothed, equipped, inoculated, and vaccinated, and given elementary drill, they could be rapidly prepared for overseas to meet the emergent demand for their services. It will be observed that the first company went out within a month of the formation of the unit, and within six months twenty-four companies were despatched. It is understood that they arrived well within the time by which they were promised and have on the whole done good service.

At first the Road Troops were not trained in anti-gas measures. As they came to be employed in the fighting zone this was found to be necessary. In March, 1917, gas training was adopted and in September, 1918, musketry also. So the training of these men became equivalent to that of the Railway Troops and was assimilated by them with surprising rapidity, considering their advanced age and physical disabilities.

Twelve Quarry Companies were also raised at Buxton and elsewhere and were affiliated with the R. and R.T.C. for depôt purposes and reinforcements.

Accommodation.

Although the numbers of all units at Longmoor had been steadily growing during 1915—16, until in September, 1916, they amounted to 51 officers and 3,781 other ranks, yet when the reorganization of the Transportation Branch, consequent on Sir Eric Geddes' mission to France in the autumn of 1916, took place, the number began immediately to rise as new formations were demanded and the raising of Road Troops was also entrusted to Longmoor. Twenty-four Road Companies, to be formed of men over military age or of low category, or specially skilled in Road Construction were authorized to be formed, trained, and sent out as quickly as possible.

The institution of Light Railways caused a large extra demand in the Railway Operating Division, R.E., and a further demand for Construction Companies was made.

This brought on a crisis in accommodation, as the total barrack room at Longmoor was only about 3,000. Hitherto the XIV. Reserve Cavalry Regiment had been quartered at Longmoor with

the Railway Troops. It was now removed. 4,000 quarters at Bordon and later, 2,000 at Aldershot, were handed over to the O.C., Railway Troops, and several companies were billeted in the neighbourhood in the interim. The largest number of all ranks under the command of the Commandant, R. and R.T.C., R.E., at any one time was 9,445.

Australians, Canadians and South Africans.

During 1917, the following companies of Australian, Canadian and South African, Railway Operating Division Troops, arrived for training under the Commandant, R. and R.T.C., R.E., and were quartered as shown :—

Unit.	Date of arrival.	Place.	Date of departure.	Strength. Officers.	O.R.
South African.					
No. 7 L.R.O. Co. ...	4. 3. 17	Bordon	18. 3 17	2	230
No. 8 do. ...	4. 3. 17	do.	18. 3. 17	2	235
No. 84 B.G. Misc. Trades Co. ...	28. 8. 17	do.	13. 10. 17	2	252
Canadian.					
No. 13 L.R.O. Co. ...	7. 5. 17	Aldershot	9. 6. 17	3	228
			9. 7. 17	—	39
No. 58 B.G.O. Co. ...	14. 3. 17	do.	17. 4. 17	4	255
Australian.					
No. 15 L.R.O. Co. ...	27. 4. 17	Bordon	29 5. 17	3	223
			23. 7. 17	—	39
No. 35 B.G.O. Co. ...	19. 7. 17	do.	4. 10. 17	3	228
No. 59 B.G.O. Co. ...	27. 3. 17	do.	11. 5. 17	3	254
No. 60 B.G.O. Co. ...	11. 4. 17	do.	14. 5. 17	3	256

The Canadian Railway Operating Division have their Depôt for reinforcements and casualties at Purfleet. The Australians and South Africans at Longmoor.

Number of Companies Sent Out.

The following table shows the number of companies sent out complete from the R. and R.T.C., R.E.

Construction Companies	28
Labour Companies	6
Operating Companies	42½
Roads Companies	29
C.O.R.C.C.	4
Canadian Operating	2
South African	3
Australian Companies	4
Total ...	118½

AMERICANS.

On 20th July, 1917, the first American Railway Regiment arrived in England, and was sent to Bordon in Camp at Oxney Farm, at first with the intention of completing training under the Commandant, Railways and Roads Training Centre, R.E. But this arrangement was soon altered and nine regiments in succession at an average strength of 1,000 passed through Oxney Camp making but a short stay. The arrangements for their camping, supplies, transport, etc., were all made by the Railway Troops, as were those for several other American units of other branches of the service which arrived at Oxney Camp subsequently.

His Majesty the King inspected one American Railway Regiment, and also the Railway Operating Division, R.E., at Bordon on 28th July, 1917.

CENTRAL REGISTRY.

As the numbers and formations increased it became difficu't to identify any particular man as to whom reference was required. A Central Registry was, therefore, instituted in April, 1917, where Index Cards of every man belonging to the Railways and Roads Training Centre, R.E., are kept and where their name, number and other particulars are recorded thus enabling the Commandant to obtain in a few minutes such trace of any man as will ensure ready reference. The Central Registry also receives all men arriving at Longmoor from any source and directs them to the unit they are allotted to.

ROPEWAYS, ETC.

During the summer of 1917, two forms of experimental Ropeways were sent to Longmoor for erection and trial.—The "Hamilton" Hand Ropeway, and a mobile ropeway with travelling ropes and winding gear and engine (The "Leeming" Ropeway), designed in the Ministry of Munitions.

Experiments and modifications were tried continuously until 25th November, 1917. The erection and working of these were inspected by a Committee of Generals and other officers from the Departments of Director-General of Movements and Railways, Ministry of Munitions, and Director-General of Transportation, France.

A Railway Track Destroyer was designed and tested at Longmoor, improved from a model used by the Germans: and is understood to have been found effective in France.

The "Rugeroni" Sleeper for use on light railway lines in marshy ground was suitably tested and found effective.

The "Kent" Monorail was also erected and tested at Longmoor.

Schools.

Newly joined officers were, for the first year, trained under the direct supervision of the Adjutant, R.E. In October, 1915, it was found necessary to place them under the charge of an officer specially employed *ad hoc*. Since then all new officers have passed through the School. Originally the course was two months, reduced under pressure of the demand for officers to a fortnight, and since fixed at one month. About 800 officers have passed through this School since it was formally constituted. It was not till the autumn of 1918, that Officers of Railways and Roads were sent in the first instance to Officers' Cadet Battalions.

R.T.O. School.—In October, 1916, the influx of officers appointed as Railway Traffic Officers with no knowledge of railway matters made it necessary to start a School for their instruction. This has since been maintained under officers with practical experience; and 247 officers have passed through it.

A Manual for Railway Traffic Officers was compiled and edited at Longmoor, and approved by G.H.Q. in France.

Internal Combustion Engines.

The inauguration of Light Railways caused a great demand for Internal Combustion Engine Drivers, as this form of traction had never been used before on British Railways. A track of some 3½ miles of 60-cm. rails was laid at Longmoor with special curves and grades, on which steam locomotives, petrol electric, petrol, and converted Ford tractors are used for the instruction of drivers, who have largely been taken from tradesmen with no previous knowledge of I.C.E. driving of any sort. 1,720 men have been so trained up to date, with, it is understood, satisfactory results in France.

Previously in 1915, one mile of 2 ft. 6in. track was sent to Longmoor for the trials of three experimental I.C.E. tractors, which were duly carried out. One Broad Gauge Petrol-driven locomotive was also sent about the same time for trial and experiment.

Transfer Depôt.

At the end of December, 1916, transfers from other units of the army began to arrive at Longmoor in large numbers owing to the fact that many men from British Railways and of skilled trades, now urgently required at their trades, had enlisted in fighting units before or early in the War—an unfortunate result of the haphazard methods of our organization and recruiting under voluntary service. Their skill had now become more essential to the scientific services than they could be to their previous unit.

It became immediately apparent that a special organization was required to deal with the intricate work of sorting out these men, and getting their documents, etc., in order. The amount of corres-

pondence became immense as a large proportion of men came without essential documents to show trade, medical category, conduct, clothing, and other necessary particulars.

The Transfer Depôt was, therefore, established under the command of Lieut. Romer (shortly promoted to Captain and Acting Major), and lately under Major G. N. Baines, R.E. A staff was formed out of the transferred warrant and non-commissioned officers, etc. By this means the difficulty was overcome, not without strenuous work and enormous correspondence, which if orders had been obeyed by the transferring units, would never have been wanted.

Upwards of 12,000 men have thus been dealt with, of whom over 10,000 have been sent on draft, 8,000 dentally examined, 11,100 sent on leave, 5,600 dentally treated, while some 900 have been returned as unfit, etc.

It will readily be realized that such a heterogeneous mass of men aggregated in a new unit under strange officers and conditions gave some trouble as regards discipline, and much as regards rations, clothing, preservation of barrack stores and administration generally.

It must be acknowledged that the high standard of conduct and discipline previously obtaining in the Railways Troops when recruits only were received has been lowered, and the greater part of such crime as has since occurred is to be traced to the transfers. On the whole, however, it is hoped that that standard is still a high one, due largely to the tact and powers of command of the Officers Commanding the different units of the Railways and Roads Training Centre.

Recreation.

Longmoor being on a remote common far from town or village, it was essential to provide all possible distractions for the men. Sports, cross-country running, football, cricket, and boxing were encouraged and well supported. The Seymour Hall, in Longmoor Camp, opened in January, 1915, provided a valuable site for lectures, concerts, and for a cinema which has been purchased from Regimental Funds and run continuously for 3½ years. A weekly concert with high-class artistes has been kept up since 1914, whist drives held once a week and dances once a month. In the spring of 1916 it was found possible to organize a string band owing to the presence of several highly skilled musicians. In spite of many changes and difficulties this band has been kept going to the end, and has contributed more than can easily be expressed to the amenity of the Camp and enjoyment of all within its reach. A brass band was also kept going until demobilization set in, in the R.O.T.D.

Miscellaneous.

The Railway Troops were early in the field in the matter of cultivation. Some 46 acres of heather-clad moor have been converted

into arable land, cleaned, manured and ploughed and have yielded several good crops of potatoes and vegetables at a profit to the Government and the Troops of £1,171.

The messing of the different units has invariably met with praise from the I.Q.M.G.S.

A model laundry has been established at Longmoor which has saved the troops much money and trouble in washing and mending, and yielded a total profit of £730.

It may be mentioned that officers and other ranks of the Railways and Roads Troops, R.E., have been sent in units or detachments not only to France but to Italy, Egypt, Salonica, Mesopotamia, North and South Russia, Vladivostock, East and West Africa, besides many detachments at home for various experiments, manufacture of material, armoured trains and railway construction work, while the Road and Quarry Troops Depôt has done much useful work in the Aldershot Command.

In February, 1917, Colonel Sinclair's title was changed from O.C., Railway Troops, R.E., to Commandant, Railways and Roads Training Centre, R.E.

One serious difficulty with which the Commandant has had to deal throughout is the constant change of officers and staff due to the demands for overseas for the most skilled and experienced of all ranks, and later, to the removal from home service of all "A" men and "B1" clerks. His Adjutant has been changed six times. There have been five officers commanding the Railway Construction Troops Depôt, three of the Railway Operating Troops Depôt, and many more numerous changes in the command of companies and adjutants of the different units.

Including all units at any time under the command of the Commandant, Railways and Roads Training Centre, R.E., up to 11th March, 1919, 1,681 officers, 59,627 other ranks have been sent overseas from this Training Centre, and 28 officers, 2,633 other ranks have been demobilized. 102 officers and 3,565 men are still in the Command, making a grand total of 1,811 officers and 65,825 other ranks. All calculations are made up to and including 11th March, 1919.

The Railways and Roads Training Centre has from 1915, been directed by the office—first—of the Director of Movements under the Q.M.G., and subsequently by that of the Director of Railways and Roads under the Director-General of Movements and Railways.

The War Office was therefore responsible for the provision of officers and the enlistment and transfer of other ranks, for the maintenance of the due proportion of reinforcements and provision of new units, and generally for the direction of all technical matters.

This Training Centre has been always under Aldershot Command for discipline and administration.

APPENDIX A.

LIST OF RAILWAY CONSTRUCTION AND RAILWAY LABOUR COMPANIES MOBILIZED AT LONGMOOR BETWEEN AUGUST, 1914, AND MARCH, 1919, FOR SERVICE WITH EXPEDITIONARY FORCES.

Designation.	Date sent overseas.	Expeditionary Force.
Old Army.		
8th Railway Co., R.E.	4. 8. 14	B.E.F. France.
10th do.	26. 11. 14	do.
R.M., R.E. (S.R.)	10. 11. 14	do.
R.A., R.E. (S.R.)	10. 11. 14	do.
New Army.		
109th Railway Co., R.E.	24. 12. 14	B.E.F. France.
110th do. ...	4. 2. 15	do.
111th do. ...	15. 2. 15	do.
112th do. ...	15. 2. 15	do.
113th do. ...	14. 4. 15	do.
114th do. ...	1. 5. 15	do.
115th do. (L. & N.W.R.)...	3. 9. 15	do.
116th do. (G.W.R.) ...	14. 12. 15	E.E.F. Egypt.
117th do. ...	23. 8. 15 & 5. 9. 15	do.
118th do. (G.E.R., N.E.R.)	15. 12. 15 & 7. 2. 16	B.E.F. France.
119th do. ...	30. 5. 16	do.
259th do. ...	30. 1. 17	do.
260th do. ...	3. 2. 17	do.
261st do. ...	26. 2. 17	do.
262nd do. (G.W.R.) ...	26. 2. 17	do.
263rd do. ...	26. 4. 17	do.
264th do. ...	13. 5. 17	do.
265th do. ...	14. 9. 17	E.E.F. Egypt.
266th do. ...	14. 9. 17	do.
268th do. ...	19. 12. 16	B.E.F. France.
269th do. ...	17. 1. 17	do.
273rd do. ...	6. 9. 16	B.S.F. Salonica.
274th do. ...	23. 10. 16	E.E.F. Egypt.
275th do. (G.W.R.) ...	21. 8. 16	B.E.F. France.
270th Railway Labour Co., R.E.	15. 11. 15	B.S.F. Salonica.
271st do.	14. 1. 16	B.E.F. France.
30th Labour Battalion—		
A Co.	17. 5. 16	B.E.F. France.
B Co.	17. 6. 16	do.
C Co.	29. 6. 16	do.
D Co. and H.Q.	22. 7. 16	do.

APPENDIX B.

COMPANIES SENT OVERSEAS FROM THE RAILWAY OPERATING TROOPS DEPÔT, R.E., ARE AS UNDER.

Designation.	Officers.	O.R.	Date of departure.	Expeditionary Force.
No. 1 Light Railway Operating	3	238	24. 1. 17	B.E.F.
No. 2 Light Railway Operating	3	231	4. 2. 17	do.
No. 18 Light Railway Train Crew	3	262	6. 2. 17	do.
No. 3. Light Railway Operating	3	228	9. 2. 17	do.
No. 19 Light Railway Train Crew	3	245	16. 2. 17	do.
No. 4 Light Railway Operating	3	232	23. 2. 17	do.
No. 6 Light Railway Operating	3	248	26. 2. 17	do.
No. 23 Light Railway Miscellaneous Trades	3	253	10. 3. 17	do.
No. 9 Light Railway Operating	3	254	12. 3. 17	do.
No. 10 Light Railway Operating	2	241	12. 3. 17	do.
No. 26 Light Railway Workshop	2	163	12. 3. 17	do.
No. 20 Light Railway Train Crew	3	252	18. 3. 17	do.
No. 37 Broad Gauge Miscellaneous Trades ...	2	204	21. 3. 17	do.
No. 21 Light Railway Train Crew	2	264	27. 3. 17	do.
No. 38 Broad Gauge Miscellaneous Trades ...	2	234	27. 3. 17	do.
No. 27 Light Railway Workshop	3	230	17. 4. 17	do.
No. 39 Broad Gauge Miscellaneous Trades ...	3	252	24. 4. 17	do.
No. 22 Light Railway Train Crew	3	224	7. 5. 17	do.
No. 12 Light Railway Operating	3	254	11. 5. 17	do.
No. 11 Light Railway Operating	3	262	17. 5. 17	do.
No. 24 Light Railway Miscellaneous Trades	3	222	17. 5. 17	do.
No. 14 Light Railway Operating	3	251	2. 5. 17	do.
No. 25 Light Railway Workshop	3	214	23. 5. 17	do.
No. 1 Electrical Section	1	25	15. 6. 17	do.
No. 2 Electrical Section	1	23	19. 6. 17	do.
No. 34 Broad Gauge Operating	3	252	21. 6. 17	do.
No. 3 Electrical Section	1	15	30. 6. 17	do.
No. 66 Wagon Erecting	2	215	30. 6. 17	do.
No. 79 Broad Gauge Workshop	3	218	10. 7. 17	do.
No. 80 Broad Gauge Workshop	3	179	23. 7. 17	do.
No. 67 Wagon Erecting	2	206	7. 8. 17	do.
No. 96 Light Railway Operating	5	241	2. 12. 17	E.E.F.
No. 98 Light Railway Train Crew	5	269	17. 12. 17	do.
No. 82 Broad Gauge Miscellaneous Trades ...	3	207	9. 2. 18	B.E.F.
No. 1 Platoon Transportation Stores Co. ...	2	60	16. 2. 18	I.E.F.
No. 1 Platoon 109th Light Railway Optg. Co.	2	67	18. 4. 18	I.E.F.
No. 86 Engine Crew	3	295	15. 11. 18	B.E.F.
No. 87 Engine Crew	3	201	24. 11. 18	do.
No. 36 Broad Gauge Operating	2	201	27. 11. 18	do.
No. 89 Engine Crew	3	246	5. 12. 18	do.
No. 55 Broad Gauge Operating	3	194	9. 12. 18	do.
No. 90 Engine Crew	1	218	27. 12. 18	do.
No. 68 Wagon Erecting	3	35	26. 1. 19	do.

APPENDIX C.

ROAD CONSTRUCTION COMPANIES MOBILIZED AND DESPATCHED TO FRANCE AND EAST AFRICA.

Designation.			Strength Other ranks.	Date sent overseas.	
301st	R.C.C., R.E. ...	...	251	1. 1. 17	
302nd	do. ...	...	251	15. 1. 17	
303rd	do. ...	...	251	17. 1. 17	
304th	do. ...	...	251	22. 1. 17	
308th	do. ...	...	252	4. 2. 17	
309th	do. ...	...	251	4. 2. 17	
310th	do. ...	...	252	10. 2. 17	
311th	do. ...	...	251	11. 2. 17	
312th	do. ...	...	251	18. 2. 17	
331st	do. ...	...	247	1. 6. 17	
332nd	do. ...	...	247	13. 6 17	
333rd	do. ...	...	251	1. 3. 17	
334th	do. ...	...	251	1. 3. 17	
335th	do. ...	...	247	12. 3. 17	
336th	do. ...	...	247	16. 3. 17	
337th	do. ...	...	249	26. 3. 17	
339th	do. ...	...	246	12. 4. 17	
340th	do. ...	...	247	14. 4. 17	
341st	do. ...	...	247	24. 4. 17	
342nd	do. ...	...	247	27. 4. 17	
343rd	do. ...	...	247	3. 5. 17	
344th	do. ...	...	246	12. 5. 17	
345th	do. ...	...	246	24. 5. 17	
346th	do. ...	...	246	12. 9. 17	
347th	do. ...	...	246	26. 9. 17	
348th	do. ...	...	246	25. 10. 17	Quarry Co.
391st	do ...	...	11	3. 5. 18	To East Africa.
392nd	do. ...	...	11	3. 5. 18	To East Africa.
349th	do. ...	...	256	19. 7. 18	
	Total ...	29.			

NOTICES OF MAGAZINES.

REVUE MILITAIRE SUISSE.

No. 5.—May, 1919.

The German and French Cavalries in the Great War.

The article on the above subject by Colonel Poudret begun in the number of the *Revue* for March last, is continued in the number under notice. A brief examination is made of the French regulations relating to the employment of cavalry in dismounted action. The same principles, it is pointed out, apply in this case as those that govern the battle-tactics of infantry; however, cavalry, even in dismounted action, possesses greater rapidity of movement than infantry, and also mobility superior to the latter. The fullest advantage, it is laid down, should be taken of these characteristics of the cavalry arm, and a sufficient mounted reserve should be kept in hand in the early stages of the fight to exploit the success of the dismounted men. Colonel Poudret points out that a cavalry detachment intended to take part in dismounted action should be divided into three distinct groups:—

(*a.*) The dismounted men (organized in half-sections, sections, companies and battalions);

(*b.*) The led horses and the transport;

(*c.*) The mounted reserve.

The formation in which, it is suggested, the dismounted men should advance to the attack is briefly described in the original article, and the points to be attended to in the offensive and the defensive battle are also shortly stated.

The Great War has brought about some changes of opinion in relation to the rôle of cavalry as such, but the French High Command has shown by its use of cavalry that it believes that this arm can still effectively intervene in a modern battle, and to some extent as a mounted force. Emphasis is laid by Colonel Poudret on the following points:—

(*i.*) Whilst before the war the majority of soldiers had come to the conclusion that cavalry would normally be confined to reconnaissance work, the experience of the war has shown that such work can generally be more advantageously undertaken by the Air Force. On the other hand, contrary to anticipations, it has been shown that cavalry can continue to play an important part in a modern battle.

(*ii.*) The horses should be utilized to carry groups of men rapidly to the battlefield for dismounted action; later, during the battle, to transport these men to the flanks, or even to positions in rear, of the enemy's line.

(*iii.*) Only in relation to the particular sphere of dismounted action have changes come into existence. Cavalry movements and other

matters special to this arm remain unchanged and as they were prior to the war.

(*iv.*) The fundamental idea in cavalry dismounted action should consist in combining a frontal attack by dismounted men with a simultaneous attack of mounted men against the enemy's flanks: the concentrated fire of guns and automatic rifles being employed to assist the troops to gain the weak points (*i.e.* the flanks) of the enemy's line.

(*v.*) It is to be assumed that practically in every case that cavalry is required to go into action, it will be supported and assisted by guns, infantry supports, labour battalions, aeroplanes, armoured cars, etc., whether they form an organic part, or not, of important cavalry formations.

(*vi.*) Divisional cavalry should always be prepared to play a part on the battlefield.

(*vii.*) *Liaison* should play a capital rôle in every operation, and hence the diversity of the means employed to effect this purpose.—(*To be continued*).

THE BATTLE OF THE YSER.

The anonymous author of the original article calls attention to a work by Commandant A. Grasset, of the French Army, entitled *Préceptes et jugements du maréchal Foch*, extracts from which have been published in the number of the *Illustration* for March, 15th 1919. Commandant Grasset apparently claims in his work that many of the important decisions of the Belgian High Command were inspired by the distinguished French Marshal. The Commandant also states that it was owing to the intervention of Marshal Foch on October 20th, 1914, that the retreat of the Belgian Army on Dunkirk was prevented, and that later the scheme for inundating the Yser region was put in hand.

The author of the original article, whilst accepting the good intentions of Commander Grasset, expresses the opinion that the latter has based his account of the operations in the Yser region on erroneous and insufficient information, and has, in consequence, been led to exaggerate the part played by Marshal Foch and the French troops when co-operating with the Belgian forces which had escaped from Antwerp. It is pointed out that when the Belgian High Command brought the defenders of Antwerp to a halt on the Yser, it was made clear to them, in an Order of the Day issued by King Albert, that any man who retired from the position then taken up without a distinct order to do so would be held a traitor to his country. The battle opened on October 17th and continued till the 31st *idem*. On October 20th the Belgians, it is said, were holding on to their positions, extending from the sea to Noordschoote, with great firmness; no question of a retreat was in the minds of the Belgian High Command, nor was any Council of War held that day to discuss such a matter. On October 21st, as on the preceding day, the Belgians had to withstand violent German attacks and suffered heavily in casualties. In order to have reserves in hand on the important section of the front, Nieuport-Dixmude, the Belgian High Command asked the French High Command to take over a short section of the front south of Dixmude, so that the Belgian troops holding it might be moved north of the last mentioned place as reinforcements. The

French Generalissimo acceded to this request, on condition that the Belgian right should maintain connection with the French troops holding Noordschoote. During the night of October 21-22, the Germans succeeded in crossing to the west of the Yser at Tervaete, and a French brigade was thereupon pushed into this neighbourhood. However, on the 24th *idem* the Germans succeeded in strengthening their hold on the west bank of the river at this point. On the 25th *idem* the French 42nd Division, at the time engaged near Nieuport, was moved south towards Dixmude, where the Belgians were very hard pressed. During the night of October 24-25, three Belgian battalions had repulsed 15 German assaults, and were practically worn out. The situation was becoming critical, and it was then that the Belgian High Command decided to inundate the region between the Yser and the Dixmude-Nieuport railway and ordered the preliminary measures to effect this purpose to be put in hand. The credit for the idea and for the execution of this scheme belongs, it is claimed in the original article, to the Belgian High Command. The Battle of the Yser was, it is said, a battle delivered and won by the Belgian Army. The victor on the Yser was none other than King Albert.

Art and the Army.

The original article refers to the lack of artistic taste shown in the designs appearing on certain official documents in use in the Swiss Army, such as diplomas, commissions, certificates, etc. They are lamentable examples of chromolithography, and few of the recipients of these documents have, it is stated, the courage to have them framed for decorative purposes.

A similar lack of artistic taste, it is stated, exists in relation to the Swiss soldiers' uniform. Complaint too is made of the music played by the regimental bands; some of the marches, it is said, are a cross between nigger-minstrel and cinema music, and set even the dogs howling. There has, however, been a revival in recent times in the matter of soldiers' songs, and songs which were the fashion long ages ago are being again rendered with taste by the soldiers of to-day.

There is room, it is urged, for art in military life.

Machine-Guns in Action.

The original article is an extract from a paper read by Capt. Bridel before the Société des Officiers at Lausanne. Therein he points out that infantry officers and young machine-gun officers should thoroughly familiarize themselves with the delicate mechanism of the machine-gun. He sets out briefly the sources of information on the subject open to Swiss officers. Regret is expressed that the military authorities have not distributed copies of the report made by the Swiss attachées who were with the belligerent armies more widely; it is suggested that every subaltern officer ought to have been furnished with a copy.

Particulars are given in the original article concerning the organization and equipment of a machine-gun company, its establishment, the

various formations used in marching, etc. Extracts are also given from the Swiss Regulations bearing on the tactics of this new arm. The necessity for close co-operation between the infantry and machine-guns is indicated and it is pointed out that the configuration of the terrain is such in Switzerland as frequently to admit of employment of machine-guns in tiers.

Apparently, considerable progress has already been made in Switzerland in carrying out combined training with infantry and the machine-gun companies. Some stress is laid in the Swiss Regulations on the importance of not bringing machine-guns into action prematurely. The instruction on the subject runs: "He who has the courage to hold back his machine-guns till the last moment and to bring them into action at the shortest possible ranges, can reckon on certain success."—(*To be continued*).

NOTES AND NEWS.

Switzerland.—There are indications that military and labour unrest has invaded even Swiss territory; an infantry company appears recently to have mutinied at St. Gallen. The trouble has arisen owing to the relaxation in discipline.

The people of the Vorarlberg seem to be anxious to join the Helvetic Confederation as a canton (making the twenty-third). The matter is to be submitted to a plebiscite. The question as to whether it will be to the advantage of Switzerland to admit the people of Vorarlberg into the fold should they so desire is discussed. A certain section of the Swiss people are distinctly averse to any increase of the Germanic element in the composition of the Republic. But will it be wise for this section to veto the proposal?

The Ajoie forms a part of the proposed new canton, and General Maitrot has made a suggestion that the Swiss should cede this region to France; the reason being that it constitutes one of the keys to the "trouée de Belfort." The suggestion has upset the susceptibilities of a section of the Swiss press, which sees in it black designs against Switzerland on the part of France.

Rumour has it that Geneva is to be the International Headquarters of the League of Nations and this has given rise to questions affecting the defence of the proposed Capital of the League.

The death is announced of Colonel Emile Ruffieux and also of Colonel Sigismond Coutau.

Belgium.—A special correspondent writes that the whole of Belgium is a vast 'zone d'arrière,' and it would appear that the people are chafing under the restrictions in force which are still necessary as long as a state of war continues to exist. The question that seems to be of greatest interest to the public in Belgium at the present time is: What is to be the future of the Belgian Army? It is suggested that the present organization of the Belgian Army is only provisional and must soon be modified. In spite of the fact that the world is in travail and expects shortly to give birth to a League of Nations, Belgium, conscious of her experiences of 1914 is anxious to keep up an armed force of such dimensions in the future as will enable her to maintain her frontiers inviolate against all aggressors. It is recognized that the

composition and organization of the new Belgian army will to some extent be governed by the demands made upon it in connection with the army of occupation in Germany: at the present time two Belgian divisions are co-operating with the Allied forces on the Rhine.

INFORMATION.

Switzerland.—A short article is published dealing with the question of Switzerland's neutrality in connection with the formation of the League of Nations. It is felt by many Swiss writers that owing to the tracing of the new frontier of France along the Rhine, Germany's shortest and easiest line of advance into the former country will now be *viâ* Switzerland. This situation is evidently disturbing the equanimity of certain students of military affairs who desire that the inviolability of Swiss territory shall be effectively guaranteed.

Bulletin Bibliographique.—Notices are published of the following works: *De la Marne à l'armée du Nord.* By General Berthaut (published by G. Van Oest et Cie of Paris and Brussels at 3fr. 90c.); *La décomposition de l'armée russe.* By General Nicholas de Monkevitz (published by Pagot et Cie of Paris and Lausanne at 4fr. 50c.); *France et Pologne. La paix française dans l'Europe orientale.* By General du Moriez (published by Pagot et Cie, Paris).

A list is also given of other new works received for review.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

September, 1918.

GERMAN LIGHT MAXIM MITRAILLEUSE.

As is well known several armies were provided before the war with mitrailleuses usually fixed on tripods or other supports. Ordinary characteristics of these weapons varied with their weights from 20 to 25 kg., and their supports. Up to a period of ten years prior to 1914 trials were made, not with a view to the substitution of regular mitrailleuses, but by the addition of other arms of a lighter and more movable pattern.

In 1906 it became known that Denmark had adopted a really portable mitrailleuse (not to be confused with the automatic rifles used by some armies) as an armament for all the infantry. In 1905 the *Scientific American* gave a description of this new weapon, invented by the Danish engineer Schouboe, and perfected by General Madsen. The rapidity of its fire was about 180 shots a minute; and its weight only 7.5 kg. In addition to its use in the Danish army, where it was distributed to the cavalry, it was adopted by the Russians in the Russo-Japanese war. It was experimented upon in England, but was not adopted.

In 1907 trials were made in Austria with a light mitrailleuse called

Salvenfeuer, weighing from 12 to 14 kg., and provided with a supporting prong or fork, but good results were not obtained as it was not further spoken of.

In 1909 the United States army adopted the light mitrailleuse Berrèt Mercié, a kind of portable Hotchkiss mitrailleuse, provided like the former with a stock and a supporting prong, and with a greater rapidity of fire of from 250 to 400 shots per minute. The fact that this army at the time of its participation in the European war hastened to substitute the Browning mitrailleuse shows that it did not place much dependence on the former weapon. The United States have also introduced into the service the light Lewis mitrailleuse, which is now principally used for aeroplane service in conjunction with the Marlin mitrailleuse. The external characteristics of the Lewis is the circulating loader placed horizontally below the breach, which gives the gun the appearance of a small cannon, although very light. It can be fired from the shoulder and is provided with a supporting prong.

In France in 1910 the munition factory at S. Étienne produced the light mitrailleuse or rifle-mitrailleuse Chauchat weighing 8 kg. and with a rapidity of fire of from 200 to 300 shots per minute; it was largely employed in the war.

Shortly after the commencement of the war the attention of all the belligerent states was concentrated on light mitrailleuses, and it may be noted that the solution of the problem of a very light mitrailleuse may be accorded to Italy. Under this point of view, Germany found itself at the commencement of the war in a less favourable condition, as its Maxim mitrailleuse of an old type was the heaviest weapon of its kind; it weighed in fact 26 kg., and with its carriage and mounting 56 kg.; other Maxims of more recent type were then tried, in which after many trials the weight was reduced to 22 kg. for the mitrailleuse and 34 for the carriage, but the enormous development of the use of mitrailleuses in this war, requires lighter weapons which can be placed in action anywhere and rapidly, and even by a single man. Germany only resolved the problem one half, reducing the weight of its Maxims by 3 kg. and abolishing the support.

The new light Maxim mitrailleuse is provided with a simple supporting prong, made with two short metal tubes, terminating below with a metal plate and point; the two tubes are fastened to the weapon near its central part. Instead of the usual stock this mitrailleuse is provided with a butt like that of a rifle, but of greater dimensions, so as to give a wide assistance to the shoulder. The trigger is like the butt of a pistol, and this allows for a firm hold with the right hand. The cartridge belt is attached to the right of the weapon. A conical tube is fixed at the muzzle, which serves to diminish the glare from the discharge. This light Maxim mitrailleuse—or rifle Spandau mitrailleuse as it is called from the name of the town where it is constructed—is similar to the German Maxim. The length of the new weapon is from 1.40 m.; the knee-piece when the prong rests on the ground is 28 cm. It will be seen that the solution by Germany of the problem of a really portable mitrailleuse is no better owing to the excessive weight of the weapon.

E. T. THACKERAY.

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