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CONTENTS.

DEEDS OF THE ROYAL ENGINEERS

Now ready, *Deeds of the Royal Engineers*, compiled in the R.E. Records Office. Extract from the Preface :—

"It is hoped that the following pages may assist lecturers on Royal Engineer history, and may help members of the Corps generally to become familiar with some of the more striking events and personalities in the long and illustrious history of the Royal Engineers."

Chapter 1.—A Short History of Military Engineers in England.
,, 2.—The Soldier Artificer Company at the Siege of Gibraltar.
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WORK BY R.E. UNITS IN THE WAR

(Continued from the R.E. JOURNAL *of March,* 1919).

THE 57TH, 456TH, 458TH FIELD COMPANIES.

ON the morning of April 10th, 1918, the 57th Field Co., R.E. (O.C. Major F. N. Lund, R.E.), marched to billets near the Bailleul-Armentieres railway crossing, due west of Nieppe.

About 3 p.m. the situation being very obscure, a General Officer suggested that a party should be sent out to protect our right flank. Two sections of the 57th Field Co., R.E., together with their attached infantry, deployed and advanced in a south-westerly direction and came into touch with large forces of the enemy near Menegate. Here, they engaged the enemy who was rapidly advancing and fought a rear-guard action, withdrawing slowly until they reached the railway embankment. This they held until dusk, great work being done by a Sergeant R.E., who, finding a Lewis gun and magazines, used them with great effect until all ammunition was exhausted.

The enemy now moved round to the flanks and seized the farm at the railway crossing. The party then withdrew under heavy machine-gun fire, to the main Bailleul-Armentieres road and there reported the situation to Staff Officers. Troops in the road were collected and sent out to take up the position on the railway line, which was held during the night.

On the night 12/13th April, the 458th (W.R.) Field Co., R.E., Commanded by Major E. Jackson, M.C., R.E., were in billets near Neuve Eglise, on road Neuve Eglise—Wulverghem.

The enemy attacked the village and got across the road between the R.E. and the centre of the village. On the early morning of the 13th inst., a counter-attack was organized by Major Jackson, R.E., with his Company assisted by some men of 1/4th York and Lancaster Regiment. This was very successful, the enemy battalion Commander and Staff and 16 O.R. being captured and brought in by the R.E. Major Jackson though wounded in the foot, refused to leave his company and established himself in the village. The enemy again attacked and the R.E., assisted by infantry had hard house to house fighting which ended in the company being still in the village. Major Jackson, however, was mortally wounded. The company was withdrawn by the G.O.C. Brigade.

The captured enemy commander referred to the R.E. Company as undoubtedly picked troops and said he had never seen men fight like them, but as they were only a small body, must have been wiped out. The company was withdrawn from Neuve Eglise with the loss of one officer and eleven O.R. (mostly bullet wounds), which did not altogether bear out the enemy commander's opinion.

On 17th April, the 456th (W.R.) Field Co., R.E., O.C. Major F. A. Neill, D.S.O., R.E., formed part of a composite force holding the defences of Mont Kemmel when it was reported that the enemy were in Donegal Farm at the foot of the hill.

Lieut. A. D. Garrett, R.E., with No. 2 Section, was ordered to occupy the farm, which he did with slight opposition, establishing himself and men in the farm and two small posts outside. During the evening, the enemy apparently heavily attacked the farm and Lieut. Garrett with eight sappers were cut off therein. The two outside posts withdrew in good order, each covering the other in turn, on to the main defences. A French raiding party which entered the farm, reported an officer and his party all dead therein and surrounded by large number of dead Germans. It was not possible to recover the bodies, but only one British officer went out, and that was Lieut. Garrett, R.E.

A SPECIALLY GOOD PIECE OF R.E. WORK.

The following account may be interesting, dealing as it does with a specially good piece of R.E. work.

The enemy had made a cut in the west bank of the Haute Deule Canal. The cut itself was evidently made some time ago, as it appears on aerial photographs, but was not noticed until the night of the 10th/11th, when owing to a rise of 9 in. in the water of the canal, the water commenced to rush through the gap very rapidly.

Lieut. Peet, R.E., 157th Field Co., R.E., went out on the 11th and attempted to block the breach with sandbags. The enemy had placed a machine gun in La Ferme and swept the breach almost continuously through the night. The sappers, lying in mud all the while, attempted to block the breach, but as the level of the canal had risen another 3 in. the bags were swept out as fast as put in.

The next night another attempt was made by Lieut. Peet. A sluice box was made for the middle of the breach and this was bagged in on the sides. Owing to the heavy machine-gun fire, which killed two sappers, it was impossible to complete the job before daylight, as each sandbag had to be anchored down with a screw picket.

The next night two shifts of sappers were employed and the bagging of the sides completed. The sluice box was then closed,

the flow of water stopped, and the box then filled in solid with sandbags. The hole was then securely banked in.

Lieut. Peet's efforts were beyond all praise, in addition he voluntarily remained back two days from going on leave in order that he might stop this breach.

The rise of water in the flooded area has now practically ceased.

F. SUMMERS, *Lieut.-Colonel, R.E.,*
C.R.E., 16th Division.

14th October, 1918.

NARRATIVE OF ACTION OF 422ND AND 423RD FIELD COMPANIES, R.E. AND PIONEERS.

On November 30th, the 422nd and 423rd Field Cos., R.E., each less one section (in reserve), and "B" and "D" Cos., Pioneers, were ordered by brigades with which they worked, to man trenches on the Brown line.

One section of 422nd Field Co., R.E., which was stationed at Villers Guislain, finding the enemy was surrounding the village from the north, retired gradually on Vaucelette Farm. Collecting a few stragglers, and being joined by a small party of infantry, this section then charged the enemy, drove him out of Gauche Wood, and recaptured a battery of 60-pounders. These they endeavoured to bring into action, but before they could do this, the party was driven back again and retired on Vaucelette Farm, which they continued to hold for the rest of the day.

One section of 422nd Field Co., R.E., stationed in Sapper Quarry, stood to in Gloster Road as soon as the alarm was given; they sustained a considerable number of casualties from shell fire, and being unsupported, were forced to fall back in the direction of Epehy. They, with some stragglers and a Lewis gun team, took up a position on a spur about 1,800 yards north-east of Epehy, whence they were able to bring effective fire to bear on the enemy. At 5.30 p.m. they established communication with the infantry who were digging in in rear of them and retired to this new line at 7 p.m.

OPERATIONS OCTOBER 20-22, 1918.—55TH, 75TH, AND 76TH FIELD COMPANIES.

The Guards Division received orders to cross the River Selle in the early morning of the 20th October, and capture the high ground east of the river.

The tasks allotted to the R.E. and 4th Bn. Coldstream Guards were as follows:—

(*a*). To construct infantry footbridges immediately before zero to pass the attacking troops over.

(*b*). To construct two pontoon or trestle bridges as soon as possible after zero, with the primary object of crossing field guns to deal with enemy tanks.

(*c*). To construct a bridge capable of carrying all loads, including tanks, over the River Selle at St. Python.

(*d*). If considered necessary, to construct a bridge up to at least 60-pounders to relieve the traffic over the tank bridge.

(*a*) of the preceding paragraph was expected to prove the most difficult of the tasks, involving a long carry down an exposed slope from the St. Python-Haussy railway, under the close range fire of the enemy. Eight footbridges were to be made available on each brigade front, alternate bridges being duplicated if possible, and a spare pier and grid dumped at each bridge for repairs.

Two field companies (75th and 76th) were employed, one on each brigade front, each field company being assisted by one company of pioneers. The bridges used were of various types, piers of cork, petrol tins, and light barrels being utilized; all the types proved entirely satisfactory, and quite stable. Work was commenced at 22.00, tapes being laid due east from the railway to the river, and notice boards erected; this work was completed by midnight. From midnight onwards one bridge was taken down every 10 minutes on each brigade front, in accordance with a definite programme, instructions being given to erect, if possible—if not, the party was to lie down, and erect at the moment our barrage opened.

All the bridges were successfully completed before zero, the great factors being the absolute silence preserved by all ranks, the excellent organization of the field company commanders, and the avoidance of any splash as the piers were put in the water; as each bridge was completed, the party withdrew, except two sappers as a maintenance party, who sheltered under the eastern bank, and a standing patrol of two infantry at the bridgehead.

The work was not discovered by the enemy until the last bridge was being erected immediately before zero; ten rounds were fired into the party without doing any damage, but it was too late for the enemy to make any organized attempt to find out what was going on. The greatest difficulty encountered was getting the piers down the steep banks, rendered very slippery by the heavy rain, without making any noise. Ropes were fixed across the river at each crossing to enable men to pull themselves across if the bridge was smashed.

With reference to (*b*), each of the field companies employed on (*a*) was ordered to make one pontoon or trestle bridge, an attempt to be made at zero minus one hour; if this failed, work was to start when our barrage opened. 75th Field Co., on the right, got their trestles in, but one leg of one of the trestles sank in a deep

muddy hole, and all efforts to extricate that leg or adjust the bridge failed until daylight when the bridge was quickly in working order.

The 76th Field Co., on the left, was entirely successful, using one made up trestle; a large part of the credit must be given to the carrying party of the 4th Bn. Coldstream Guards who went into the river in the dark with the trestle on their shoulders, and up-ended it in exactly the right place. This bridge was completed at zero minus 15 minutes and was used very soon after zero by Field Artillery, M.G. Limbers, etc.

The construction of the bridge to take tanks proved the most difficult of the tasks allotted to the R.E., and was entrusted to the 55th Field Co., R.E. The only approach, by which material could be got to the site of the bridge, was blocked 300 yards west of the site by a heavy brick railway bridge which had been blown down into the road; the work of clearing this obstacle was commenced at 0400; until 0800 persistent shelling, with H.E. and gas, rendered work slow; after this hour the gas shelling ceased and the men could discard their gas masks, and the rate of clearing improved. The large blocks of brickwork were broken up by explosive, and a tank did invaluable work hauling away some of the large blocks. About 1500 the first supply tank with material scrambled over the débris, and at 1700 work was actually commenced on the bridge, work being carried on under the most difficult circumstances; shelling, both H.E. and gas, was heavy up to about midnight; the darkness, and the necessity for putting on gas masks at frequent intervals, and the slippery state of the heavy timbers and R.S.Js. owing to the rain, rendered the handling of the material (one heavy trestle and two 18-ft. spans) and the placing of the trestle, matters of extreme difficulty; both R.E. and Pioneers were employed, and showed the greatest endurance and determination. The bridge was open for traffic at 0800 on the 21st. Continuous reliefs worked throughout the night on clearing the débris of the railway bridge, and a route for single traffic was through at the same time; this was widened to take double traffic within the next 24 hours.

The credit for this successful piece of work (both clearing the débris of the railway bridge, and erecting the tank bridge) belongs to the following officers:—Major H. M. S. Meares, M.C., R.E., in charge of the work, Lieut. C. J. Creed, R.E., who worked for 24 hours continuously, 2nd.-Lieut. Birch, who commanded the Supply Tanks, and 2nd-Lieut Hunter, 4th Bn. Coldstream Guards.

The bridge to take 60-pounder guns was constructed by the 75th Field Co., R.E., on the 22nd inst, work commencing at 0900 and the bridge being open for traffic at 1600; the bridge consisted of two heavy trestles, and three bays, and no difficulties were experienced except in the clearing of the débris of an iron footbridge which had originally spanned the river at the site.

This narrative of work would not be complete without reference to the work of the R.E. patrols in connection with the operations; on two nights previous to the crossing of the River Selle, two R.E. patrols, each consisting of a R.E. officer and two men, were sent out to obtain information as to the crossings; on both nights these patrols had to fight for their information, three of the enemy being killed; the patrol leaders showed the greatest determination. On the night of the 20th October, two patrols were sent forward, one to get at the bridges in Vertain, one to reconnoitre the river Harpies; the former could not reach their objectives, but the latter brought back valuable information, in spite of the fact that the enemy was holding the eastern bank of the stream, and very much on the alert.

E. J. D. LEES, *Lt.-Col., R.E.*,
C.R.E., Guards' Division.

A SPECIAL ORDER OF THE DAY BY MAJOR-GENERAL E. P. STRICKLAND, C.B., C.M.G., D.S.O., COMMANDING 1ST DIVISION.

The task that the Division was called on to perform yesterday was one entailing the utmost forethought for every detail, the most careful and precise Staff work in all branches, a thorough and precise organisation in Bns. of the most minute detail, and gallantry, tact and endurance on the part of all troops engaged.

The complete success of the operations is very greatly due to the skill, ability, rapidity and completeness with which the bridging arrangements were completed and perfected.

I wish to pay special tribute to Lieut.-Colonel C. E. P. Sankey, D.S.O., his Field Co. Commanders, and all ranks of the D.E. and Section, 1st Australian Tunnelling Company, A.E., for the part they have played in these operations. The cool gallantry with which they placed the bridges in position under heavy fire after long and arduous hours of labour, was magnificent. After this severe ordeal they were engaged for the rest of the day in bridging under fire, without which the operations could not have been completed.

They have very worthily upheld the very high traditions of the Royal Engineers.

5th November, 1918.

REPORT ON EXAMINATION OF ENEMY TUNNEL NEAR BELLENGLISE.

With the Controller of Mines, IVth Army, we visited this tunnel at 12.30 p.m., on 30. 9. 18, and made a short examination and found it 1420 yards long with 19 entrances and five vertical shafts. There were 35 living chambers, two explosive magazines, and an engine room containing two lighting sets, and the whole tunnel was wired and fitted for electric lighting. The G.O.C., 46th Div., came into the tunnel and I asked him if he could send up the German electrician

and engineer who had operated the plant and had been captured by the Divisional troops.

At 4 p.m. these two German prisoners and two stretcher bearers arrived under escort and I explained to them that we wanted to start up the plant and light the tunnel. I asked the German electrician if there was not a demolition circuit from the switchboard connecting up the hidden charges through the tunnel which would be detonated when the current was turned on. He said there was not, and he was well warned of what would happen to him if anything blew up, and that we would keep him down there till he had started up the plant and we had tested all the circuits on the switchboard. He then stated that there was a special circuit installed for that purpose through the whole gallery, and he consented to show us the charges. The charges consisted of cases of perdite, boxes of gun cotton, tins of picric, and 5·9 shells hidden behind the timbering and cellar walls at the entrances. The wires of the special circuit were cut and all fuses and detonators taken out and the charges removed or rendered safe. All the infantry occupying the tunnel and chambers were cleared out of the tunnel and sentries posted near entrances and the electrician started up the generating set in one hour and a half, all the circuit switches were closed and all lights put on, and since then we have kept the plant running and a party guarding them and searching for traps, mines, etc. A number of 5·9 shells were found set in behind loose timbers with nose cap against back of leg so that pressure would detonate them. Many stick grenades were lying about with the string out and the buttons hooked in the wire beds or nails so that a careless pull or lifting of the grenade would detonate them. Concealed grenades with strings and buttons sticking out.

Amount of explosives, etc., found in tunnel:—

85 boxes of perdite (4 tons).
2 ,, ,, guncotton (British).
2 ,, ,, ,, (German).
2 cases of picric.
16 5·9 shells.
21 7-in. pipe charges with fuses and tamps.
5 boxes of detonators.
4 tins ,, ,,
2 boxes of ignitors.
2 ,, ,, primers.
1 case of detonators and fuses.
1 ,, ,, electric detonators.
7 coils of fuse.

W. J. Wilson, *Major, R.E.*,
O.C., 256 Tunnelling Co., R.E.

Capt. J. Morley Williams, who was with me throughout, has now gone over all the tunnel and declares it free from explosives, traps, &c,

3rd October, 1918.

A GAS ATTACK.

At about 4.25 a.m., 26th September, 1917, the enemy commenced to discharge gas (subsequently identified as Chloro-Picrine) in Puits 8 or 8 Bis, or both.

The distribution of *personnel* underground was at that time :—

(*a*). 1 N.C.O. and 6 other ranks, 170th Company R.E., 24 hours guard at Puits 8 and 8 Bis, 240 metre level with 2 French listeners.

(*b*). 2 French pumpmen, Puits 8, 350 metre level.

(*c*). A French shift, number unknown, working at Bure 5.

(*d*). 2 Brigade signallers, 99th Brigade repairing telephone lines.

At about 4.15 a.m. the two signallers descended Bure 5 after a short talk with the French shift, who a few minutes later, receiving word that Fosse 9 was being heavily bombarded, left at once for Fosse 9 escaping ahead of the gas though having to use their respirators. The two signallers evidently detected the gas, put on their respirators and attempted to return. One succeeded in getting away, the other only got to a point half way between Bure 5 and the turn to Fosse 4 whence his body was later recovered.

Word was received from the French mine authorities about 10 a.m. that gas was being discharged down Puits 8, which was the main downcast, and all points to which the natural ventilation would carry the gas were immediately warned. Lieut. Wood and 11 other ranks left headquarters at 10.30 a.m. with apparatus and descended Puits 9, Annequin, to discover the situation and attempt a rescue if possible. Lieut. Robertson and nine other ranks fully equipped with rescue apparatus left at 1 p.m. to assist. Lieut. Wood made four separate attempts to get through, penetrating in each case to a distance of 1,000 metres before compelled to return by the lachrymatory effect of the gas, as it was found that however closely the box respirator was fitted it was not proof against leakage in the high concentration which obtained.

Capt. Thirlwell and eight other ranks left at 6.30 p.m. to relieve Lieut. Wood's party. He succeeded in reaching Bure X and in descending this before, he had to return, owing to the same failure of the box respirator. Between 1 and 2 a.m. 27th September, 1917, the enemy shelled Fosse 9 and Fosse 4, both downcasts, with mustard shells gassing the whole of Capt. Thirlwell's party as they were

ascending. Capt. Thirlwell and one other rank have since died and six are still in a serious condition.*

It was then decided to abandon all efforts at rescue from Fosse 9, and after consultation with the French, to work via Fosse 4 Vermelles, as by this time the gallery connecting Fosse 3 and Fosse 4 to the cross roads Z was clear of the gas which had descended during the bombardment. Capt. Brown and 11 other ranks descended Fosse 3 at 9 p.m., and found the air good to the point Z, from which station he attempted to get through to Fosse 8, as it was still hoped that the imprisoned men might be alive in some *cul-de-sac* off the main air-way. It had been noticed that the gas followed the main air-way with remarkable fidelity and was almost like a solid wall so clearly defined were its boundaries. He succeeded in getting to the head of Bure 5, a distance of 1,200 metres, before one of his party became gassed, probably due to leakage through the fabric of his face mask. This party had fixed its masks on with adhesive tape thus avoiding to a great extent the eye trouble experienced by the previous parties.

As there were no possible means of measuring the concentration of the gas, it was feared, from the trouble already experienced, that the box respirator was not sufficient protection to enable the rescue work to be carried out. The Chemical Adviser, I Corps, accordingly manufactured a new one in which the container was changeable and which was fitted with the latest German face pieces reported to be four times more impervious to infiltration of gas than the fabric in the box respirator.

The French authorities were consulted and it was decided to make use of the existing compressed air line and establish two depôts, A and B. These were to be completely enclosed canvas chambers into which compressed air at 70 lbs. pressure was fed, and then starting from the point B to make a final attempt to get through to Fosse 8 with the new respirators. Sixty hours from 12 midnight, 28th-29th, were allowed for this, after which all efforts were to be devoted to blocking Bure 5 and so saving the group of collieries connecting with Fosse 8, as should the enemy cut the tubing at the junction all these would be lost.

Lieut. Gibbons and 11 other ranks left at 10 p.m., 28·9·17, and succeeded in getting all material to the point A. Capt. Roberts and 10 other ranks left at 2 p.m. on the 28·9·17 and completed the depot at A. Lieut. Wheler, A.S. and 11 other ranks left at 7 a.m. on the 29·9·17 and completed depôt B. At 6 p.m. on the 30th, Capt. Brown and 25 other ranks left to attempt the final rescue,

* One of the men gassed in Capt. Thirlwell's party sufficiently recovered to be examined. He reports that they were not gassed whilst coming up Fosse 9. It is possible that some mustard gas was mixed with the Chloro-Picric (Lieut. Wood's party reported a diversity of tastes and smells), and that these men were all gassed by leakage through the doors while waiting to ascend.

and descended Bure 5, discovering the body of Pte. Shanks. This showed that the imprisoned men had attempted to escape and were dead, and hence the risk of further lives in rescue work was not justified. It was then decided to test the gas and it was found that the gallery had cleared sufficiently to permit entry without the respirator for short periods.

The French miners were at once notified and it was decided to take immediate advantage of the situation to block Bure 5. Accordingly at 9 p.m., 1st October, Capt. Roberts, Capt. Brown, and 13 other ranks, with two French winchmen and a shift of French miners, descended to complete the first clay seal in Bure 5, after which our men would no longer be needed. Capt. Brown made his way along the road to Fosse 8 from the bottom of Bure 5 for about 500 yards, discovering the body of Corporal Lewis, confirming the fact that all the men were dead. Capt. Roberts tapped the compressed air line taking a branch down the shaft to the point at which work was to be carried on, assisted the French in cutting pipes, and advanced the work of sealing Bure 5 to a stage which the French were satisfied, with the presence of only two of our men to act as sentries to deal with any Germans who might be exploring. The French miners have reported that at 5 a.m., 3. 10. 17 the stopping in Bure 5 then consisted of 1·50 metres of brickwork, and our men were no longer needed.

This completely severs Fosse 8 from the mines in our area and the French miners do not consider it possible for the enemy to approach the stopping from his side and destroy it with explosives as the road leading to it is now a dead end and the ventilation difficulties would be insuperable.

It was found that respirators which had successfully withstood the test in the gas chambers leaked after a couple of hours in the heavier concentration found in the mine, and that 2,000 yards, counting in and out journeys, was the maximum distance that could be reached with them. Afterwards, when the gas had weakened, 3,000 yards counting in and out journeys, seemed to be the maximum, owing to the great strain on the lungs and heart action caused by breathing against the resistance of the container.

It is considered that from eight to ten hours is the maximum for which the box respirator could be continuously worn, for this reason, that attention ought to be directed to the necessity of relieving the pressure on the lungs by a vacuum machine, or a small clock-work fan inserted between the face piece and the container, and to relieving the exhaust valve to permit of easy exhalation. For given the requisite quantity of gas, and a favourable wind of sufficient duration, the discharge of a gas cloud lasting 24 hours is possible.

R. C. MANNING, *Major, R.E.*,
O.C., 170th Co., R.E.

THE TRANSITION PERIOD (IN THE WORLD-WIDE WAR OF 1914).

By LIEUT.-COLONEL ARTHUR A. CROOKSHANK, R.E.

CALL it what you like, these notes refer to defence lines built for a type of warfare which occupies an intermediate stage between rigid trench, motionless warfare or fortress fighting, and open, or motionfull warfare in which the trench has atrophied and dropped out of use altogether.

In trench fortress warfare the defences consists of a five or more line system of trenches, with innumerable cross trenches and posts or keeps. In this system the garrison remained motionless for years on end. In such a long space of time the defences naturally became highly developed (in fact, over-developed) into super-trench fortresses, the whole of the Army spending most of its time on field and civil engineering.

This type of warfare in due course, following an inexorable law, indulged in luxuries. It went in for mining, which provided complete systems of main and branch galleries, dressing stations, stores (Artillery and Engineers), living-rooms, and trench-mortar emplacements, twenty or thirty feet below ground.

Trenches became super-trenches, except as regards the obstacles in front of them and, in some cases, the drainage and cleanliness also. They were lined with timber (wainscoted or panelled) or with metal, provided with wooden floors and drains, sometimes with roofs also.

Keeps or posts were small forts for a garrison of a few men only, designed for all-round defence because as a rule the garrison had only to hold out for a few hours, knowing that they would be relieved by brigades either in reserve or resting behind the line, or by the garrison on their right or left. Operations being on a small front the line could usually be restored and made good by counter-attack.

The defences referred to in these notes are intended to be only light artillery proof, *i.e.*, to hold up the enemy, make him deploy and sit down for a bit, force him to call in the aid of his heavy artillery and to delay his advance until it arrives. In other words the defences are meant to fight a rearguard time-gaining action on a wide front and large scale. They consist of a two or three-line system with cross-trenches, parts of which, such as important high ground

and dangerous valleys or villages, are reinforced by having more lines and more cross-trenches. A three-line system includes the provision of an advanced line of outposts, which may consist of posts only and need not be continuous. Although we are here concerned with semi-trench-fortress warfare, the subject might equally well be called semi-open warfare. We ought therefore to be thinking partly in terms of open warfare, and to be guided and influenced to some extent, by the rules of the game of "movies," or war of movement as against war of four-year old positions.

When playing the game in the open the rule is four lines; the first a line of double sentries assisted by patrols, the second a line of picquets or sentry group Headquarters, the third a line of supports, and the fourth a line of main bodies and reserves. The first three lines were manned by the outpost troops amounting to $\frac{1}{4}$ to $\frac{1}{8}$ of the whole force. The second and third lines could be each reinforced by men from the line or lines behind it. The first line was a line of observation, the duty of the garrison being to cry "I spy!" loose off a clip of ammunition and then try to beat the record, and the enemy, in the cross-country race for the second line (of picquets).

The other three lines were lines of resistance or fighting or battle lines, the greatest resistance being given on the third or fourth line; the fourth line being generally used to rally and re-form *on* and then counter-attack *from*, in order to re-take the third line and thence restore the first two lines or whole position. Consequently it would be better to use the term "four-line system" instead of "three-line."

The keeps or posts (previously referred to and hereinafter called "strong points") in these notes are not designed for all-round fire, and have no gorge defence. In this semi-open warfare, when men are surrounded, they are usually wiped out or taken prisoners; the strong points are intended to hold out while all the lines except the last, are collapsing; the final stand being made in the last line of trenches and the strong points or portions thereof. Time of construction is kept down by doing as little revetting, mining and building as possible. Breast works are avoided, but where absolutely necessary, as in lines which have to go across water-logged ground, the defence system is given two lines only; revetting in trenches is avoided by having interior slopes not too steep, and good drainage.

Mining is confined to providing underground shelters for crews of observation posts and of M.G. batteries, and in some cases for Battalion and Brigade Headquarters also. Machine guns are fought from open emplacements, the only buildings at ground level being for artillery observers.

In one respect only will these defences be superior to, and more

developed than, trench-fortress systems, and that is in the barbed-wire obstacles (probably also in the siting of lines and in drainage). This superiority is due to the fact that these defences are built under peace conditions instead of in the dark, under fire of snipers, machine guns and light artillery, and with frequent interruptions from other infernal machines.

As regards siting, we will suppose that it has been decided to make a defence system consisting of a continuous line of trenches between two places, either as part of a longer system continued right and left, or as a " switch," skew or diagonal system, connecting a system in front with one in rear.

Early in the war, defence systems consisted of isolated posts usually made as a ring, or all round-fire defences, round a village on high ground. The system was known as the " blob " system, or, in aggravated cases, as the " excema " design. Defences on this principle have been found to be of little use, as on a misty morning or a dark night the enemy may be able to walk straight through the system along the low ground between the " blobs. "

A continuous line made, for about the same cost, as in *Fig.* 1,

Plan.

FIG. 1.

would probably be a more efficient defensive system. When men are retiring from a position in front, or when reinforcements are coming up from behind, they must have a continuous line to be stopped on and to be organised on, otherwise they do not stop at all, but continue their straggle to the rear as a shapeless rabble.

Design of the Defence System as a Whole.—The general line of the defences having been determined for strategical or political reasons, the first thing to concentrate on is contained in one blessed word " observation," or " ground observation," without which artillery, especially light artillery, is blind and of very limited utility.

Nearly every fight since the dawn of history—in this war—has been for observation, *i.e.*, directly or indirectly for high ground or a ridge : Hill 70, Hill 63, Aubers Ridge, Vimy Ridge, Lorette Ridge, Chemin des Dames, Messines Ridge, Passchendaele Ridge, Mont Kemmel, Mont St Quentin, etc. The key of the whole enemy western front was the St. Gobain " massif."

Observation consists of two kinds, long range (for heavy artillery) and short range (for light artillery and machine guns).

Ground Observation Posts and their Defences.—In designing, commence operations by getting hold of a layer map and marking off on it places suitable for ground observation. Then go out on the ground, taking with you, if possible, an artillery observation officer, and select the observation posts on the ground.

In every case, in this sort of work, whether for observation posts, strong points or trenches, etc., the design and selection of site must be a compromise between the map and the ground, the latter having the casting vote in case of a tie. Design on the map first, then on the ground, then back to the map, then back to the ground, and so on. These observation posts, with their protection, are the most important places in the line; the defences must be designed so that the observation posts can be held at all costs. To get good O.Ps. it may be necessary to go out some considerable distance in front of the straight line drawn between the fixed right end and the fixed left end of the system.

The defences will then be placed well in front of these O.Ps., with possibly one trench line behind, as a reverse slope line or jumping-off line for a counter attack. The crew of the O.P., to do their work properly, should remain in peace and quiet, not worried by shells meant for trenches near by, or by the thought that a surprise raid or sudden rush of the enemy might sweep them up along with the first line or first and second lines.

The "Reverse" Slope and Forward Slope Controversy.—The expression "reverse slope" brings us on to highly debatable ground. There are two rival schools in this thorny question, the forward slopers and the back slopers, and between the two of them there have been great battles of words, both on paper and in the air. An engineer officer of high rank in an Allied army, gave *Fig.* 2, in a recent lecture,

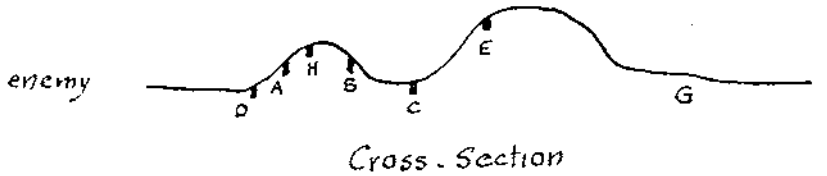


FIG. 2.

as a typical modern defence system. Forward lines at DA, back lines at BC, observation posts—forward line at H, back line at E, artillery at C and G. The only objection to this design is that there is not one bit of country in a hundred in which double-humped camels of the above kind are to be found. On this sort of ground (which is the ideal one dreams about, and which one is always looking for

but very rarely finds), everyone would be a reverse sloper. There would be no forward slopers.

The bad half-penny rivalry between the forward and the back slope schools appears to mean that the rabid forward sloper would place his whole defence system between A and B (see *Fig.* 3), and the bigoted back sloper the whole of this between C and D.

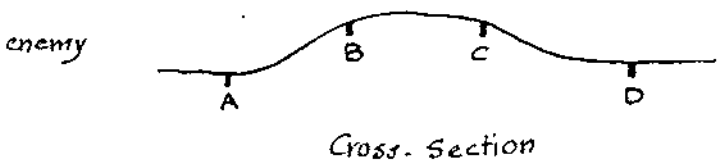


FIG. 3.

The solution of the problem is probably, as in so many other cases, a combination of the two, *i.e.*, to use the good points of both systems, keeping the centre of gravity in, or giving weight to the forward slope, so as to retain observation. It must not be forgotten that the back sloper loses the observation (*i.e.*, in one humped country). He makes the enemy a present of observation, and gives up ground to him. The enemy commands your approaches and lines of communication, while you cannot see his; the enemy can walk about in the open much as he pleases, do what he likes and see what you are doing, while you are driven to ground and forced to be very cautious. The knotty problem resolves itself into the fact that a back slope line is all right where you can get observation behind it, *e.g.*, in double-humped country where you have observation behind or over observation, *i.e.*, two lines of it, and where the loss of your forward observation line is not vital. In single-humped country, however, such as in *Fig.* 3, where you have only one observation line, the loss of that may be disastrous, because the enemy thus gets command of your approaches and L. of C., while his own are dead or invisible to you, also because, as already explained, what we are fighting for in this war is observation. In this case, the only use of a reverse slope trench—as at D, *Fig.* 3, is to enable you to re-form (on a definite continuous line) the men defeated out of your forward trenches A and B, also your reinforcements from valleys, villages, sunken-roads, woods or other existing cover in rear. It gives you a line from which to organise a counter-attack for the purpose of re-capturing your observation above and behind B, and your forward trenches at A and B, and of thus restoring your original line, *i.e.*, D is an assembly trench for a counter-offensive.

The expressions "forward slope" and "back or reverse slope" are really misnomers, because the problem can be the same in billiard-table country, *i.e.*, in country where there are no slopes at all.

In *Figs.* 4 and 5 the conditions are the same for us, except that in 4 the difference of level is less than in 5, *i.e.*, the long-range observation is not so good, and that the belt of high trees can be destroyed by burning, and can be filled with gas.

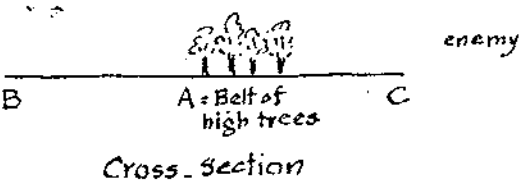


FIG. 4.

FIG. 5.

The Real Point at Issue.—The word "slope" should not be used, as it may lead one away from the real point at issue, which is to be or not to be in a position to observe the enemy's approaches; in other words, to be or not to be so placed that we prevent the enemy from seeing our approaches.

A defensive system can be said to consist of two parts or areas, the front, in which infantry predominate, and the back, in which artillery form the majority of the troops in action. In designing a defensive system one has, therefore, not the choice of two alternatives (forward or reverse slope positions), but of three, namely:—

(1) To have A (see *Figs.* 4 and 5) behind both front and back areas.

(2) In front of both.

(3) Between the two.

In case (1) the enemy sees both your areas and you see both his; in case (2) he works a few observers up to A, and then sees everything of you, you see nothing of him except his periscopes; he then directs ground observed guns on to both your areas. In case (3) he sees your front area, but not your back area—you see everything of him.

Evidently (3) is the solution of the problem. If at B there are trees or hills higher than A and commanding C, you can then have A in front of both your front and back areas, both your areas are screened, the enemy sees nothing of you, and your artillery and machine guns obtain ground observed fire over his advance.

Design of Defence System as a Whole.—To return to our muttons—when the observation posts with their defences have been determined

on the ground, we then have a number of fixed points in our system. It only remains then to lay out the lines required to connect these fixed points. Here we may be influenced by places which it is important to protect, because we want to use them ourselves and prevent the enemy having the use of them, such bridges or portions of roads, villages or other existing cover. We may be influenced also by obstacles which it is an economy to make use of—such as rivers, canals, marshes, ponds, etc.; also by places which we want to keep the enemy out of—such as quarries, cuttings, farms, villages, woods, etc.; also by places which we want to avoid and keep clear of ourselves—such as woods and low-lying ground, because of gas and of morning mists favourable to the attack, and of the expense of breast work; roads, especially road junctions (because of artillery fire), or any other land-marks shewn on the maps, or conspicuous objects—such as windmills, chimneys, mounds, solitary trees, small copses, etc. which attract enemy fire. We may be influenced by places wanted for batteries or nests of machine guns. For these consult and work in with the machine gunners.

Generally speaking the design of the lines in the intervals between observation posts is similar to designing a cart road with a ruling gradient. When crossing spurs and valleys you go forward towards the enemy on the high ground and back on the low, in order to retain command of as much of the spur as possible; this is our old friend "observation" to prevent the enemy commanding you, and to get that very valuable asset, "cross fire" across the valley; a valley is always a source of danger and a likely line of attack for the enemy.

Design on a large scale map first, and then by give and take on the ground. Give as little ground as possible to the enemy and take as much as you can inside your own lines. Design by trial and elimination, first on the map then on the ground, in turn.

Detail Siting of Lines.—The detail siting of lines of the ground is a most important work, the success of the defence system (like the foundations of a building) depends upon it. It should only be done by properly qualified officers. They should have plenty of time to do it methodically and carefully, and should not be hustled by having working parties treading on their heels. On the other hand they should not be too far ahead of their working or spitlocking parties. The siting officers should move their trial lines backwards and forwards until they have found exactly the right place for each portion. They should then go across No Man's Land to the enemy, and look at the other side of the picture. They should act the part of enemy attacking infantry and enemy observers, advance on the trench line to see where they first come under observation and first under fire from the trench line. They should know every inch of their ground so as to be able to tell at once if their tapes

have been moved. Cases have occurred of a trench being dug to a tape traced by a farmer, who lifted the tape, took it off his own fields, and put it down during the night on another man's fields; also of a trench being dug to a tape traced by some cows, which had dribbed the tape away from its original site; also of a trench being dug the wrong side of a tape, making the traverses about 2′ 6″ wide instead of 15′ 0″. There are few things more unsatisfactory, from a field-engineer's point of view, than to have to fill in a trench and dig another one close to it. It shakes the confidence of the working parties in the sappers and also makes the former lose heart and interest in the work.

Field of Fire.—Trenches, except those made exclusively to provide cover, or as communications, *i.e.*, fire trenches, should be sited to give the best possible field of fire for the infantryman's rifle, and should be screened from artillery ground observation if possible, by hedges, trees, etc. Sky lines should be avoided, so should long lengths of straight; the line must be in waves, or corrugated, to get cross fire, and to make it harder for the enemy's artillery. Better a hidden trench with a range of 200 or 300 yards, than an exposed trench with a range of 800 or 1000 yards. Cases have occurred of trenches with a short field of fire being much more stoutly defended than those with a long field. In the former, the defenders know that if they get out of the trench to go backwards they will be shot down at short range by the enemy, so they stick it to the close fighting or bayonet stage. With a long field of fire the defenders see the enemy continually advancing, in spite of all the ammunition they are firing off (nearly all of which is of no effect); they lose heart and retire out of their trench, which they can do with little chance of being hit by the attacking infantry at long range. Also a large proportion of fighting occurs at night, when long ranges are useless. A long range has the advantage, however, that it gives the artillery a good chance of inflicting casualties. Lines which have the enemy on top of them, *i.e.*, which are commanded by the enemy's attacking infantry, should be given a longer range, say not less than 500 yards.

Ideal Arrangement.—The ideal conditions are shown in *Fig.* 6; this is what one is always looking for but very rarely finds. The distance AB is say 300 yards, hedge B screens our trench A from enemy artillery observation; ground at C is under our observation

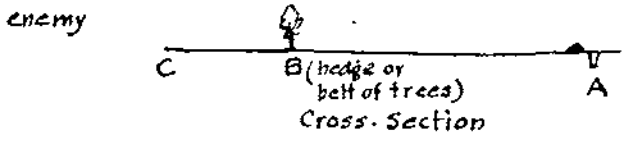
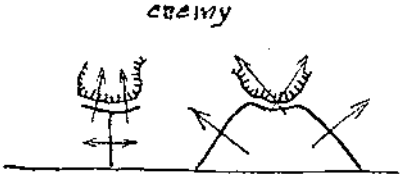


FIG. 6.

from tall trees or high ground behind A, or to one flank of it. As the enemy advances across C he comes under our ground observed artillery fire.

Dead Ground.—Small patches of dead ground (such as a quarry, pit, sunken road, steep bank or dip in the ground) in front of the general line of a trench should be commanded by a bastion if possible, if not by a tee head (see *Fig. 7*), *i.e.*, if the line itself cannot be bent forward to command them or, better still, to include them. Always site a line to have grazing fire, and avoid plunging fire as much as possible.

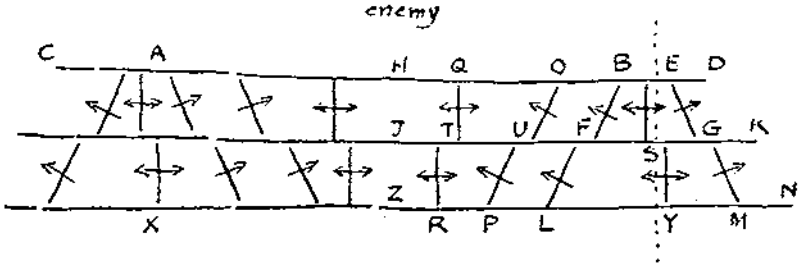


Plan.

FIG. 7.

Strong Points.—Having determined the general design of the trench system, of say three lines, more or less parallel, with an outpost line in front, then design the strong points. These are simply parts of the system which are reinforced by having more trenches and more ostacles than the rest. A strong point will of course be made round each observation post, and the remaining strong points will, if possible, be on high ground; each strong point should be able to see the one on its right, and the one on its left, so that it can visual signal to them, and also watch the progress of the fighting near them.

It is both criminal and impossible to have a standard design for a strong point. A single case, the simplest, and also about the scarcest, may however be considered. Take a three-line system in dead-flat and open marshy country (see *Fig. 8*). The lines in this,



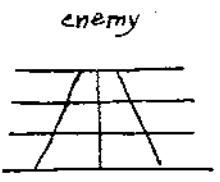
Plan.

FIG. 8.

and in other plans in these notes, are shewn straight to make the drawing clearer. In actual practice they never would be, and must not be, even in bowling-green country. A strong point Y is to be placed to block or bar a road which the system crosses at right angles. Under these very rare conditions we get a symmetrical "strong point," with strong flanks BFL and EGM, no gorge defence (as already explained) and a central fighting, communication and shooting-two-ways line through SY. Each line has an anti-enfilade offset in it.

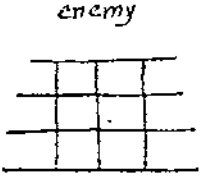
The defensive system will then, under the conditions of semi-trench warfare for which we are designing, be fought on the elastic or flexible line or bowstring system, as follows. The enemy attacks all along this portion of the line, and succeeds in gaining ground towards HJZ and DKN. He then succeeds in widening his two breaches to the right and left, but is held up by the strong points round SY and AX. The defenders will then fight on the following lines in succession :—(1) HQOBED. (2) JFBEGK. (3) ZLFBEGMN. (4) ZLFSGMN. (5) ZLYMN. They then strategically advance to the rear "according to plan" (*i.e.*, the plan of the victorious enemy). Students of fortification architecture will recognise in these lines the Vauban system, poorly camouflaged; this reversion to type is natural and excusable in a country where one is surrounded by such splendid examples of the great master's genius, and where one breathes his atmosphere.

The design of each strong point is of course, ruled, with a rod of iron, by local topographical conditions, which you will find will give you every sort of shape or mis-shape from variations on the A type *Fig.* 9, through the H type *Fig.* 10, to the V type *Fig.* 11.



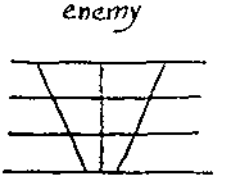
Plan.

FIG. 9.



Plan.

FIG. 10.



Plan.

FIG. 11.

Fig. 11 is a bad type, because it is in unstable equilibrium. The acute salients or angles at the forward corners being weak in fire, so also are the flanks. There can be no more standardization in the design of strong points than in the shape of clouds in the sky. Two points should, however, be remembered: provide a good field of fire on each flank, *i.e.*, make both flanks strong, and keep the centre of gravity back: do not get it between your first and second lines, or in the forward half of the system (as in *Fig.* 11 above).

Obstacles for Strong Points.—As regards obstacles, the outer line PLFBEGMN, *Fig.* 8, would have a broad belt of barbed wire entanglement in front of it, and all other lines a narrow belt, the central line having a narrow belt on either side of it.

Design of Lines between Strong Points.—There now remain the portions of the system between the strong points. If the enemy's best line of advance and only chance of getting through is towards HJZ, *i.e.*, if he is obliged to attack on H, and cannot hope to do any good elsewhere, then the branch or cross lines near the strong point can be designed to be diagonal as OUP. Cross lines near HJZ should be at right angles, as QTR, firing both ways and ready to meet a penetration either side of Q. A diagonal or skew line of the type OUP is weak against an attack on O or between O and B. All the cross lines, also lines in the strong points, should of course, be waved and staggered, off-setted or stepped where they cross the mains, to make them enfilade fire-proof.

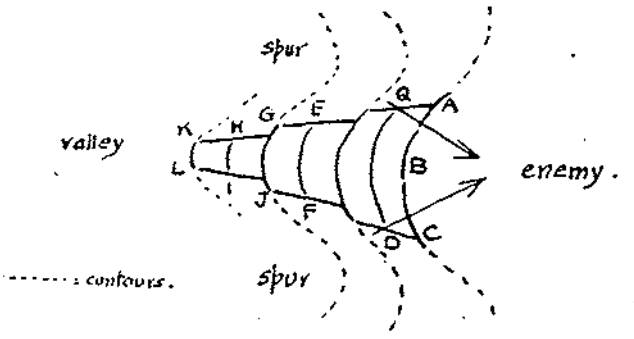
Junctions on "Hinges."—In placing these cross lines, certain features require careful and special treatment, viz.:—Villages, valleys and woods, also junctions of defensive systems, *i.e.*, places where your system crosses others, or where branch systems connect yours with other systems in front or behind. These "hinges" should be carefully worked out, so that each line of the three or four line system runs continuously through the junctions without a break. They should then be designed as strong points; in other words, junctions of systems should be sited at naturally strong points, *i.e.*, the type of strong point which is born and not made.

Villages.—As regards villages, the enemy likes getting into villages and filling the cellars and stumps of walls with machine guns. Keep him out of them by placing a line round the outside of the village, but near to it, and on the enemy side. The village is presumed to be still inhabited, and the houses and back-gardens not available for knocking about. If the village is ruined and dead, and one has a free hand and a blank cheque, reinforced concrete machine gun boxes should be built in the cellars and ruins—on a properly designed system—with over-lapping areas of fire. This system strengthens the continuous trench, which is made, as above mentioned, outside and on the enemy side of the village.

Valleys.—As regards valleys, a favourite manœuvre of the enemy was to creep up these on a misty morning by means of patrols with light machine guns, followed by light trench mortars, enfilade the trench system, and make the defenders either quit altogether or keep their heads down. A frontal attack on the trench was then an easy matter.

The valley should be provided with longitudinal trenches, forming a V with the water course, giving cross fire across the valley and its approaches; the connecting trenches giving fire straight down the

valley (see *Fig.* 12). The longitudinal trenches AK and CL should



Plan.

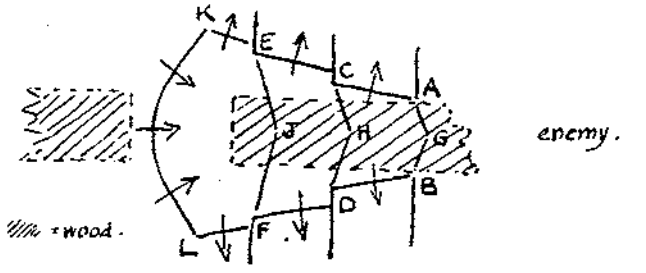
FIG. 12.

be kept low down, so as to give grazing fire along the bottom of the valley instead of plunging fire from a high level trench. A high level trench may sometimes have to be provided in addition to the low level one. In important valleys, dangerous for us and favourable for the enemy's attack, extra lines may have to be added, as—QD, EF, GK, JL, HI, and KL. The portion GKLJ sometimes comes behind the last or rear line of the system.

Woods.—As regards woods, these are unpopular nowadays because gas clings to them, and it is difficult to clear them of it. Nevertheless woods, especially forests and large woods, give an advantage to the defenders, and are an anxiety to the attackers. The defences should be designed for both cases, *i.e.*, both with and without gas in the attack.

The lines can sometimes be swung clear of woods, either in front or behind them.

If the lines have to go through a wood, make cross trenches ACE and BDF (see *Fig.* 13), and a connector EKLF through the wood



Plan.

FIG. 13.

by a wide clearing in front of KL. Also barbed wire chevrons AG, BG, CH, DH, EJ, FJ, enfiladed by machine guns at A, B, C, D, E and F. Make trenches also along AG, BG, CH, DH, EJ, FJ, in case the enemy does not use gas. The advantage of these trenches is that they can be made air-photo proof by winding the trace about between the trees and dodging them as they stand, without cutting down anything except a narrow belt in front of the wire chevrons, just wide enough for enfilade fire. Large villages or towns require to be similarly treated.

Obstacles.—As regards natural obstacles, examine the map and, later on, the ground, for all existing obstacles, canals, streams, wet ditches, water of any sort, marshes, boggy ground, country cut up by ditches or rough ground (useful to make the enemy swear on a dark night and thus give himself away), cattle fences, etc. Use these for all you are worth, partly to save the expense of barbed wire obstacles and partly to have a variety of obstacle, and thus confuse and surprise the enemy—barbed wire entanglements get monotonous.

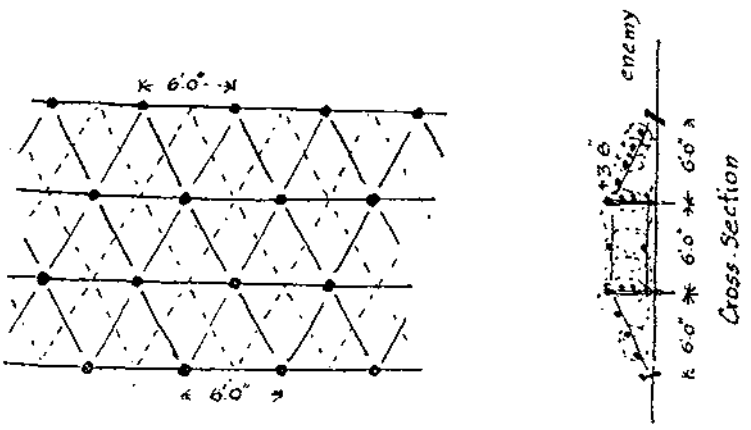
Design your lines fairly close along and, say, 50 to 100 yards behind these obstacles, and if the obstacle is serious enough to require bridging, such as a wide and deep canal or river, place a second line near enough behind the first to enable you to interfere with the enemy's efforts to get his guns across the water, after you have lost your first line close behind the obstacle. Any existing bridges should of course have bridge-head defences of a more or less semi-circular shape in plan.

Other Obstacles.—All bridges, road junctions, and possible observation posts, such as high buildings or isolated trees should be prepared for demolition. Dams should also be made with sluice gates ready for shutting down and flooding ditches, hollows, valleys or marshes if the flow is in the right direction, *i.e.*, from the enemy or parallel to your line. In the latter case, defences near the dam should be strengthened.

As regards barbed wire obstacles, existing cattle fences can be reinforced, hedges wired and loose wire spirals thrown into ditches and into water which must be forded, *i.e.*, is not jumpable. In some places abattis can be made of trees or big bushes.

Wire Entanglements.—In obstacle-less country one has to fall back on a barbed wire entanglement; in the latter the best part of the obstacle is the spiral. In designing, therefore, all one has to do to produce a cheap entanglement is to make a framework or support to keep the spiral in position and up to full cross-section. For this floor is necessary, also a ceiling, the spiral forming loops outside both. If the floor is omitted the bottom loops of the spiral become too low in some places, and too high up in others, thus giving the enemy "crawler" an opening.

The ceiling is required to keep the spiral up to full height, otherwise it will gradually "sit down" on to the ground by its own weight and give the enemy "jumper" a chance (see *Fig.* 14). The spiral will be laid along the line shewn dotted in the plan; the ceiling and floor wires and the sloping guys to be taut, other wires fairly slack.



Plan.

FIG. 14.

If pickets or wire are scarce the spiral can be supported on an apron fence (see *Fig.* 15).

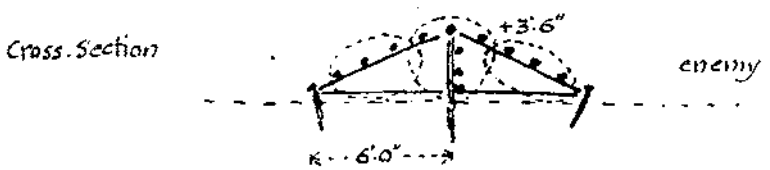
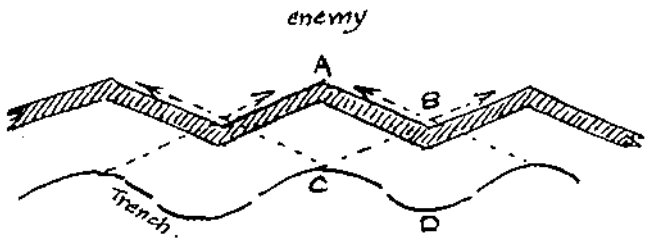


FIG. 15.

In construction the amount of wire to be used per yard run of belt should be specified, otherwise the entanglement will be too thin and inefficient in some places and too dense and expensive in others. Other points to look out for are (1) the attachment of the wires to the posts, so that they will not run down. The wires can be "tourniqueted" round or windlassed. (2) Drive the pickets well into the ground. (3) Devise a regular "drill" for the work, in order to save time and ensure uniformity.

A considerable amount of supervision is required to produce a good quality wire entanglement, indeed this work requires more skilled supervision than any other class of unskilled labour work, *i.e.*, earthwork, trenches, breastworks, dug-outs, etc., mentioned in these notes.

As regards trace, the entanglement should be designed in saw-tooth or chevron shape (see *Fig.* 16).

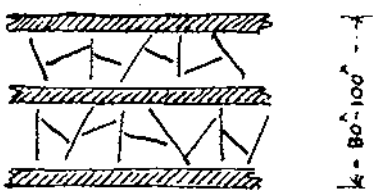


Plan.

FIG. 16.

The distance AC or BD to be not more than 150 yards, for close range rifle fire at night, or less than 50 yards, to be hand-bomb proof. The sides of the chevrons such as AB, should be sited so as to be enfiladable from the trench, but the belt should, if possible under the above conditions, not be parallel to the trench, as shewn in *Fig.* 16. The wire should, if possible, be concealed from enemy observation, but it is not worth while making excavations for wire only.

The entanglement should consist of two types, the broad consisting of three belts each belt as in (see *Fig.* 14), connected by cattle fences, making a total width of 80 to 100 yards (see *Fig.* 17).

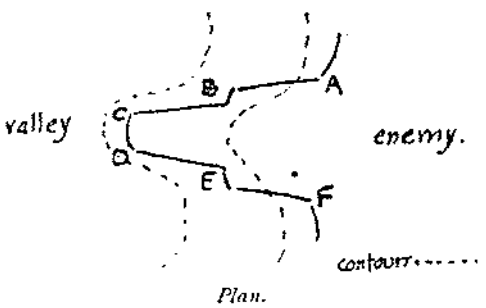


Plan.

FIG. 17.

The narrow type will consist of a single belt (as in *Fig.* 14).

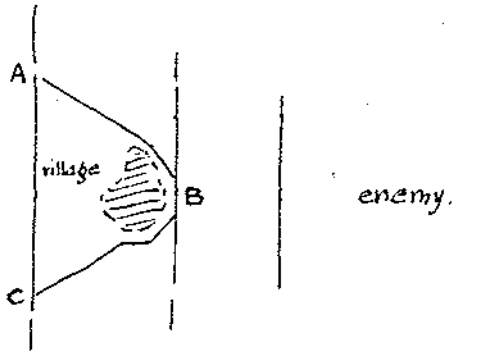
The broad type will be put round the perimeter of each strong point (see *Fig.* 8), and in dangerous valleys (see *Fig.* 18)—such as ABC,



Plan.

FIG. 18.

FED and CD, or round the enemy side of dangerous villages (see *Fig.* 19), as AB, BC.



Plan.

FIG. 19.

Elsewhere, the narrow type to be used. One belt should first be laid right along the system from end to end, say along the second line in a three-line system or whichever line the best fight can be put up on, and round the strong points. Other lines can then be wired as time, materials and labour permit.

Design of Trench (plan or trace).—The usual types of trench design in plan, are the rectangular, or Greek key pattern, (see *Fig.* 20).

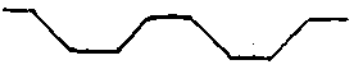
Plan.

FIG. 20.

The semi-circular (see *Fig.* 21) and the Vauban—135° (see *Fig.* 22).

Plan.

FIG. 21.



Plan.

FIG. 22.

Traverses can be placed forward of the general line or behind it, the latter is the more usual method. As regards the relative merits of the three types, the rectangular and the semi-circular have a large percentage of fireless, or useless parapet. The semi-circular is easier than the rectangular for trench traffic, but difficult to revet to a regular curve; the 135° type has no fireless parts at all, gives, in itself, without any waving of the general line, that blessed thing

cross fire, and is the best for trench traffic, especially for stretchers. It can also be used for breast-works. The 135° design is consequently the most efficient. Traverses should be at least 15 ft. wide.

The two traces (1) the wavy or corrugated pattern (see *Fig.* 23).

Plan.

FIG. 23.

(2) and the saw-tooth pattern (see *Fig.* 24), are useful for communication trenches, also for portions of fire trenches, where there is not a good field of fire, such as steep slopes, or where the other designs cannot be made to fit in between two fixed points without distortion or mutilation.

Plan.

FIG. 24.

In these notes the word "cost" means not only cost in cash, materials, which are often hard to get at any price, or labour, which has a nasty habit of suddenly and unexpectedly becoming scarce, but also in time. The latter is often a vital or decisive factor in war; loss of time may mean loss of men's lives, and of battles and campaigns.

Design of Trench (*cross section*).—As regards design of the cross section of trenches (see *Fig.* 25), the width of the floor of the trench

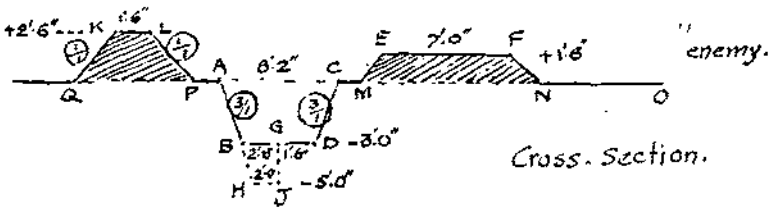


FIG. 25.

BD should be as small as possible. The slope AB or CD depends on the soil, and should be the steepest slope at which the cut earth will stand by itself, *i.e.*, its angle of repose, under heavy

showers, if built for summer use only, and under frost plus thaw, if built for winter use.

On the average, the slopes AB and CD may be made 3/1, allowing a total cover of 6′ 6″ (to enable men to walk along without stooping). BHJG, the through-traffic part of the trench, becomes minus 5′ 0″, BG=2′ 8″ and the width of the trench at ground level AC=6′2″.

As regards the crest (or height of parapet), 1′ 6″ is better than 1′ 0″. The latter is apt to be blinded by small bumps or irregularities in the ground surface, or by long grass. The width EF should be rather more than absolute bullet-proof minimum, because the edges at E and F are apt to get worn away. The text book height of crest for fire standing=4′ 6″ is too great, 4′ 0″ or 4′ 3″ is high enough for the average British soldier.

Design of Parados (trench cross-section).—The design of the parados is open to discussion—whether it should be higher than the parapet, or of the same height, or lower. The advantages of making it higher than the parapet, say 1′ 0″, are :—

(1) It is an aid to concealment ; what gives away a trench is the movement of the men firing from it and their white faces, both more visible on a sky line or against a distant background than against a near background.

(2) It stops bullets which come just over the top of the parapet, and prevents them doing damage to men behind.

(3) It gives more protection against back fire from shells bursting behind the parados.

(4) The enemy cannot use the trench against you immediately after he has captured it.

(5) It enables an irregular sky line to be given to the trench without interfering with the fire capacity, as would be the case if the parapet were irregularised instead of the parados.

The disadvantages are :—

(1) It might stop and burst those few shells which come with a flat trajectory just over the top of the parapet.

(2) More concealment work is required, *e.g.*, turfing, etc., to the top of the parados, to make it less visible to enemy advancing infantry.

(3) The trench cannot be used for firing to the rear, if surrounded or the flank suddenly turned, without putting in work on it. This is, however, not a real objection, as trenches which are at all likely to be wanted for firing both ways (such as rectangular cross-trenches and interior or spinal trenches of strong points) would be designed with a double parapet to fire both ways, and two fire steps.

Construction of Trenches.—In construction the important thing is to leave the trench in a usable condition at each stage of the

proceedings; if it is only possible to do a little work on the first day, leave the trench fit for fire lying down or fire kneeling, and complete it to fire standing, next day. As regards tasks, unskilled labour, such as Chinese coolies, can do 220 cubic feet a day, including trimming spoil.

Work should be started by peeling a skin (of 6″ or 9″) off MN, (see *Fig.* 25), and stacking it at O. The earth, as it comes out of the excavation should be formed into the parapet. Directly the latter is finished, the skin from O should be laid over it. Crops and roots can be re-planted and saved, in this way also the excavated earth concealed. The parados is then done in the same way. Small borrow pits will be required to make up the parados, as the earth obtained out of the trench is insufficient for both parapet and parados. The passage BHJG should not be dug out unless the vertical revetment GJ can be done at the same time.

Before ground is broken at all, three templates to the shapes MEFN, QKLP and ABDC, and a pick and shovel for every man, should be on the ground. Later on a fourth template should be provided for BHJG. If a long three line system is to be built, concentrate labour on :—

(1) Getting one continuous line through from end to end.
(2) Strong points.
(3) Valleys and villages.
(4) Other lines.

The same principle applies to obstacles.

A fighting line or sorts, will then be ready along the whole front as early as possible.

Drainage.—The life of a trench varies directly with the efficiency of the drainage, which must be done at the same time as the trenches. Levels must therefore be taken and drainage designs got out before ground is broken. Cases have occurred of large and deep soak-pits being made against the fall of the ground, *i.e.*, uphill, when the bottom of the trench itself was porous, and the bottom of the soak-pit was not, thus making it into a reservoir, also when the trench, if the floor had not been porous, could have been drained out over the surface of the ground by cutting a short trench on the down-hill side of the trench. Cases have also occurred of a drain being cut in the watershed of a trench, and of a drain being made which conveyed the water from a neighbouring stream into the trench.

If the passage BHJG is not likely to be excavated for some time after ABDC, the drainage should be designed for the level of minus (5′ 0″) not forgetting to allow for the fall in the trench floor, but only dug to minus (3′ 0″). The drains could then be deepened, when BHJG is being dug.

If the floor is likely to remain as BGD for some time, a shallow

drain BRG (see *Fig.* 26) should be made. The passage BHJG should never be dug out until material for revetting GJ is on site.

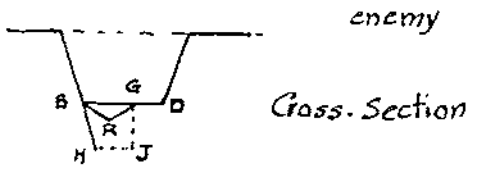


FIG. 26.

Breastworks (*Design of Defences as a whole*).—Breastwork lines are expensive both in materials and in time and should be avoided if possible. Where unavoidable the defence line should be first made to consist of detached posts about 200 yards apart, with a continuous obstacle in front (to get a fightable line, of sorts, through quickly). More posts should then be added, reducing the interval to 100 yards. The posts should be "staggered," *i.e.*, the general line should be wavy and not straight. Breastwork should only be made continuous in very important and dangerous places.

The design in *Fig.* 27 can sometimes be adopted in flat country.

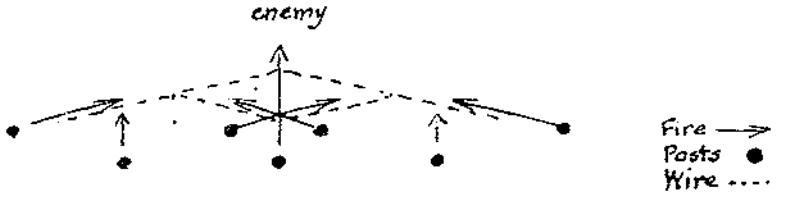
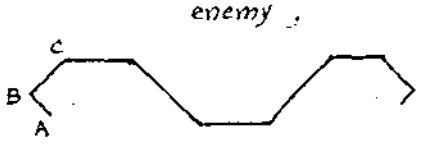


FIG. 27.

Breastwork Posts.—A breastwork post is a very conspicuous and very vulnerable object; every effort must be made to conceal it behind hedges, trees, rushes, etc., as it will not stand many hits from shells.

Design of Plan.—*Fig.* No. 28 shews a one-traverse type of post in the 135° trace style. The entrance AB should be made perpen-



Plan.

FIG. 28.

dicular to BC to prevent casualties to men (firing from BC) by a shell bursting in prolongation of BC.

Breastwork, Design of Cross-section.—*Fig.* No. 29 shews a cheap type

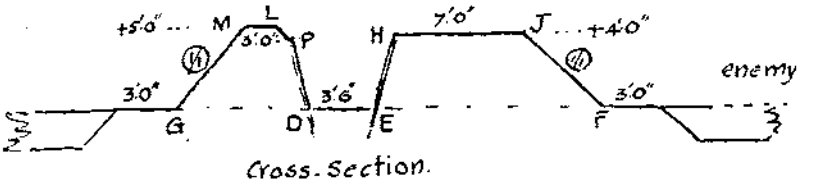


FIG. 29.

of breastwork ; the parapet is 4′ 0″ high (after allowing for settlement and weathering, *i.e.*, it is first built to 4′ 6″ or 4′ 9″) ; the exterior slopes of parapet and parados are 1/1; 1/2 is considerably more expensive ; trench floor DE is 3′ 6″ wide, *i.e.*, as narrow as possible. (Templates to be made for EHJF and DPLMG.) If the highest subsoil water level permits, a through traffic passage can be dug, the floor width DE must then be widened to 5′ 0″ (see *Fig.*30).

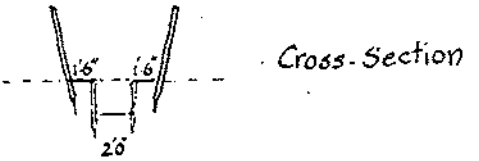


FIG. 30.

Breastwork Construction.—The borrow pits should be taped out and made wide and shallow, and the edge nearest the parados and parapet cut to a slope of 1/1, and not vertical ; the berm to be at least 3′ 0″ wide.

If the soil is damp or soft and not able to carry the pressure due to a head of 4 ft. of earth, the skin at EF and GD if of good turf should not be removed ; it is valuable as a foundation. In green surroundings HJ and JF should be sodded partly for concealment and partly as protection against weather. PLM in the parados should also be turfed, and lastly MG if sods are plentiful. LP to be bevelled off at 1/1. Thickness of parados at level of P to be 3′ 0″.

In construction the points to look out for are:—

(1) Borrow-pits—keep the berm inviolate, and do not make a hole 4′ 0″, with vertical sides at the toe of the exterior slopes of parapet and parados.

(2) If hurdle revetment is used, make it continuous hurdle work if possible, as being more flexible and elastic, and thus giving off

fewer splinters under shell fire or other explosions. With ready-made hurdles use stout posts driven in well, as stanchions, to hold up the hurdles, in addition to the vertical withes in the hurdles. These posts to be wire-guyed top and bottom. Guys to be so adjusted that (*a*) the hurdle finishes up, after taking the load, at the correct (interior) slope with the guys taut. Each guy to be windlassed up separately, not two together.

(3) Anchorages for the guys are important, the holding power of the ground, with a high subsoil water level, being small, anchorages can be of 1 : 1 pickets or of sunken logs, parallel to the line of the hurdles or trench.

After a little practice breastworks of good quality can be made by unskilled labour such as Chinese.

MISCELLANEOUS.

Lengths of Straight in Trenches.—Portions of straight in trenches should be made :—

(1) In cross trenches where they cross main lines, on the enemy side of the latter.

(2) Where a trench enters a strong point, *i.e.*, just outside the latter on the enemy side and on the flanks of the strong point's perimeter.

(3) Occasionally in main lines to prevent the enemy working his way along, such as when widening a breach or penetration of the system.

Passages through Lines.—Gaps should be made through wire for artillery, and, between these artillery-gaps, others for infantry; they should be marked by posts at least 6′ 0″ above ground, so that they can be quickly picked up from a distance. A pole with a white cross or X on top is a very efficient sign.

Ways for artillery should be made across the lines—in the case of trenches, either by not digging the trench, or by cutting ramps down to the floor of the trench, or by portable trench bridges. Steps or ramps should also be made to enable infantry to get out of the trench quickly. Gaps should be left similarly in breastworks.

Notice Boards.—Notice boards should be liberally provided, showing trenches, with nicknames and defence names, *e.g.*, Dunkirk to Basle Defences, Champagne Sector Reserve Line, Jazz Trench, O.Ps., M.G. emplacements, dug-out entrances, artillery positions, etc. Strong points should have a map, painted on a large board, of the S.P. and trenches round it.

Buildings, Above-ground and Under-ground.—Although we are dealing with semi-trench-fortress or semi-open warfare, still, if conditions permit, divisional-artillery-proof buildings should be made for O.Ps. the positions of which should, of course, be very

carefully concealed by camouflage. Underground shelters should be made for the crews of O.Ps. also of machine gun batteries, and for battalion and brigade Headquarters, if existing (above ground) buildings and cellars, etc., can not be found. If conditions still permit, then make underground shelters for garrisons of strong points also.

In the execution of the work, as in every class of work where only a few men can be employed in any one place, and the rate of progress is slow, two days shifts should be put on, or three shifts of eight hours each, *i.e.*, continuous work all round the clock, in under-ground work or wherever artificial lighting can be arranged for. It is better to have only one-half or one-third the number of jobs in hand simultaneously, and to work two or three shifts; the golden rule being to get something useable finished and wiped off the slate quickly. After a little practice dug-out work can be done by unskilled labour such as Chinese.

Geological conditions and subsoil water should be studied and trial borings always made before starting work on any dug-out.

(To be followed by "Notes on Trench War" by Major H. A. S. Pressey, M.C., R.E.).

PROPORTIONING CONCRETE.

By MAJOR A. ff. GARRETT, R.E.

IN the *R.E. Journal* of November, 1918, page 202, is a transcript of a paper on the above subject by H. C. Johnson and W. Kingston with an editorial note by the Editor of "Concrete." The authors have evidently exercised great care over their tests and experiments, but the results appear to be inconclusive, and the conclusions they arrive at differ in some respects from those of the editorial note. Now I think that most of the anomalous results and discrepancies in these experiments (and also in many others) will be cleared up, if the general laws of proportioning of concrete are considered *ab initio*. The fundamental laws for proportioning to secure the maximum strength are as follows:—

1. The strength of concrete varies, within limits, with the percentage of cement.

2. If the percentage of cement is constant, then the strongest concrete will be that in which conjointly—

(*a*). The ratio of the total surface areas of all the particles of the aggregate and sand to the finished volume of the concrete is a minimum.

(*b*). There are no voids.

3. The quantity of water for maximum strength must be the minimum required to secure thorough hydration of the cement combined with proper mixing and working of the concrete.

4. The aggregate and sand must be clean, and the crushing strength of the aggregate must be at least equal to the required strength of the finished concrete.

It is believed that the above four laws, and the consequences to be deduced therefrom, cover all the various theories which have been put forward from time to time by various writers and experimenters. They will be almost self-evident if we consider what a concrete mixture essentially consists of. It is composed of an active cementing material in a fine state of division, mixed with a quantity of inert material, consisting of pieces of stone and particles of sand of all sizes and shapes from say three inches downwards.

Now the only way in which the cement can weld the whole together is by forming a thin film over the surfaces of the aggregate, and it is at once obvious that the more cement there is, the thicker and

stronger this cementing film will be, and on the other hand, if the quantity of cement is limited, then the smaller the total of the surfaces to be cemented, the stronger will be the concrete. It is perhaps unnecessary to labour the point, but it is so fundamental that a further illustration may be given. Suppose the aggregate to consist of one inch cubes. For one cubic foot of cement we would require 1,728 such cubes, and the total area of the surfaces to be cemented together would be $1,728 \times 6 = 10,368$ square inches, as each cube has six faces each of which has to be cemented.

Now suppose we had to deal with 2-inch cubes. To make one cubic foot we should require 216 2-inch cubes, and the surface to be cemented would be only $216 \times 24 = 5,184$ square inches, or half the area in the case of the one inch cubes. In other words we should only require half the quantity of cement for an equally strong concrete. Of course, the aggregate does not consist of cubes, but of particles of every conceivable shape, but the same principle applies and is expressed in law 2 (*a*) above. But in addition to the sums of the surface areas being kept to a minimum, there must be no voids, and this introduces many complications. Starting with say two inch broken stone, we require a quantity of say one inch stone to fill the interstices between the two inch, a further quantity of half inch to fill the interstices between the one inch, and so on until we finally arrive at the finely ground cement, filling the interstices between the grains of the finest sand which is used. But as fine particles have a larger surface area compared with their volume than larger particles, the principle to be observed is not to use more fine sand than is absolutely necessary to fill the voids. The above considerations explain at once —

(*a*). Why too much fine sand always weakens mortar or concrete.
(*b*). Why a concrete of large aggregate is stronger than a concrete compound of smaller aggregate.
(*c*). Why the densest concrete is always the strongest concrete.

It will also be seen that accurate proportioning is of great importance.

As regards quantity of water, any excess of water beyond that required for hydration and working the concrete is objectionable because—

(i.) Water occupies volume, and if in excess must therefore decrease the density of the concrete.
(ii.) The object being to form a paste of cement and water, and to coat every particle of the aggregate and sand with this paste, it follows that any excess of water will dilute the paste and make it thin and weak, and the excess will rise to the surface of the concrete and drain away, carrying the cement particles with it.

Examined in the light of the above considerations, the result of the experiments of Messrs. Johnson and Kingston are easily explained. It will be noticed that their "corrected concrete" shows a marked improvement in every case where the original mixture contained *fine* sand. In the three cases in which the corrected concrete shows a decrease in strength the original mixture was made with coarse sand, and the decrease must be explained by the fact that the method of proportioning used is not sound. This is evident when we notice that in every case where there was a decrease the density of corrected concrete is less than that of the standard 1:2:4 mixture. While the method of proportioning proposed aims at obtaining the densest concrete, the table of results clearly shows that this desirable result was not always obtained, and the whole process strikes one as too rough and ready. When any considerable amount of concrete work has to be carried out, we require much more careful proportioning than can be carried out by adding sand, etc., until a "workable" concrete is obtained.

Opinions are bound to differ greatly as to the exact point at which a concrete becomes workable, and the best and strongest concrete will only be obtained by such methods by a lucky fluke, though doubtless considerable improvement may be effected over a simple 1:2:4 specification.

The most practical method of securing a really satisfactory mixture is probably that described by Taylor and Thompson in their book "Concrete, plain and reinforced," a book which should be studied by every engineer who has a large amount of cement concrete work to carry out.

Mr. William B. Fuller carried out a very large number of tests with various materials in order to determine the maximum density curve, and he gives formula whereby this may be determined for crushed stone and sand, for gravel and sand, for crushed stone and screenings, and for various sizes of aggregate. The maximum density curve is plotted on a diagram in which the abscissæ represent the diameters of the meshes of sieves used for the granulometric analysis of the aggregate, and the ordinates the percentages by weight which pass through these sieves. It only takes a few minutes to make a granulometric analysis of any sand or aggregate, and the necessary sieves of varying numbers of meshes to the inch can be extemporized very cheaply. Having got granulometric analysis of the various sands, gravels, crushed stone, etc., which may be available, the problem is to combine them in such proportions as to ensure the resulting mixture approaching as nearly as possible to the maximum density curve. The best practical method of doing this is described in Taylor and Thompson's book Appendix I., and though it at first sight appears to be somewhat difficult and complicated, this method after a very little experience will be found

eminently practical, and it deserves to be much more widely known and recognized than it at present appears to be. Experiments made at Karachi by the writer and Major Harston in 1917 showed that a combination of 1 cement, 1½ sand, 1½ river gravel, 3 hill gravel, (a 1:6 concrete), gave a curve almost identical with the maximum density curve, and gave a crushing strength on 3-in. cubes after 28 days of nearly 2,400 lbs. per sq. inch, as against 1,900 lbs. with the old 1:2:4 mixture previously employed, which contained an excess of fine particles. The granulometric analysis of the two mixtures were :—

OLD 1:2:4 MIXTURE.

Percentage by weight passing sieves of meshes.	
·75 inch	100
·50 ,,	94
·20 ,,	73
·13 ,,	54
·10 ,,	49
·07 ,,	41
·04 ,,	30

CORRECTED MIXTURE.

Percentage by weight passing sieves of meshes.	
·75 inch	100
·50 ,,	79
·20 ,,	45
·13 ,,	39
·10 ,,	36
·07 ,,	33
·04 ,,	25

As regards quantity of water, experiments at Karachi made by crushing 3-in. cubes after one week gave the following average results—

Percentage water by volume.	Crushing strength lbs. per sq. inch.
5 per cent.	700
7½ ,,	1,200
10 ,,	1,320
12½ ,,	1,390
15 ,,	1,170
17½ ,,	830
20 ,,	470

The maximum strength is therefore obtained with about 12% of water by volume of the total volume of dry aggregate. This agrees very closely with Taylor and Thompson's results of maximum strength with 7½% water by weight, which with an aggregate weighing 105 lbs. per cubic ft. would correspond to 12·7% by volume. This

is about 75 gallons of water per hundred cubic feet of dry mixture. In reinforced work, however, it is often necessary to use more water to get the concrete to flow freely round the steel.

I would suggest that any further experiments should be carried out on the basis of Mr. Fuller's maximum density curves, in order to avoid needless exploration of ground already covered, and consequent waste of effort. While Mr. Fuller's curves may not, and probably do not, give absolutely the strongest concrete for all classes of material, they certainly do form a scientific basis to start from, and will be found to give results vastly superior to any haphazard or rule of thumb method. It may be confidently predicted that if Messrs. Johnson and Kingston will proportion their concrete according to Mr. Fuller's curves, they will obtain even better results than with their "corrected" mixtures.

CONCRETE FLOORING TILES.

By LIEUT.-COLONEL ARTHUR A. CROOKSHANK, R.E., and LIEUT. N. JOHNSTON, R.E.

TOWARDS the end of the Summer of 1917, the Concrete age began to take the place of the Timber age, owing to the fact that timber, and especially sawn timber, was getting scarce. With the approach of winter it became necessary to devise some means of providing hard floors for horse standings, stables, cart and horse water points, etc., *i.e.*, for places which had managed to struggle through the summer without hard floors by having their sites frequently changed: and which would normally have been provided in winter with floors made of rough logs, forest planks or bricks (the latter were also beginning to peter out). Cement was fairly plentiful, sand was obtainable locally and ballast procurable in limited quantities: it was consequently decided to try concrete flooring slabs or tiles, laid dry so as to make a portable floor, which could be taken up, carried away and used again, if necessary.

The design of the tiles was based on the following conditions:—

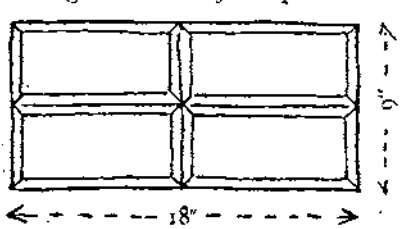
(1). The tile to be handle-able by one man, if possible, and, at any rate, by not more than two.

(2). To be strong enough to stand a load, when in floor (with nothing serious in the way of foundation under it) of horses "crowded at a check."

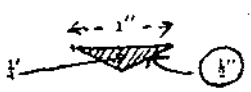
(3). To be suitable for wet swabbing over, *i.e.*, to drain off easily.

(4). To have a hard iron-shoe-proof surface, but yet to be not too smooth or skiddery a flooring.

After various trials the design eventually adopted was as in Sketch.



Longit. Section.



Cross Section of chamfering of tile or of beading in mould.

Reinforcement, in the shape of wire netting, expanded metal or heavy plain wire was not added, as the tiles were only to stand the live load of horses and men, and not the strain of a bursting shell.

The longside of the tile was laid at right angles to the horse (in a standing), so that the bevelled pattern not only saved the edges from being chipped in handling and in transit, but provided, with the short cutting across the middle, continuous channels over the floor for surface liquids to run down, and for swabbing, the tiles being laid with broken joints.

The two cuttings, short and long, with the bevelled edges, broke up the large smooth surface of the tile and prevented the horses from slipping up and skidding on the floors when the tiles were new: the largest slippery space measuring 8 in. × 3½ in.

The top, or face of the tile should be given a hard and smooth surface, in imitation of the glazed flooring tiles of peace time practice, otherwise those animals which will not stand still in the stable, and which frequently stamp their feet, will very soon break up the surface by hammering, especially as, on Service, the tiles often have to be laid "hot," so to speak: one cannot wait for them to set properly (a process which takes a considerable time in a climate like the autumn in Flanders). They are snapped up by excited and impatient crowds waiting outside the factory for their daily ration, not handled too gently, and then put into floor, wet or green, for heavy draught Clydesdales to immediately fall upon and paw.

The hard surface was obtained by making the top quarter inch of the tile (or the bottom quarter inch in the mould, *i.e.*, the depth of the "pattern," of neat cement.

The next problem to be decided upon was the prescription or recipe for the concrete. In concrete work of any kind it is a great mistake to blindly follow the empirical formulæ given in Engineering Text-books, such as 4 : 2 : 1 or 8 : 4 : 1. The correct proportions vary directly with the nature of each of the ingredients available or procurable, and can, therefore, only be determined by experiment with the materials to be actually used on the work.

What one wants, and what one is driving at in concrete, is a substance of which any one part will not fail much easier than the others, under the loads for which it is designed. The interstices between the stones require to be filled with an equally hard substance, and each stone should also have a thin covering or wrap of the substance all round it, *i.e.*, each plum should be bedded in the matrix and not in direct contact with its neighbour. Concrete wants to be designed, also, according to the work it is going to do: a concrete designed for the floor of an ablution room to carry infantry crowded at a check, should not be used in an engine room floor, where heavy machinery will be mounted on it, or in

a high wall carrying a heavy roof. For the light weight floor, a soft ballast like broken brick or sand-stone might do.

A case has occurred in which an officer designed a concrete for the floors of open or roofless stables, in which the aggregate consisted of small lumps of soft chalk. Unfortunately, he did not stop at the design: he went further, and covered a considerable tract of country with these standings.

It may be taken for granted that this so-called "concrete" was more useful to the horses for tooth-powder in dry weather, or as a soft bedding in wet weather (being not roofed over), than as a hard floor to stamp about on.

In designing concrete the first thing to do is to obtain the correct proportion between the ballast and the mortar (or aggregate and matrix). This varies greatly, according to the nature of the ballast; for instance, with lime-stone broken to a 3-in. ring, over 50 per cent. of the volume would be voids; but if the stone varies in size, from say 2 in down to ¼ in., the voids are less than 30 per cent.: 2½-in. ring gravel, free of sand, has 34 per cent. voids.

On Field Service, one usually has little or no choice of materials. You consequently take the ballast as you find it, or as it is given you, fill a bucket or oil tin with it, then pour in water till the ballast is awash, measuring the water as it goes in. This gives you the amount of voids: add, say, 20 per cent. more, to separate the stones from each other and to avoid having them touching: this gives you the proportion of ballast to mortar. In first-class work the excess should be 40 per cent. over the volume of the voids, instead of 20 per cent.

We now want to know the recipe for the mortar: this must be determined by trial and error experiments. Again Text-book formulæ cannot be used, because cement on Field Service is often not up to sample. Allowance must be made for war profiteering, also for deterioration due to the cement not being properly stored and cared for. Sand on Field Service is frequently of poor quality, a case of "Hobson's choice." Here the same principle applies, as in the case of the ballast and mortar: each grain of sand must be completely surrounded by cement. As in the case of the aggregate, if the sand is graded, *i.e.*, sands of different sized grains are blended together, a great saving in cement will result. For instance, by using ballast consisting of stones of various sizes, the voids in the stones can be reduced to 35 per cent., and by using sand of different sized grains, the voids in the sand can be reduced to 33 per cent., *i.e.*, by having a range of size in both your stones and your sand. a poor and cheap concrete, consisting of ballast : sand : cement :: 8 : 3 : 1 parts, will be just efficient as a rich and costly concrete in which the proportions are—ballast : sand : cement :: 4 : 2 : 1, and in which the ballast and sand grains are not "Graded" and the voids consequently amount to 50 per cent.; although the

poor concrete uses only half as much cement as the rich, *i.e.*, the rich and expensive concrete uses twice as much cement as the other, and is no better for it.

As regards sand, angular grains give the greatest tensile strength, and round grains the greatest compression strength.

Take the sand and cement as found: mix it in several different proportions, make up a briquette from each mixture, and choose the one which sets best and which gives the biggest breaking loads.

The designs for both tile and concrete having been got out, the next thing to do is to get your concrete tile factory started and to organise for works efficiency, eliminate all wastage in materials, wastage in labour, get each man employed at the kind of work for which he is best suited by nature and by training, and then see that he does no useless movements or actions, *i.e.*, no work which could be done by a cheaper and lower class of labour, *i.e.*, eliminate all wastage of his energy and get the best value out of him.

A factory, on a very small scale, was sited near a stream, as the ballast or aggregate had to be washed, and started under the charge of Lieut. N. Johnston, of an Army Troops Co., R.E., in June, 1917. This small factory is not to be compared with big factories employing a large number of hands, and using narrow gauge railways and concrete mixing machinery capable of turning out 80 yards of mixture per one shift day, and other gadgets or elaborate labour-saving machines.

The following results were obtained by Lieut. Johnston:—

Concrete.—The best aggregate was that obtained by passing through $\frac{3}{4}$ in. sq. mesh sieve; it was gravel which had to be well washed; it contained all sizes, from $\frac{3}{4}$ in. downwards, and a good deal of sharp, coarse sand, *i.e.*, it had a good range in sizes, and was well graded.

When sand was not procurable, the concrete was made of gravel : cement :: 4 : 1. A mixture at 5 : 1 was tried, and found unsatisfactory.

When sand was available, the best mixture was found to be gravel : sand : cement :: $3\frac{1}{2}$: 1 : 1.

A mixture of sand : cement :: 4 : 1 (*i.e.*, no gravel) was found to be unsatisfactory, probably owing to the sand being all of very small grains of about the same size. A sand with large, medium and small grains, would probably give good results.

Moulds.—A stretcher pattern mould, carried by two men and holding four tiles lying flat, *i.e.*, the tiles were cast horizontally, was found to be the best under the following conditions:—When

(1). Blocks are not larger than 18 in. × 9 in. × $2\frac{1}{2}$ in.

(2). A large mixing and moulding shed is not available.

(3). A Tip-truck railway system is not available for pouring concrete into moulds.

The above type of mould is economical in floor space (for stacking) and easy for man-handling, and has also other advantages explained later on.

In a factory on a larger scale using concrete mixing machinery, a narrow gauge railway system with Tip-trucks, big buildings, and a great amount of labour, moulds in which the tiles are cast vertically on edge (like a shelf of books) between sheet iron partitions, enable the moulds to be filled up quicker than with the horizontal mould, but they require much greater floor space, a longer time for the concrete to set (having only one edge exposed to weather, instead of the whole flat surface, and the mould made of iron instead of wood) it is impossible to have a hard face of neat cement, a good pattern in it, or to turn out a neat and clean edged tile, and the "strata," or planes of settlement in the concrete, run the wrong way.

Method of manufacture, and sizes of gangs:—

(1). Cleaning Gravel.—Two men.
(2). Mixing Gravel by hand.—Five men.
(3). Cleaning Moulds.—Six men.
(4). Oiling Moulds (with Linseed Oil).—Two men.
(5). Filling Moulds.—Two men with a mate (who shovels the concrete out of buckets into the moulds) can turn out 50 to 60 tiles an hour.
(6). Removing and Stacking Moulds, also Stacking Tiles.—Four men.

The tiles are left 48 hours in the moulds under cover before being stacked out in the open.

The above gangs, amounting to 22 men, can turn out, at a push, 500 to 700 tiles a day.

MEMOIR.

BRIG.-GENERAL HUBERT JOHN FOSTER.

COLONEL (T/BRIG.-GENERAL) H. J. FOSTER, R.E., retired, who died on the 21st March last, at Cooma, New South Wales, was the youngest and oldest surviving son of the late John N. Foster of Sandy Place, Beds.

After receiving a classical education at Harrow, where he won the gold medal for mathematics, he passed into the Royal Military Academy, Woolwich, being the first Harrow boy to pass direct from Harrow. He passed first into the Royal Engineers, receiving the Sword of Honour, and the Pollock Gold Medal. After the usual training at the School of Military Engineering he was posted to the 31st Company, R.E., which was sent to Cyprus on occupation of that island by a force under Lord Wolsely, 1878. Later he joined the Telegraph Troops at Aldershot, going with it on active service to Egypt in 1882. He was present at the engagement of Kassassin, the battle of Tel-el-Kebir, and occupation at Cairo. He was next posted to the 1st Company, R.E., at Gibraltar.

Sitting for the Staff College Examination in 1883 he passed first of the R.E. candidates. After a course of two years he received Staff College Certificate, passing with honours in French and Mathematics, and in extra languages—Italian, Russian, and Modern Greek.

After leaving the Staff College he was on secret service reconnaissance duty in Greece for the Foreign Office and Admiralty in connection with the Naval Blockade which averted the Turco-Greece war, 1886, and received thanks of Admiralty for this work.

He served a term as Brigade Major, R.E. Irish Command, Dublin, and was then transferred to the Intelligence Department, War Office, doing duty with the section dealing with the British Empire, where he acquired a good knowledge of the Dominions and Colonies. This duty included correction of Colonial Defence schemes and collaboration with the Secretary of the Colonial Defence Committee, Colonel Sir George Clarke, R.E. (now Lord Sydenham), and with Admiral Sir Cyprian Bridge, Director of Naval Intelligence. It also entailed consultation with the Foreign Office and the Colonial Office, and the drafting of papers on Imperial Defence and Strategy for the War Office, the Colonial Defence Committee, and occasionally for the Prime Minister of the day.

After five years at the Intelligence Department, he was sent on a special confidential mission to Canada in 1895 and to the United States in 1897.

Subsequently appointed Staff Officer of Engineers in the Scottish Command, and he was offered command of the Telegraph Company but preferred duty with the government of Canada, as Quarter-Master General, and later acted for a year as Chief of Staff to General Hatton, G.O.C., Canada. This work took him all over Canada, and he acquired knowledge of the country and its military forces, so that the Cabinet asked him to become Commandant of the Canadian Military College, Kingston. He, however, accepted the War Office offer of Colonel of a division of the Intelligence Department—which appointment however fell through owing to the South African war necessitating economy.

He was appointed Military Attaché to the Embassy at Washington. During three years in this position he made a thorough study of the U.S. and the Army Headquarters. He travelled continually over the country, some 10,000 miles yearly, visiting the various military posts and the coast defences, arsenals, etc., and attending all manœuvres. He formed excellent relations with the senior officers of the army and gained a thorough knowledge of the United States and its army.

He was Military Attaché in Mexico to H.M. Legation travelling in the country and, writing for the War Office, a book on the army and military situation of Mexico.

On return to London he was again posted to the Intelligence Department. While there he wrote a book on the strategic aspect of the Canadian Frontier.

In 1906, he accepted the appointment of Director of Military Science at the University of Sydney, with position of General Staff Officer, British Army During his nine years tenure of that position he lectured continuously on Imperial Defences, Military History, Strategy, and Tactics, and held annually several Staff Courses in the field for senior officers, which were attended by some hundreds of senior officers, including nearly all those who have commanded divisions in this war:—Sir W. Bridges, Sir H. Chauval, Major-Generals McCay-Holmes, Monash, Hobbs, many Brigadier-Generals and Commanding Officers. During this period he wrote the following books in connection with his work:—*Defence of the Empire, A Tactical Exercise, Organisation: On How Armies are Formed for War, Staff Work, War and the Empire.*

He also wrote constantly for the press, and gave lectures to the public on military matters, especially on the war in 1914/15. In December, 1915, he accepted temporary service in the Department of Defence, acting Chief of the General Staff, Dept. of Defence.

Brigadier-General Foster travelled extensively. He knew every

country in Europe, except Serbia, and knew Western Europe well. Having served in Gibraltar, Egypt, and Cyprus, he studied the Mediterranean from Spain to Constantinople and Morocco, Algiers, Tunis, Syria, and Greece. All his service he made a study of the geography, history, languages, peoples and politics of most European countries. During eleven years of his service, he went all over the American Continent from Cuba and Mexico to Alaska, and knew Canada and the United States well.

He had twelve years residence and travel in Australia and visited New Zealand, India, Ceylon, China, and Japan. He had some personal knowledge of the whole British Empire and long made a serious study of its geography, history, external politics, and especially of its defence. He made many journeys to South Asia, India, Malaya, Siam, Java, and other of the Dutch Islands, French Indo-China, the Phillipines, New Guinea, thus greatly extended his knowledge of the countries adjoining Australia.

TRANSCRIPT.

FIELD MARSHAL SIR DOUGLAS HAIG ON THE "FEATURES OF THE WAR."

From the Fourth Supplement to *The London Gazette* of Tuesday, 8th April, 1919.

[WE are departing in this instance from our usual practice of publishing Extracts from Dispatches only in the *Supplement to R.E. Journal* and reproduce below Part II. of Sir Douglas Haig's final dispatch, since it furnishes a general review of the whole war.—EDITOR, *R.E. Journal.*]

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(10) In this, my final Dispatch, I think it desirable to comment briefly upon certain general features which concern the whole series of operations carried out under my command. I am urged thereto by the conviction that neither the course of the war itself nor the military lessons to be drawn therefrom can properly be comprehended, unless the long succession of battles commenced on the Somme in 1916 and ended in November of last year on the Sambre are viewed as forming part of one great and continuous engagement.

To direct attention to any single phase of that stupendous and incessant struggle and seek in it the explanation of our success, to the exclusion or neglect of other phases possibly less striking in their immediate or obvious consequences is, in my opinion, to risk the formation of unsound doctrines regarding the character and requirements of modern war.

If the operations of the past 4½ years are regarded as a single continuous campaign, there can be recognized in them the same general features and the same necessary stages which between forces of approximately equal strength have marked all the conclusive battles of history. There is in the first instance the preliminary stage of the campaign in which the opposing forces seek to deploy and manœuvre for position, endeavouring while doing so to gain some early advantage which might be pushed home to quick decision. This phase came to an end in the present war with the creation of continuous trench lines from the Swiss frontier to the sea.

Battle having been joined, there follows the period of real struggle in which the main forces of the two belligerent Armies are pitted against each other in close and costly combat. Each commander seeks to wear down the power of resistance of his opponent and to pin him to his position, while preserving or accumulating in his own hands a powerful reserve force with which he can manœuvre, and when signs of the enemy becoming morally and physically weakened are observed, deliver the decisive attack. The greatest possible pressure against the enemy's whole front must be maintained, especially when the crisis of the battle approaches. Then every man, horse, and gun is required to co-operate, so as to complete the enemy's overthrow and exploit success.

In the stage of the wearing out struggle losses will necessarily be

heavy on both sides, for in it the price of victory is paid. If the opposing forces are approximately equal in numbers, in courage, in moral and in equipment, there is no way of avoiding payment of the price or of eliminating this phase of the struggle.

In former battles this stage of the conflict has rarely lasted more than a few days, and has often been completed in a few hours. When Armies of millions are engaged, with the resources of great Empires behind them, it will inevitably be long. It will include violent crises of fighting which, when viewed separately and apart from the general perspective, will appear individually as great indecisive battles. To this stage belong the great engagements of 1916 and 1917 which wore down the strength of the German Armies.

Finally, whether from the superior fighting ability and leadership of one of the belligerents, as the result of greater resources or tenacity, or by reason of higher moral, or from a combination of all these causes, the time will come when the other side will begin to weaken and the climax of the battle is reached. Then the commander of the weaker side must choose whether he will break off the engagement, if he can, while there is yet time, or stake on a supreme effort what reserves remain to him. The launching and destruction of Napoleon's last reserves at Waterloo was a matter of minutes. In this World War the great sortie of the beleaguered German Armies, commenced on the 21st March, 1918, lasted for four months, yet it represents a corresponding stage in a single colossal battle.

The breaking down of such a supreme effort will be the signal for the commander of the successful side to develop his greatest strength and seek to turn to immediate account the loss in material and moral which their failure must inevitably produce among his opponent's troops. In a battle joined and decided in the course of a few days or hours, there is no risk that the lay observer will seek to distinguish the culminating operations by which victory is seized and exploited from the preceding stages by which it has been made possible and determined. If the whole operations of the present war are regarded in correct perspective the victories of the summer and autumn of 1918 will be seen to be as directly dependent upon the two years of stubborn fighting that preceded them.

(11) If the causes which determined the length of the recent contest are examined in the light of the accepted principles of war, it will be seen that the duration of the struggle was governed by and bore a direct relation to certain definite factors which are enumerated below.

In the first place, we were unprepared for war, or at any rate for a war of such magnitude. We were deficient in both trained men and military material, and, what was more important, had no machinery ready by which either men or material could be produced in anything approaching the requisite quantities. The consequences were two-fold. Firstly, the necessary machinery had to be improvised hurriedly, and improvisation is never economical and seldom satisfactory. In this case the high-water mark of our fighting strength in infantry was only reached after 2½ years of conflict, by which time heavy casualties had already been incurred. In consequence, the full man power of the Empire was never developed in the field at any period of the war.

As regards material, it was not until midsummer, 1916, that the artillery situation became even approximately adequate to the conduct of major operations. Throughout the Somme battle the expenditure of artillery ammunition had to be watched with the greatest care. During the battles of 1917 ammunition was plentiful, but the gun situation was a source of constant anxiety. Only in 1918 was it possible to conduct artillery operations independently of any limiting consideration other than that of transport.

The second consequence of our unpreparedness was that our Armies were unable to intervene, either at the outset of the war or until nearly two years had elapsed, in sufficient strength adequately to assist our Allies. The enemy was able to gain a notable initial advantage by establishing himself in Belgium and northern France, and throughout the early stages of the war was free to concentrate an undue proportion of his effectives against France and Russia. The excessive burden thrown upon the gallant Army of France during this period caused them losses, the effect of which has been felt all through the war and directly influenced its length. Just as at no time were we as an Empire able to put our own full strength into the field, so at no time were the Allies as a whole able completely to develop and obtain the full effect from their greatly superior man power. What might have been the effect of British intervention on a larger scale in the earlier stages of the war is shown by what was actually achieved by our original Expeditionary Force.

It is interesting to note that in previous campaigns the side which has been fully prepared for war has almost invariably gained a rapid and complete success over its less well prepared opponent. In 1866 and 1870, Austria, and then France, were overwhelmed at the outset by means of superior preparation. The initial advantages derived therefrom were followed up by such vigorous and ruthless action, regardless of loss, that there was no time to recover from the first stunning blows. The German plan of campaign in the present war was undoubtedly based on similar principles. The margin by which the German onrush in 1914 was stemmed was so narrow and the subsequent struggle so severe that the word "miraculous" is hardly too strong a term to describe the recovery and ultimate victory of the Allies.

A further cause adversely influencing the duration of the war on the Western front during its later stages, and one following indirectly from that just stated, was the situation in other theatres. The military strength of Russia broke down in 1917 at a critical period, when, had she been able to carry out her military engagements, the war might have been shortened by a year. At a later date, the military situation in Italy in the autumn of 1917 necessitated the transfer of five British divisions from France to Italy, at a time when their presence in France might have had far-reaching effects.

Thirdly, the Allies were handicapped in their task and the war thereby lengthened by the inherent difficulties always associated with the combined action of Armies of separate nationalities, differing in speech and temperament, and, not least important, in military organization, equipment, and supply.

Finally, as indicated in the opening paragraph of this part of my Dispatch, the huge numbers of men engaged on either side, whereby a continuous battle front was rapidly established from Switzerland to the sea, outflanking was made impossible and manœuvre very difficult, necessitated the delivery of frontal attacks. This factor, combined with the strength of the defensive under modern conditions, rendered a protracted wearing out battle unavoidable before the enemy's power of resistance could be overcome. So long as the opposing forces are at the outset approximately equal in numbers and moral, and there are no flanks to turn, a long struggle for supremacy is inevitable.

(12) Obviously, the greater the length of a war the higher is likely to be the number of casualties incurred in it on either side. The same causes, therefore, which served to protract the recent struggle are largely responsible for the extent of our casualties. There can be no question that to our general unpreparedness must be attributed the loss of many thousands of brave men whose sacrifice we deeply deplore, while we regard their splendid gallantry and self-devotion with unstinted admiration and gratitude.

Given, however, the military situation existing in August, 1914, our total losses in the war have been no larger than were to be expected. Neither do they compare unfavourably with those of any other of the belligerent nations, so far as figures are available, from which comparison can be made. The total British casualties in all theatres of war, killed, wounded, missing, and prisoners, including native troops, are approximately three millions (3,076,388). Of this total some two and a half millions (2,568,834) were incurred on the Western front. The total French losses, killed, missing, and prisoners, but exclusive of wounded, have been given officially as approximately 1,831,000. If an estimate for wounded is added, the total can scarcely be less than 4,800,000, and of this total it is fair to assume that over four millions were incurred on the Western front. The published figures for Italy, killed and wounded only, exclusive of prisoners, amount to 1,400,000, of which practically the whole were incurred in the Western theatre of war.

Figures have also been published for Germany and Austria. The total German casualties, killed, wounded, missing, and prisoners, are given at approximately six and a half millions (6,485,000) of which the vastly greater proportion must have been incurred on the Western front, where the bulk of the German forces were concentrated and the hardest fighting took place. In view of the fact, however, that the number of German prisoners is definitely known to be considerably understated, these figures must be accepted with reserve. The losses of Austria-Hungary in killed, missing, and prisoners are given as approximately two and three-quarter millions (2,772,000). An estimate of wounded would give a total of over four and a half millions.

The extent of our casualties, like the duration of the war, was dependent on certain definite factors which can be stated shortly.

In the first place, the military situation compelled us, particularly during the first portion of the war to make great efforts before we had developed our full strength in the field or properly equipped and trained our Armies. These efforts were wasteful of men, but in the circumstances

they could not be avoided. The only alternative was to do nothing and see our French Allies overwhelmed by the enemy's superior numbers.

During the second half of the war, and that part embracing the critical and costly period of the wearing out battle, the losses previously suffered by our Allies laid upon the British Armies in France an increasing share in the burden of attack. From the opening of the Somme Battle in 1916 to the termination of hostilities the British Armies were subjected to a strain of the utmost severity which never ceased, and consequently had little or no opportunity for the rest and training they so greatly needed.

In addition to these particular considerations, certain general factors peculiar to modern war made for the inflation of losses. The great strength of modern field defences and the power and precision of modern weapons, the multiplication of machine guns, trench mortars, and artillery of all natures, the employment of gas, and the rapid development of the aeroplane as a formidable agent of destruction against both men and material, all combined to increase the price to be paid for victory.

If only for these reasons, no comparisons can usefully be made between the relative losses incurred in this war and any previous war. There is however, the further consideration that the issues involved in this stupendous struggle were far greater than those concerned in any other war in recent history. Our existence as an Empire and civilization itself, as it is understood by the free Western nations, were at stake. Men fought as they have never fought before in masses.

Despite our own particular handicaps and the foregoing general considerations, it is satisfactory to note that, as the result of the courage and determination of our troops, and the high level of leadership generally maintained, our losses even in attack over the whole period of the battle compare favourably with those inflicted on our opponents. The approximate total of our battle casualties in all arms, and including Overseas troops, from the commencement of the Somme Battle in 1916 to the conclusion of the Armistice is 2,140,000. The calculation of German losses is obviously a matter of great difficulty. It is estimated, however, that the number of casualties inflicted on the enemy by British troops during the above period exceeds two and a half millions. It is of interest, moreover, in the light of the paragraph next following, that more than half the total casualties incurred by us in the fighting of 1918 were occasioned during the five months, March-July, when our Armies were on the defensive.

(13) Closely connected with the question of casualties is that of the relative values of attack and defence. It is a view often expressed that the attack is more expensive than defence. This is only a half statement of the truth. Unquestionably, unsuccessful attack is generally more expensive than defence, particularly if the attack is pressed home with courage and resolution. On the other hand, attack so pressed home, if skilfully conducted, is rarely unsuccessful, whereas in its later stages especially, unsuccessful defence is far more costly than attack.

Moreover, the object of all war is victory, and a purely defensive attitude can never bring about a successful decision, either in a battle or in a campaign. The idea that a war can be won by standing on the defensive and waiting for the enemy to attack is a dangerous fallacy,

which owes its inception to the desire to evade the price of victory. It is an axiom that decisive success in battle can be gained only by a vigorous offensive. The principle here stated has long been recognized as being fundamental and is based on the universal teaching of military history in all ages. The course of the present war has proved it to be correct.

To pass for a moment from the general to the particular, and consider in the light of the present war the facts upon which this axiom is based.

A defensive *rôle* sooner or later brings about a distinct lowering of the moral of the troops, who imagine that the enemy must be the better man, or at least more numerous, better equipped with and better served by artillery or other mechanical aids to victory. Once the mass of the defending infantry become possessed of such ideas, the battle is as good as lost. An Army fighting on enemy soil, especially if its standard of discipline is high, may maintain a successful defence for a protracted period, in the hope that victory may be gained elsewhere or that the enemy may tire or weaken in his resolution and accept a compromise. The resistance of the German armies was undoubtedly prolonged in this fashion, but in the end the persistence of our troops had its natural effect.

Further, a defensive policy involves the loss of the initiative, with all the consequent disadvantages to the defender. The enemy is able to choose at his own convenience the time and place of his attacks. Not being influenced himself by the threat of attack from his opponent, he can afford to take risks, and by greatly weakening his front in some places can concentrate an overwhelming force elsewhere with which to attack. The defender, on the other hand, becomes almost entirely ignorant of the dispositions and plans of his opponent, who is thus in a position to effect a surprise. This was clearly exemplified during the fighting of 1918. As long as the enemy was attacking, he obtained fairly full information regarding our dispositions. Captured documents show that, as soon as he was thrown once more on the defensive and the initiative returned to the Allies, he was kept in comparative ignorance of our plans and dispositions. The consequence was that the Allies were able to effect many surprises, both strategic and tactical.

As a further effect of the loss of the initiative and ignorance of his opponent's intentions, the defender finds it difficult to avoid a certain dispersal of his forces. Though for a variety of reasons, including the fact that we had lately been on the offensive, we were by no means entirely ignorant of the enemy's intentions in the spring of 1918, the unavoidable uncertainty resulting from a temporary loss of the initiative did have the effect of preventing a complete concentration of our reserves behind the point of the enemy's attack.

An additional reason, peculiar to the circumstances of the present war, which in itself compelled me to refuse to adopt a purely defensive attitude so long as any other was open to me, is to be found in the geographical position of our Armies. For reasons stated by me in my Dispatch of the 20th July, 1918, we could not afford to give much ground on any part of our front. The experience of the war has shown that if the defence is to be maintained successfully, even for a limited time, it must be flexible.

(14) If the views set out by me in the preceding paragraphs are accepted, it will be recognized that the war did not follow any unprecedented course, and that its end was neither sudden nor should it have been unexpected. The rapid collapse of Germany's military powers in the latter half of 1918 was the logical outcome of the fighting of the previous two years. It would not have taken place but for that period of ceaseless attrition which used up the reserves of the German Armies, while the constant and growing pressure of the blockade sapped with more deadly insistence from year to year at the strength and resolution of the German people. It is in the great battles of 1916 and 1917 that we have to seek for the secret of our victory in 1918.

Doubtless, the end might have come sooner had we been able to develop the military resources of our Empire more rapidly and with a higher degree of concentration, or had not the defection of Russia in 1917 given our enemies a new lease of life.

So far as the military situation is concerned, in spite of the great accession of strength which Germany received as the result of the defection of Russia, the battles of 1916 and 1917 had so far weakened her Armies that the effort they made in 1918 was insufficient to secure victory. Moreover, the effect of the battles of 1916 and 1917 was not confined to loss of German man power. The moral effects of those battles were enormous, both in the German Army and in Germany. By their means our soldiers established over the German soldier a moral superiority which they held in an ever-increasing degree until the end of the war, even in the difficult days of March and April, 1918.

(15) From time to time as the war of position dragged on and the enemy's trench systems remained unbroken, while questions of man power and the shortage of shipping became acute, the wisdom or necessity of maintaining any large force of mounted men was freely discussed. In the light of the full experience of the war the decision to preserve the Cavalry Corps has been completely justified. It has been proved that cavalry, whether used for shock effect under suitable conditions or as mobile infantry, have still an indispensable part to play in modern war. Moreover, it cannot safely be assumed that in all future wars the flanks of the opposing forces will rest on neutral States or impassable obstacles. Whenever such a condition does not obtain opportunities for the use of cavalry must arise frequently.

Throughout the great retirement in 1914, our cavalry covered the retirement and protected the flanks of our columns against the onrush of the enemy, and on frequent occasions prevented our infantry from being overrun by the enemy's cavalry. Later in the same year at Ypres, their mobility multiplied their value as a reserve, enabling them rapidly to reinforce threatened portions of our line.

During the critical period of position warfare, when the trial of strength between the opposing forces took place, the absence of room to manœuvre made the importance of cavalry less apparent. Even under such conditions, however, valuable results may be expected from the employment of a strong force of cavalry when, after there has been severe fighting on one or more fronts, a surprise attack is made on another front. Such an occasion arose in the operations before Cambrai at the

close of 1917, when the cavalry were of the greatest service; while throughout the whole period of trench fighting they constituted an important mobile reserve.

At a later date, when circumstances found us operating once more in comparatively open country, cavalry proved themselves of value in their true *rôle*. During the German offensive in March, 1918, the superior mobility of cavalry fully justified their existence. At the commencement of the battle, cavalry were used under the Fifth Army over wide fronts. So great, indeed, became the need for mounted men that certain units which had but recently been dismounted were hurriedly provided with horses and did splendid service. Frequently, when it was impossible to move forward other troops in time, our mounted troops were able to fill gaps in our line and restore the situation. The absence of hostile cavalry at this period was a marked feature of the battle. Had the German command had at their disposal even two or three well-trained cavalry divisions, a wedge might have been driven between the French and British Armies. Their presence could not have failed to have added greatly to the difficulties of our task.

In the actions already referred to east of Amiens, the cavalry were again able to demonstrate the great advantage which their power of rapid concentration gives them in a surprise attack. Operating in close concert with both armoured cars and infantry, they pushed ahead of the latter and by anticipating the arrival of German reserves assisted materially in our success. In the battle of the 8th October, they were responsible for saving the Cambrai—Le Cateau—St. Quentin Railway from complete destruction. Finally, during the culminating operations of the war when the German Armies were falling back in disorganized masses a new situation arose which demanded the use of mounted troops. Then our cavalry, pressing hard upon the enemy's heels, hastened his retreat and threw him into worse confusion. At such a time the moral effect of cavalry is overwhelming and is in itself a sufficient reason for the retention of that arm.

On the morning of the Armistice, two British Cavalry Divisions were on the march east of the Scheldt, and before the orders to stop reached them they had already gained a line ten miles in front of our infantry outposts. There is no doubt that, had the advance of the cavalry been allowed to continue, the enemy's disorganized retreat would have been turned into a rout.

(16) A remarkable feature of the present war has been the number and variety of mechanical contrivances to which it has given birth or has brought to a higher state of perfection.

Besides the great increase in mobility made possible by the development of motor transport, heavy artillery, trench mortars, machine guns, aeroplanes, tanks, gas, and barbed wire have in their several spheres of action played very prominent parts in operations, and as a whole have given a greater driving power to war. The belligerent possessing a preponderance of such mechanical contrivances has found himself in a very favourable position as compared with his less well provided opponent. The general superiority of the Allies in this direction during the concluding stages of the recent struggle undoubtedly contributed power-

fully to their success. In this respect the Army owes a great debt to science and to the distinguished scientific men who placed their learning and skill at the disposal of their country.

It should never be forgotten, however, that weapons of this character are incapable of effective independent action. They do not in themselves possess the power to obtain a decision, their real function being to assist the infantry to get to grips with their opponents. To place in them a reliance out of proportion to their real utility, to imagine, for example, that tanks and aeroplanes can take the place of infantry and artillery, would be to do a disservice to those who have the future of these new weapons most at heart by robbing them of the power to use them to their best effect.

Every mechanical device so far produced is dependent for its most effective use upon the closest possible association with other arms, and in particular with infantry and artillery. Aeroplanes must rely upon infantry to prevent the enemy from overrunning their aerodromes, and, despite their increasing range and versatility of action, are clearly incapable in themselves of bringing about a decision. Tanks require the closest artillery support to enable them to reach their objectives without falling victims to the enemy's artillery, and are dependent upon the infantry to hold the position they have won.

As an instance of the interdependence of artillery and tanks, we may take the actions fought east of Amiens on the 8th August, 1918, and following days. A very large number of tanks were employed in these operations, and they carried out their tasks in the most brilliant manner. Yet a scrutiny of the artillery ammunition returns for this period discloses the fact that in no action of similar dimensions had the expenditure of ammunition been so great.

Immense as the influence of mechanical devices may be, they cannot by themselves decide a campaign. Their true *rôle* is that of assisting the infantryman, which they have done in a most admirable manner. They cannot replace him. Only by the rifle and bayonet of the infantryman can the decisive victory be won.

(17) This war has given no new principles; but the different mechanical appliances above mentioned—and in particular the rapid improvement and multiplication of aeroplanes, the use of immense numbers of machine guns and Lewis guns, the employment of vast quantities of barbed wire as effective obstacles, the enormous expansion of artillery, and the provision of great masses of motor transport—have introduced new problems of considerable complexity concerning the effective co-operation of the different arms and services. Much thought has had to be bestowed upon determining how new devices could be combined in the best manner with the machinery already working.

The development of the Air Service is a matter of general knowledge, and figures showing something of the work done by our airmen were included in my last Dispatch. The combining of their operations with those of the other arms, and particularly of the artillery, has been the subject of constant study and experiment, giving results of the very highest value. As regards machine guns, from a proportion of one gun to approximately 500 infantrymen in 1914, our establishment of machine

guns and Lewis guns had risen at the end of 1918 to one machine gun or Lewis gun to approximately 20 infantrymen. This great expansion was necessarily accompanied by a modification of training and methods both for attack and defence, and resulted ultimately in the establishment of the Machine Gun Corps under an Inspector-General.

During the same period, the growth of our artillery was even more remarkable, its numbers and power increasing out of all proportion to the experience of previous wars. The 486 pieces of light and medium artillery with which we took the field in August, 1914, were represented at the date of the Armistice by 6,437 guns and howitzers of all natures, including pieces of the heaviest calibre.

This vast increase so profoundly influenced the employment of artillery and was accompanied by so intimate an association with other arms and services that it merits special comment.

In the first place, big changes were required in artillery organization, as well as important decisions concerning the proportions in which the different natures of artillery and artillery ammunition should be manufactured. These changes and decisions were made during 1916, and resulted in the existing artillery organization of the British Armies in France.

In order to gain the elasticity essential to the quick concentration of guns at the decisive point, to enable the best use to be made of them and to facilitate ammunition supply and fire control, Artillery Commanders, acting under Army and Corps Commanders, were introduced, and Staffs provided for them. This enabled the large concentrations of guns required for our offensives to be quickly absorbed and efficiently directed. The proportions required of guns to howitzers and of the lighter to the heavier natures were determined by certain factors, namely the problem of siting in the comparatively limited areas available the great numbers of pieces required for an offensive; the "lives" of the different types of guns and howitzers, that is the number of rounds which can be fired from them before they become unserviceable from wear, and questions of relative accuracy and fire effect upon particular kinds of targets.

The results attained by the organization established in 1916 is in itself strong evidence of the soundness of the principles upon which it was based. It made possible a high degree of elasticity, and by the full and successful exploitation of all the means placed at its disposal by science and experience, ensured that the continuous artillery battle which began on the Somme should culminate, as it did, in the defeat of the enemy's guns.

The great development of air photography, sound ranging, flash spotting, air-burst ranging, and aerial observation brought counter-battery work and harassing fire both by day and night to a high state of perfection. Special progress was made in the art of engaging moving targets with fire controlled by observation from aeroplanes and balloons. The work of the Field Survey Sections in the location of hostile battery positions by re-section and the employment of accurate maps was brought into extended use. In combination with the work of the Calibration Sections in the accurate calibration of guns and by careful calculation

of corrections of range required to compensate for weather conditions it became possible to a large extent to dispense with registration, whereby the chance of effecting surprise was greatly increased. In the operations east of Amiens on the 8th August, 1918, in which over 2,000 guns were employed, practically the whole of the batteries concentrated for the purpose of the attack opened fire for the first time on the actual morning of the assault.

The use of smoke shell for covering the advance of our infantry and masking the enemy's positions was introduced and employed with increasing frequency and effect. New forms of gas shell were made available, and their combination with the infantry attack carefully studied. The invention of a new fuze known as "106," which was first used in the battle of Arras, 1917, enabled wire entanglements to be easily and quickly destroyed, and so modified our methods of attacking organized positions. By bursting the shell the instant it touched the ground and before it had become buried, the destructive effect of the explosion was greatly increased. It became possible to cut wire with a far less expenditure of time and ammunition, and the factor of surprise was given a larger part in operations.

Great attention was paid to the training of *personnel*, and in particular the Chapperton Down Artillery School, Salisbury Plain, was formed for training artillery brigade commanders and battery commanders, while Artillery Schools in France were organized for the training of subalterns and non-commissioned officers.

A short examination of our principal attacks will give a good idea of the increasing importance of artillery. On the first day of the Somme Battle of 1916 the number of artillery *personnel* engaged was equal to about half the infantry strength of the attacking divisions. On this one day a total of nearly 13,000 tons of artillery ammunition was fired by us on the Western front. Our attacks at Arras and Messines on the 9th April and 7th June, 1917, saw the total expenditure of artillery ammunition nearly doubled on the first days of those battles, while the proportion of artillery *personnel* to infantry steadily grew.

During the period following the opening of the Somme Battle, the predominance of our artillery over that of the enemy gradually increased, till at the time of the Arras Battle it had reached a maximum. In the course of the summer and autumn of 1917, however, the enemy constantly reinforced his artillery on our front, being enabled to do so owing to the relaxation of pressure elsewhere.

The battle of Ypres in the autumn of 1917 was one of intense struggle for artillery supremacy. By dint of reducing his artillery strength on other parts of the Western front, and by bringing guns from the East, the enemy definitely challenged the predominance of our artillery. In this battle, therefore, the proportion of our artillery to infantry strength was particularly large. In the opening attack on the 31st July our artillery *personnel* amounted to over 80 per cent. of the infantry engaged in the principal attack on our front, and our total expenditure of artillery ammunition on this day exceeded 23,000 tons. During the succeeding weeks the battle of the rival artilleries became ever more violent. On the two days, 20th and 21st September, about 42,000 tons

of artillery ammunition were expended by us, and in the successful attack of the 4th October, which gave us the main ridge about Broodseinde, our artillery *personnel* amounted to 85 per cent. of the infantry engaged in the assault.

During the winter of 1917–1918 the enemy so greatly added to his artillery strength by batteries brought from the Russian front that in his spring offensive he was able temporarily to effect a definite local artillery superiority. This state of affairs was shortlived. Even before the breakdown of the German offensive, our guns had regained the upper hand. In the battles later in the year the superiority of our batteries once more grew rapidly, until the defeat of the German artillery became an accomplished fact. From the commencement of our offensive in August, 1918, to the conclusion of the Armistice, some 700,000 tons of artillery ammunition were expended by the British Armies on the Western front. For the fortnight from the 21st August–3rd September our average daily expenditure exceeded 11,000 tons, while for the three days of crucial battle on the 27th, 28th, and 29th September nearly 65,000 tons of ammunition were fired by our artillery.

The tremendous growth of our artillery strength above described followed inevitably from the character of the wearing-out battle upon which we were engaged. The restricted opportunities for manœuvre and the necessity for frontal attacks made the employment of great masses of artillery essential.

The massing of guns alone, however, could not have secured success without the closest possible combination between our batteries and the infantry they were called upon to support, as well as with the other arms. The expansion was accompanied, therefore, by a constant endeavour to improve the knowledge of all ranks of both artillery and infantry and the air service concerning the work and possibilities of the other arms.

An intelligent understanding of "the other man's job" is the first essential of successful co-operation. To obtain the best results from the vast and complex machine composing a modern army, deep study of work other than one's own is necessary for all arms. For this study much time is needed, as well as much practical application of the principles evolved, and for reasons already explained, opportunity sufficient for adequate training could not be found. None the less, the best possible use was made of such opportunities as offered, and much was in fact accomplished.

(18) As a natural corollary to the general increase of our Forces, the Signal Service, required alike for the proper co-ordination of supply and for the direction and control of the battle, has grown almost out of recognition. From an original establishment of under 2,400 officers and men, trained and equipped chiefly for mobile warfare, at the end of 1918 the *personnel* of the Signal Service had risen to 42,000, fully equipped with all the latest devices of modern science to act efficiently under all conditions as the nervous system to the whole vast organism of our Army.

The commencement of trench warfare and the greater use of artillery led to a rapid development of the signal system, which as fresh units

were introduced became more and more elaborate. At the same time, the increase in the power and range of artillery made the maintenance of communications constantly more difficult. Many miles of deep trenches were dug in which cables containing 50 to 100 circuits were buried to gain protection from shell fire. The use of wireless communication gradually became more widely spread and finally constituted part of the Signal establishment of all formations down to divisions. To provide an alternative method of communication with front line troops, in 1915 carrier pigeons were introduced and a special branch of the Signal Service was formed controlling ultimately some 20,000 birds. In 1917 a Messenger Dog Service was started for similar purposes and did good work on a number of occasions.

The expansion of the work of the Signal Service in the more foward areas was accompanied by a similar development on the Lines of Communication, at General Headquarters, Armies, and Corps. Construction and Railway Companies were formed and about 1,500 miles of main telegraph and telephone routes constructed in the Lines of Communication area alone, in addition to many miles in Army areas. Provision had to be made for communicating with London, Paris, and Marseilles, as well as between the different Allied Headquarters. On the advance of our forces to the Rhine telephone communication was established between General Headquarters at Montreuil and Cologne. Signal communication entailing the putting up of many thousands of miles of wire was provided also for the control of railway traffic, while to supplement electric communication generally a Dispatch Rider Letter Service was maintained by motor cyclists.

The amount of Signal Traffic dealt with became very great, and on the Lines of Communication alone more than 23,000 telegrams have been transmitted in twenty-four hours. Similarly, at General Headquarters as many as 9,000 telegrams have been dealt with in twenty-four hours, besides 3,400 letters carried by Dispatch Rider; and Army Headquarters has handled 10,000 telegrams and 5,000 letters in the same space of time, and a Corps 4,500 telegrams and 3,000 letters. In addition to telegrams and letters, there has been at all times a great volume of telephone traffic.

Something of the extent of the constructional work required, in particular to meet the constant changes of the battle line and the movement of Headquarters, can be gathered from the fact that as many as 6,500 miles of field cable have been issued in a single week. The average weekly issue of such cable for the whole of 1918 was approximately 3,300 miles.

(19) The immense expansion of the Army from 6 to over 60 infantry divisions, combined with the constant multiplication of auxiliary arms, called inevitably for a large increase in the size and scope of the services concerned in the supply and maintenance of our fighting forces.

As the Army grew and became more complicated the total feeding strength of our forces in France rose until it approached a total of 2,700,000 men. The vastness of the figures involved in providing for their needs will be realized from the following examples. For the main-

tenance of a single division for one day, nearly 200 tons dead weight of supplies and stores are needed, representing a shipping tonnage of nearly 450 tons. In an Army of 2,700,000 men, the addition of one ounce to each man's daily rations involves the carrying of an extra 75 tons of goods.

To cope with so great a growth, the number of existing directorates had gradually to be added to or their duties extended, with a corresponding increase in demands for personnel. The supervision of ports was entrusted to the Directorate of Docks, which controlled special companies for the transhipping of stores. By the end of November, 1918, the number of individual landings in France at the various ports managed by us exceeded 10½ million persons. During the 11 months January to November, 1918, the tonnage landed at these ports averaged some 175,000 tons per week.

To the Directorate of Transport, originally concerned with the administration of horse vehicles and pack animals, fell the further duty of exploiting mechanical road traction. Despite the employment of over 46,700 motor vehicles, including over 30,000 lorries, the number of horses and mules rose greatly, reaching a figure exceeding 400,000. The replacement, training and distribution of these animals was the duty of the Directorate of Remounts. The Directorate of Veterinary Services reduced losses and prevented the spread of disease, while the Inspector of Horse Feeding and Economies ensured that the utmost value was obtained from the forage and grain consumed.

To meet the requirements of mechanical and horse traffic, the upkeep or construction of a maximum of some 4,500 miles of roadway was entrusted to the Directorate of Roads. Some idea of the work involved may be obtained from the fact that for ordinary upkeep alone 100 tons of road material are required per fortnight for the maintenance of one mile of road. Under this Directorate were organized a number of Road Construction Companies, together with Quarry Companies to supply the necessary metal. In the month of October, 1918, over 85,000 tons of road material were conveyed weekly by motor transport alone, involving a petrol mileage of over 14,000,000 weekly. The total output of stone from the commencement of 1918 to the date of the Armistice amounted to some 3,500,000 tons.

For the working of the existing railways and for the construction or repair of many miles of track, both normal and narrow gauge, railway troops of every description, Operating Companies, Construction Companies, Survey and Reconnaissance Companies, Engine Crew Companies, Workshop Companies, Wagon Erecting Companies, and Light Railway Forward Companies had to be provided. Under the Directorate of Railway Traffic, the Directorate of Construction, and the Directorate of Light Railways, these and other technical troops during 1918 built or reconstructed 2,340 miles of broad gauge and 1,348 miles of narrow gauge railway. Throughout the whole period of their operation they guaranteed the smooth and efficient working of the railway system. In the six months May to October, 1918, a weekly average of 1,800 trains were run for British Army traffic, carrying a weekly average load of approximately 400,000 tons, while a further 130,000 tons were carried

weekly by our light railways. The number of locomotives imported to deal with this traffic rose from 62 in 1916 to over 1,200 by the end of 1918, while the number of trucks rose from 3,840 to 52,600.

The Inland Water Transport section were organized under a separate Directorate for the working in France and Flanders of the canal and cross-channel barge traffic. On Inland waterways alone an average of 56,000 tons of material were carried during 1918, the extent of waterways worked by us at the date of the Armistice being some465 miles.

The wonderful development of all methods of transportation had an important influence upon the course of events. No war has been fought with such ample means of quick transportation as were available during the recent struggle. Despite the huge increase in the size of Armies, it was possible to effect great concentrations of troops with a speed which, having regard to the numbers of men and bulk of material moved, has never before been equalled. Strategic and tactical mobility has been the guiding principle of our transportation arrangements; but this was itself at all times vitally affected by questions of supply and by the necessity of providing for the evacuation and replacement on a vast scale of the sick and wounded.

The successful co-ordination and economic use of all the various kinds of transportation requires most systematic management, based on deep thought and previous experience. So great was the work entailed in the handling of the vast quantities of which some few examples are given above, so complex did the machinery of transport become and so important was it that the highest state of efficiency should be maintained, that in the autumn of 1916 I was forced to adopt an entirely new system for running our Lines of Communication. The appointment of Inspector-General of Communications was abolished, and the services previously directed by that Officer were brought under the immediate control of the Adjutant-General, the Quartermaster-General, and the Director-General of Transportation. The last mentioned was a new office created with a separate Staff composed for the greater part of civilian experts to deal specifically with transportation questions. At the same time, the command and administration of the troops on the Lines of Communication were vested in a "General Officer Commanding the Lines of Communication Area."

The huge bulk of the supplies to be handled was due not merely to the size of our Army. It arose also from the introduction of new weapons and methods of war, and from the establishment of a higher standard of comfort for the troops. The incessant demands of the fighting forces for munitions were supplied by the Directorate of Ordnance Services, combined with a great expansion of Ordnance Workshops; while the Directorate of Engineering Stores provided on a vast scale the materials required for the construction of trench defences and kindred purposes. For the comfort and well-being of the troops, the Directorate of Supplies stored and distributed in sound condition fresh food, to take the place as far as possible of tinned rations. Through the agency of an Inspectorate of Messing and Economies, regular schools of cookery gave instruction to nearly 25,000 cooks, and careful measures were taken for the recovery of kitchen by-products. In August, 1918,

over 860,000 lbs. of dripping were received from Armies and consigned to England, while the cash value of the by-products disposed of from all sources has exceeded £60,000 in a single month. Provision was made for baths, and a new Inspectorate supervised the running of Army laundries on up-to-date lines.

The Expeditionary Force Canteens made it possible to obtain additional comforts close up to the front. During 1918, the value of the weekly sales in the different canteens averaged 8½ million francs. These canteens were valuably supplemented by the various voluntary institutions ministering to the comfort and recreation of our troops, such as the Y.M.C.A., the Church Army, the Scottish Churches Huts, the Salvation Army, the Soldiers' Christian Association, the Catholic Women's League and Club Huts, the United Army and Navy Board, the Wesleyan Soldiers' Institute, and the British Soldiers' Institute. In many cases these organizations carried on their work almost in the actual fighting line, and did much to maintain the high moral of our Armies. To permit the troops to avail themselves of the opportunities so offered, methods devised by the Paymaster-in-Chief enabled soldiers to obtain money anywhere in the Field. Parcels and letters from home have been delivered by the Army Postal Service with remarkable regularity.

As the effects of the enemy submarine warfare began to be felt and the shortage of shipping became more and more acute, so it became increasingly necessary for the Army in France to be more self-supporting. To meet this emergency vast hospitals and convalescent depôts capable of accommodating over 22,000 men were erected west of the Seine at Trouville. Additional General Hospitals with accommodation for over 7,000 patients were established in the neighbourhood of Boulogne, Etaples, and elsewhere. Between January, 1916, and November, 1918, the total capacity of hospitals and convalescent depôts in France grew from under 44,000 to over 157,000 persons.

Great installations were set up for the manufacture of gun parts and articles of like nature, for the repair of damaged material as well as for the utilization of the vast quantities of articles of all kinds collected from the battlefields by the organization working under the direction of the Controller of Salvage. The Forestry Directorate, controlling over 70 Canadian and other Forestry Companies, worked forests all over France, in the North-West, Central and South-West Departments, the Vosges, Jura, and Bordeaux country. As the result of its work our Armies were made practically independent of overseas imported timber. The Directorate of Agricultural Production organized farm and garden enterprises for the local supply of vegetables, harvested the crops abandoned by the enemy in his retreat, and commenced the reclamation of the devastated area.

At the same time, a great saving of shipping was effected by the speeding up of the work at the docks. The average tonnage discharged per hour in port rose from 12½ tons in January, 1917, to 34½ tons in July, 1918; while the average number of days lost by ships waiting berth at the ports fell from some 90 ship days per week at the beginning of 1917 to about nine ship days per week in 1918.

For the accommodation of so wide a range of services, installations of all kinds, hutments, factories, workshops, storage for ammunition, clothing, meat and petrol, power houses and pumping stations, camps and hospitals, had to be planned and constructed by the Directorate of Works. Our business relations with the French, the obtaining of sites and buildings, called for the establishment of a Directorate of Hirings and Requisitions; while my Financial Adviser in France assisted in the adjustment of financial questions connected with the use of French railways and harbours, the exploitation of French forests and similar matters. The safe-guarding from fire of the great number of buildings erected or taken over by us and of the masses of accumulated stores was entrusted to a definite Staff under the supervision of a Fire Expert.

The creation and maintenance of the great organization briefly outlined above made big demands upon our available supply of *personnel*. Though these demands so far as possible were met, under the supervision of the Controller of Labour, by imported labour or prisoners of war, it was not practicable at any time to supply more than a proportion of our needs in this manner. Many fit men who might otherwise have reinforced the fighting line had also to be employed, especially during the earlier stages of the war.

As, however, our organization arrived at a greater state of completion and its working became smooth, so it began to be possible to withdraw considerable numbers of fit men from the rearward services. In many cases it was possible, where replacement was necessary, to fill the places of the fit men so withdrawn by women or unfit men. In this way, when the man-power situation became acute a considerable saving was effected. During the great British attacks of 1918, of a total male feeding strength of a little over 2¼ millions 1½ millions were in front of railhead. Even so, as has been found to be the case in the Armies of all other belligerents, so in our Army the number of fit men employed in the rearward services has at all times been large, and necessarily so.

It is hardly too much to assert that, however seemingly extravagant in men and money, no system of supply except the most perfect should ever be contemplated. To give a single example, unless our supply services had been fully efficient the great advance carried out by our Armies during the autumn of last year could not have been achieved.

Wars may be won or lost by the standard of health and moral of the opposing forces. Moral depends to a very large extent upon the feeding and general well-being of the troops. Badly supplied troops will invariably be low in moral, and an Army ravaged by disease ceases to be a fighting force. The feeding and health of the fighting forces are dependent upon the rearward services, and so it may be argued that with the rearward services rests victory or defeat. In our case we can justly say that our supply system has been developed into one of the most perfect in the world.

(20) The preceding paragraph illustrates the demands which the conduct of operations made on the Staff and Directorates controlled by the Quartermaster-General. The parallel development of the Adjutant-General's Branch, while concerned with matters less patent to the casual observer, has been no less remarkable. The problem of ensuring

the supply of reinforcements at the times and places at which they will be required to replace casualties is present in all warfare, and is difficult in any circumstances. In operations conducted on the scale reached in this war it is exceedingly intricate. The successful solution of this problem alone entitles the Adjutant-General and his Staff to the greatest credit. It has formed, however, but a small part of their work.

Owing to the impossibility of foretelling what claims would be made on man-power by industry or by other theatres of war, it was necessary to prepare elaborate forecasts of the *personnel* likely to be required at various dates, and to work out in advance the best manner of utilizing reinforcements in the event of their being available in greater or less numbers. We were faced with an unexpected contraction in man-power in the winter of 1917 and an unexpected expansion in the summer of 1918. Both these developments were encountered with a success which could only have been attained by the greatest forethought and application on the part of the Staff concerned.

To reduce to cadre a depleted Division, to fill it up when men became available, to break up a battalion and redistribute its *personnel*, to comb out a certain number of fit men from the rearward services, all sound simple operations. In reality each requires an immense amount of sympathetic treatment and clerical labour, the extent of the work involved being instanced by the fact that in the month of April, 1918, over 200,000 reinforcements were sent up to the fighting forces. The carrying out of measures of this nature was made more difficult by the continual formation of new types of unit to meet new requirements. It was necessary to find the *personnel* for those units with the least possible dislocation elsewhere, and with an eye to the most advantageous employment of the individual in regard to his medical category and special qualifications. The following figures will give some indication of the magnitude of the task. The Adjutant-General's office at the Base has prepared over eight million records containing the military history of individual soldiers in France, and has received and dispatched over 22 million letters.

Whatever the quality of the troops, a just and efficient administration of military law is an indispensable adjunct to a high standard of discipline. I gratefully acknowledge the care with which officers of the Adjutant-General's Branch in all formations have ensured the observation of every safeguard which our law provides against injustice. They have seen to it that every plea which an accused or convicted soldier wishes to bring forward is heard, and that Commanders are advised as to the suitability of sentences. I take this opportunity of recording my satisfaction at the success which has attended the operation of the Suspension of Sentences Act. The number of men under suspended sentence who by good conduct and gallant service in the field have earned remission of their sentence has been most encouraging.

Closely related to the administration of military law is the work of the military police under the Provost Marshal, and of the military prisons in the field. In the battle zone, where frequently they had to do duty in exposed positions under heavy fire and suffered severe casualties, the military police solved an important part of the problem

of traffic control, by preventing the unavoidable congestion of troops and transport on roads in the vicinity of active operations from degenerating into confusion. In back areas, their vigilance and zeal have largely contributed to the good relations maintained between our troops and the civilian population.

Although the number of soldiers undergoing sentences of imprisonment in France has at no time amounted to 1 per thousand, the size of the Army has necessitated a considerable expansion of the Military Prisons in the field. The Director of Military Prisons, his Governors and warders have sought, not retribution, but to build up the self-discipline of the prisoner. They have been rewarded by seeing a large percentage of the men committed to their charge subsequently recover their characters as good soldiers.

Under the general control of the Adjutant-General, the Base Stationery Depôt, which went to France in 1914 with a *personnel* of ten, has expanded into the Directorate of Army Printing and Stationery Services, employing over 60 officers and 850 other ranks. In addition to the printing and distribution of orders and instructions, it undertook the reproduction on a vast scale of aerial and other photographs, the number of which grew from 25,000 in 1916 to two and a quarter million in 1918. Other examples of administrative success are the Prisoners of War Section and the Directorate of Graves Registration and Enquiries.

Of the care taken for the physical and moral welfare of the troops I cannot speak too highly.

In the former domain, the achievements of the Director-General of Medical Services and his subordinates have been so fully recorded by me in previous dispatches that they need no further emphasis. It is sufficient to say that, in spite of the numbers dealt with, there has been no war in which the resources of science have been utilized so generously and successfully for the prevention of disease, or for the quick evacuation and careful tending of the sick and wounded.

In the latter sphere, the devoted efforts of the Army Chaplains of all denominations have contributed incalculably to the building up of the indomitable spirit of the Army. As the result of their teaching, all ranks came to know and more fully understand the great and noble objects for which they were fighting.

Under the immediate direction of the Adjutant-General in matters concerning military administration, the Principal Chaplain for members of all Churches except the Church of England, and the Deputy Chaplain-General for members of the Church of England administer to the greatest harmony a very complete joint organization. Provided with a definite establishment for armies, corps, and divisions, as well as for the principal base ports, base camps, hospitals, and certain other units, they ensure that the benefit of religion is brought within the reach of every soldier.

In all the senior offices of this joint organization, down to divisions, the Principal Chaplain and Deputy Chaplain-General have each their representatives, the appointments to those offices in the Principal Chaplain's section being apportioned between the different Churches, Protestant and Roman Catholic, in proportion to the numbers of their following in the Army as a whole. This organization has worked for

the common good in a manner wholly admirable and with a most noteworthy absence of friction. It has undoubtedly been much assisted, both in its internal economy and in its relations with commanders and troops, by being at all times in direct touch with the Adjutant-General's Branch.

No survey of the features of the war would be complete without some reference to the part played by women serving with the British Armies in France. Grouped also under the Adjutant-General's Branch of the General Staff, Queen Alexandra's Imperial Military Nursing Service, the Nursing Sisters of the Canadian Army Medical Corps and of the Australian, New Zealand, South African, and Territorial Force Nursing Services and the British Red Cross Society have maintained and embellished a fine tradition of loyalty and efficiency. These services have been reinforced by members of Voluntary Aid Detachments from the British Isles, the Oversea Dominions, and the United States of America, who have vied with their professional sisters in cheerfully enduring fatigue in times of stress and gallantly facing danger and death.

Women in the British Red Cross Society and other organizations have driven ambulances throughout the war, undeterred by discomfort and hardship. Women have ministered to the comfort of the troops in huts and canteens. Finally, Queen Mary's Auxiliary Army Corps, recruited on a wider basis, responded with enthusiasm to the call for drafts, and by the aid they gave to our declining man power contributed materially to the success of our arms.

(21) The experience gained in this war alone, without the study and practice of lessons learned from other campaigns, could not have sufficed to meet the ever-changing tactics which have characterized the fighting. There was required also the sound basis of military knowledge supplied by our Training Manuals and Staff Colleges.

The principles of command, Staff work, and organization elaborated before the war have stood the test imposed upon them and are sound. The militarily educated officer has counted for much, and the good work done by our Staff Colleges during the past 30 years has had an important influence upon the successful issue of the war. In solving the various strategic and tactical problems with which we have been faced, in determining principles of training and handling of troops and in the control and elaboration of Army organization generally, the knowledge acquired by previous study and application has been invaluable. Added to this have been the efficiency and smoothness of working resulting from standardization of principles, assisted in many cases by the previous personal acquaintance at the Staff College of those called upon to work together in the field.

The course of the war has brought out very clearly the value of an efficient and well-trained High Command, in which I include not merely commanders of higher formations, but their Staffs also.

This has been the first time in our history that commanders have had to be provided for such large forces. Before the war, no one of our generals had commanded even an Army Corps such as has been used as a subsidiary formation in the battles of the last few years. In consequence, commanders have been faced with problems very different to those

presented by the small units with which they had been accustomed to train in peace. That they exercised their commands with such success as most of them did shows, I venture to think, that their prior training was based on sound principles and conducted on practical lines.

Similarly as regards the Staff, the magnitude of our operations introduced a situation for which no precedent existed. The Staff Colleges had only produced a reserve of Staff officers adequate to the needs of our Army on a peace footing, and for the mobilization of the Expeditionary Force of six divisions. Consequently, on the expansion of the Army during the war many officers had to be recruited for Staff appointments—from good regular officers chiefly, but also from officers of our new Armies—and trained for the new duties required of them. Though numbers of excellent Staff officers were provided in this way, it was found as a general rule that the relative efficiency in Staff duties of men who had passed through the Staff colleges, as compared with men who had not had that advantage, was unquestionably greater.

Good Staff work is an essential to success in all wars, and particularly in a struggle of such magnitude as that through which we had just passed. No small part of the difficulty of achieving it lies in the possibility that officers on the Staff of higher formations may get out of touch with the fighting forces, and so lose sense of proportion and become unpractical. Every endeavour was made to avoid this by maintaining a constant interchange of such officers with others from the front, so that all might keep abreast with the latest ideas and experience both in the fighting line and elsewhere. In pursuance of this principle, in addition to 18 officers from Army or Corps Staffs and other officers from the Intelligence Corps or General List, there were brought in during the period of my command some 50 officers direct from active duty with divisions or smaller units to hold for longer or shorter periods appointments in the General Staff branch at G.H.Q.

It may be accepted as a general rule that previous organization should be upset as little as possible in war. As each war has certain special conditions, so some modification of existing ideas and practices will be necessary, but if our principles are sound these will be few and unimportant. In the present war, new organizations and establishments for dealing with the demands of both the fighting and the rearward services have been brought into being continually, and added to or absorbed by our existing organization and establishment.

The constant birth of new ideas has demanded the exercise of the greatest care, not only to ensure that no device or suggestion of real value should be overlooked or discouraged, but also to regulate the enthusiasm of the specialist and prevent each new development assuming dimensions out of proportion to its real value. As the result of our own experience and that of the French during the fighting of 1915, all kinds of trench weapons were invented, bombs, bomb throwers, mortars, and even such instruments as trench daggers. In those days the opinion was freely expressed that the war would be finished in the trenches and every effort was made to win victories in the trenches themselves. In consequence, rifle shooting was forgotten and was fast becoming a lost art. Similarly as regards artillery, the idea of dominating and

defeating the hostile artillery before proceeding to the infantry attack was considered an impossibility.

Then followed the experience of the battle of the Somme in 1916, which showed that the principles of our pre-war training were as sound as ever. That autumn a revival of old methods was inaugurated. Musketry shooting was everywhere carried out, and bayonet fighting was taught as the really certain way of gaining supremacy in hand-to-hand fighting. At the same time, as pointed out in paragraph 17 above, the greatest care was devoted to artillery shooting, as well as to the training of all arms for open fighting. The events of the next two years fully confirmed the lessons drawn from the battle of the Somme. In short, the longer the war has lasted the more emphatically has it been realized that our original organization and training were based on correct principles. The danger of altering them too much, to deal with some temporary phase, has been greater than the risk of adjusting them too little.

(22) Some idea of the extent of the organization built up during the war for the training of our Armies can be gathered from a survey of the different schools actually established.

In the Armies important schools were maintained for the instruction of officers and non-commissioned officers of infantry and artillery in their several duties, for training in scouting, observation and sniping, in the use of trench mortars, in signalling, musketry, and bayonet fighting, anti-gas precautions, mining, and defence against tanks. The different Corps controlled a similar series of schools. Added to these were the special schools of the Cavalry Corps, including a School of Equitation; the Tank Corps Mechanical School; and the different courses instituted and managed by divisions, which were largely attended whenever the battle situation permitted.

Other schools under the direct supervision of General Headquarters provided instruction in the machine gun, Lewis gun and light mortar, in anti-aircraft gunnery, in observation for artillery, in sound ranging and flash spotting, wireless, bridging and other engineering duties, in firing and bombing from aeroplanes, and in physical and recreational training. At the Base depôts big training and reinforcement camps were set up for infantry, artillery, cavalry, engineers, machine gunners, cyclists, Tank Corps, Signal and Gas *personnel*. Further, a regular succession of Staff officers and others were sent home to take part in the various schools and courses established in England.

In the course of the past year it was found desirable to make provision for the more thorough co-ordination of effort among these various schools, and also for assisting commanders, especially during battle periods, in the training and instruction of such troops as might from time to time be in reserve. For this purpose an Inspectorate of Training was established. Training and organization must always go hand-in-hand; for while tactical considerations dictate the organization of units and methods of training, upon sound tactical organization and training depend the development and effective employment of good tactics.

In the early spring of 1918 the foundations were laid of an educational scheme which might give officers and men throughout the Army an

opportunity to prepare themselves for their return to civil life. Delayed in its application by the German offensive and the crowded events of the summer and autumn of that year, since the conclusion of the Armistice the scheme has been developed with most excellent results under the general direction of the training subsection of my General Staff branch, and generously supported in every possible way by the Educational Department at home. Divided into a general and a technical side every effort has been made both to give opportunities for the improvement of general knowledge and to enable trained men to "get their hands in" before returning to civil life. In this way between 400,000 and 500,000 persons have been brought under instruction, while the number of attendances at lectures has approached a million in the course of a month.

(23) The feature of the war which to the historian may well appear the most noteworthy is the creation of our new Armies.

To have built up successfully in the very midst of war a great new Army on a more than Continental scale, capable of beating the best troops of the strongest military nation of pre-war days, is an achievement of which the whole Empire may be proud. The total of over 327,000 German prisoners captured by us on the Western front is in striking contrast to the force of six divisions, comprising some 80,000 fighting men all told, with which we entered the war. That we should have been able to accomplish this stupendous task is due partly to the loyalty and devotion of our Allies and to the splendid work of the Royal Navy, but mainly to the wonderful spirit of the British race in all parts of the world.

Discipline has never had such a vindication in any war as in the present one, and it their discipline which most distinguishes our new Armies from all similarly created Armies of the past. At the outset the lack of deep-seated and instinctive discipline placed our new troops at a disadvantage compared with the methodically trained enemy. This disadvantage, however, was overcome, and during the last two years the discipline of all ranks of our new Armies, from whatever part of the Empire they have come, was excellent. Born from a widespread and intelligent appreciation of the magnitude of the issues at stake and a firm belief in the justice of our cause, it drew strength and permanence from a common-sense recognition of what discipline really means—from a general realization that true discipline demands as much from officers as from men, and that without mutual trust, understanding, and confidence on the part of all ranks the highest form of discipline is impossible.

Drawn from every sphere of life, from every profession, department, and industry of the British Empire, and thrust suddenly into a totally new situation full of unknown difficulties all ranks have devoted their lives and energies to the service of their country in the whole-hearted manner which the magnitude of the issues warranted. The policy of putting complete trust in subordinate commanders and of allowing them a free hand in the choice of means to attain their object has proved most successful. Young officers, whatever their previous education may have been, have learnt their duties with enthusiasm and speed, and have accepted their responsibilities unflinchingly.

Our universities and public schools throughout the Empire have proved once more, as they have proved time and again in the past, that in the formation of character, which is the root of discipline, they have no rivals. Not that universities and public schools enjoy a monopoly of the qualities which make good officers. The life of the British Empire generally has proved sound under the severest tests, and while giving men whom it is an honour for any officer to command, has furnished officers of the highest standard from all ranks of society and all quarters of the world.

Promotion has been entirely by merit, and the highest appointments were open to the humblest provided he had the necessary qualifications of character, skill, and knowledge. Many instances could be quoted of men who from civil or comparatively humble occupations have risen to important commands. A schoolmaster, a lawyer, a taxicab driver, and an ex-Sergeant-Major have commanded brigades; one editor has commanded a division, and another held successfully the position of Senior Staff Officer to a Regular division; the under-cook of a Cambridge College, a clerk to the Metropolitan Water Board, an insurance clerk, an architect's assistant, and a police inspector became efficient General Staff Officers; a Mess Sergeant, a railway signalman, a coal miner, a market gardener, an assistant secretary to a haberdasher's company, a Quartermaster-Sergeant and many private soldiers have risen to command battalions; clerks have commanded batteries; a schoolmaster, a collier, the son of a blacksmith, an iron moulder, an instructor in tailoring, an assistant gas engineer, a grocer's assistant, as well as policemen, clerks, and privates, have commanded companies or acted as adjutants.

As a body, and with few exceptions, new officers have understood that the care of their men must be their first consideration, that their men's comforts and well-being should at all times come before their own, that without this they cannot expect to win the affection, confidence, loyalty, and obedience of those they are privileged to command, or to draw the best from them. Moreover, they have known how to profit by the experience of others, and in common with their men they have turned willingly to the members of the old Regular Army for instruction and guidance in all branches of their new way of life.

On their part, officers, non-commissioned officers, and men of the old Regular Army have risen to the demands made upon them in a manner equally marvellous. Their leaven has pervaded the whole of the mighty force which in 4½ years of war has gathered from all parts of the world round the small, highly trained Army with which we entered the war. The general absence of jealousy and the readiness to learn, which in the Field has markedly characterized all ranks of our new Armies, is proof both of the quality of our old Army and of the soundness of our pre-war training. If further proof were needed, it is found in the wonderful conduct and achievements of our Armies, new and old, and in the general pride with which they are universally regarded.

In the earlier stages of the war the Regular Army was called on to provide instructors and cadres round which the new Armies could be formed. All that was best in the old Regular Army, its discipline,

based on force of character, leadership, and mutual respect, its traditions, and the spirit that never knows defeat have been the foundations on which the new Armies have been built up. Heavy demands were necessarily made upon our establishment of trained Regular officers, most regrettably depleted by the heavy sacrifices of the early days of the war. The way in which such demands have been met by those who survived those days has justified our belief in them.

Neither have the officers of the new Armies, whether drawn from the British Isles or the Dominions, risen with less spirit and success to the needs of the occasion. The great expansion of the Army, and the length of the war, necessitated an ever-increasing demand being made on them for filling responsible positions in command, staff, and administrative appointments. The call has been met most efficiently. The longer the war continued, the greater became the part played in it by the new Armies of the Empire.

NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 1.—January, 1919.

(Continued).

THE BELGIAN VICTORY IN FLANDERS.

An account is given in the original article of the operations of the Belgian Army during the period 28th September—30th October, 1918.

July 18, 1918, will ever remain memorable in the history of the world; it was the date whereon the new strategy of Marshal Foch caused the tide to turn on the Western Front, whereby the wave of the Hun invasion was rolled back beyond the limits of the Rhine; on that day was launched the first of a series of pushes, on the extended battle line stretching from Amiens to St. Mihiel, pushes which eventually freed northern France and Belgium from the enemy after an occupation of four years and more.

Taken by surprise, the German High Command was now obliged to sacrifice a great part of the reserves and the élite of the German army, and, almost simultaneously, the opportunity was seized by the Entente troops to recommence active hostilities on the Flanders Front, whereon comparative calm had reigned since the great German push of April, 1918.

The Belgian Army, which had checked the enemy, on the 17th April, on the Merckhem front, inflicting terrible losses on him, had impatiently waited for the hour when it would be its turn to advance to the attack. When this hour arrived, the enthusiasm of Belgian troops enabled them to accomplish great deeds, the importance whereof is attested by the following events:—The recapture of the "Crête de Flandres"; the recrossing of the Yser; the re-occupation of the coast line.

On the 28th September, the Belgian Army and the 2nd British Army was launched to the attack on the front Dixmude to the Lys; three French Divisions and a Cavalry Corps were in support of the Belgian Army, and, a few days later, joined in the attack.

These combined forces formed a group of Armies under the immediate command of King Albert.

The operations, in which the Belgian Army took part, may be said to have consisted of two phases: the Battle of the "Crête de Flandres," which began on the 28th September and ended on the 4th October: a complete lull then occurred for the space of ten days, after which, on the 14th October, the troops were again launched to the attack and the "Battle of Thourout-Thielt" followed.

A short account of the Battle of the "Crête de Flandres" is given in the original article; it is illustrated by a sketch map whereon the six defensive lines successively taken up by the Germans, between Dixmude and Ypres, are marked. During the four years of their occupation of this region the Germans had done a great deal to strengthen the positions held by them. But, in spite of the obstinate defence put up by the invaders, they were driven out of these positions. Some 6,000 prisoners were taken, including about 100 officers; further, 1,250 guns, 300 machine-guns and a great quantity of ammunition and stores were also captured by the Belgians during these operations. Between the 28th September and the 2nd October, nine German Divisions had successively attempted to oppose the advance of the Belgians, who, however, had now had their enthusiasm raised to so high a pitch by their first success that, in spite of their heavy losses, they were determined to punish the hated oppressors of their countrymen. The Belgians realized too that the liberation of their country was now in sight, and they therefore continued to push forward with added zest.

The Women's Army Auxiliary Corps.

The author of the original article points out that the generally accepted principle upon which the Swiss Army is recruited is based on the generalization that every Swiss is liable for military duty according to his aptitude and in such a sphere that the maximum effort can be developed by the nation in strategical and tactical operations. Similar principles apply in the recruiting of all armies, but nowhere has the principle been ever pushed to such extremes, it is said, than was recently the case in the British Army. In order to permit of the greatest effort in the fighting line, by putting every man fit to shoulder a rifle in the ranks, the British High Command has not hesitated to organize a Corps of Women.

The number of the *Revue de Paris* for 1st August, 1918, contains, it is pointed out, an interesting article on the W.A.A.C. by Mme. Andrée Viollis. A summary of the article in question is given in the number of the *Revue* under notice.

Notes and News.

Switzerland.—The Federal Chamber is still considering the question of reducing the military estimates. Apparently, one of the directions in which it is hoped to effect an economy is by the postponement of the embodiment of the recruits of the 1919 Class. The recruits of the 1918 Class, who had to be demobilized on account of the influenza, will, however, be called up to complete their course of instruction. It is suggested that the Army of the future should not be destroyed until there are sure grounds for the view that it will never be wanted. Europe, at the dawn of 1919, does not present the spectacle of being peopled by races in a frame of mind fit to bring into existence the organization known as the "League of Nations." Go slowly in the matter of military reform, is the advice given by the contributor of the original notes.

Attention is called to a brochure entitled *Wilson en Europe* recently published in Geneva; it apparently contains an attack on all who are

not prepared to accept unreservedly the proposal relating to the establishment of a "League of Nations." The "League of Nations," it is pointed out by the contributor of the original notes, will have to undertake police duties and, in consequence, an armed force of some kind will have to be maintained by it, since it may become necessary, as a last resort, to occupy the territories of a Power, should it prove impossible, in the future state of existence of the idealist, to determine a dispute or difference, in which such a Power is involved, by arbitration. History provides many examples of the manner in which the spirit of an international contract may be broken, whilst the letter thereof is strictly observed, *e.g.*, Prussia's agreement with Napoleon, after Jena in 1806, to the effect that she would only maintain a standing army of 30,000 men for the purposes of maintaining internal order; yet when the War of Independence began in 1813, she had in reserve seven classes of trained soldiers which were at once incorporated into her standing army. The most recent example of the worthlessness of international contracts lies in the repudiation by Germany of the provisions of the Hague Conventions, as soon as she realized that she had absolutely no chance of obtaining a complete and conclusive victory on the Western Front.

Switzerland's duty at the present time, says the contributor of the original notes, is to take care that, in military matters, the cart is not put before the horse. Pacifism is a magnificent ideal, but the moment it becomes morbid the result is war.

The present situation is that a formidable army, that of Germany, which menaced the world for years, has disappeared, and with it the military forces of Austria-Hungary, Turkey and Bulgaria. On the other hand, it is pointed out, Great Britain and the United States of America, which previous to 1914 were naval Powers only, now possess formidable armies also. Hence the tilt in the beam of the balance has been reversed, the Anglo-Saxon peace weighs heavier than the peace of defeated Germany. What has happened is that the dominating Power of yesterday has been replaced by that of the morrow; history repeats itself.

Colonel Schlappach has succeeded to the command of the Swiss 3rd Division *vice* Colonel Gertsch.

The number of the *Revue* under notice concludes with a Bibliography; particulars of a number of works on military subjects are given therein, including Colonel Feyler's recent work *Le problème de la guerre*.

No. 2.—February, 1919.

THE NEED FOR MAINTAINING AN ARMY IN SWITZERLAND.

The original article is contributed by Colonel C. Sarasin, Commander of the Swiss 5th Infantry Brigade, who points out that the Swiss Army is passing through a critical era in its existence. Those who are attacking it, he points out, see in the Swiss Army an instrument essential to the maintenance of good order in the State; the last thing desired by the calumniators of the army. The real danger arising out of the present situation is the effect that the agitation is likely to have on the minds of the young men in the Republic; the youth of Switzerland, Colonel

Sarasin tells us, has to-day a totally different conception of its duty towards the defence of the State to that which prevailed in his boyhood. Anti-militarist theories are based on grounds which, to some extent no doubt, are idealistic, but the disinclination to serve in the army is due chiefly to the mischievous theory that every man should be free to choose for himself what authorities he shall obey and what calling in life he shall adopt. If human nature were perfect and altruism could be made to replace egoism in human relations, all armed forces would, Colonel Sarasin points out, become superfluous. But in spite of all the talk about the formation of a League of Nations, the human race has still to journey thousands of leagues before it can enter the ideal world. Colonel Sarasin is of opinion that in a democratic country such as Switzerland, it is impossible to think of civic duty as something apart from military duty He urges that Switzerland shall not only continue to maintain her army, but that this army shall be made fully capable of carrying out all the duties likely to be imposed upon it.

Colonel Sarasin suggests that if the Government considers it necessary to cut down military expenditure, the best way of doing so would be to reduce the establishments of the " first line troops " by eliminating from the battalions that which is of smallest value ; he further recommends, in effect, that the infantry battalion should consist of three companies and a M.G. detachment.

The importance of military training is touched upon in the original article, and it is urged that the value of the experiences gained during the mobilization of the Swiss army from August, 1914, to December, 1918, should not be lost sight of. The best equipped army, it is pointed out, is worthless unless it is at the same time well trained.

Attention is called to an article in the *Schweizerische Militärzeitung* (No. 43, of 1917). It is stated in the article in queston, *as a regrettable fact*, that the subaltern officers of the Swiss army do not possess the qualities required in the leaders of men. Colonel Sarasin is of opinion that although matters have recently improved considerably in the leadership shown by officers, there is still much room for improvement ; he gives his views as to the directions in which remedies can be applied.

The deficiences of the N.C.Os. are also dealt with in the original article and suggestions are made for improving their position and prospects.—(*To be continued.*)

The Belgian Victory in Flanders.

The article on the above subject begun in the number of the *Revue* for January, 1919, is continued. An account is given of the Battle of Thourout-Thielt ; a sketch map being provided whereon are marked the successive positions taken up by the Belgian Army between September 28th and October 18th, 1918.

It is pointed out that after the serious defeat which the German army experienced during the last days of September, 1918, when it was driven out of the strong positions held by it on the Crête de Flandres, it sought refuge in the Flandern I Stellung covering Roulers, a position which had been prepared for defence long beforehand. The Belgian

General Staff realised on October 2nd that the enemy had made arrangements to defend the Flandern I Stellung *à outrance* and it had, in consequence, issued the necessary orders for the massing of troops, particularly of artillery, for a fresh general attack. As a preliminary measure it became necessary to re-establish communications by road and rail in this devastated region, since the enemy, as soon as hi retreat began, had destroyed most thoroughly all roads and railways in this locality. The troops had now to begin a fight against the Flanders mud which rendered movements of all kinds extremely slow and painful. Thanks to the efforts of the engineers and the labour battalions, railways were once more restored, roads began to come into existence, bridges were constructed over rivers, canals and even shell-holes. The prodigious efforts and untiring zeal of the troops of all arms produced within a few days most remarkable results.

The work on communications which had to be carried out rendered it necessary to postpone the date for opening the second battle for the liberation of Flanders, to October 14th. The success of the Entente troops in the Battle of Thorout-Thielt was so complete that the enemy had at last to give up possession of the Belgian coast and retired westward, thus freeing the whole of Northern Flanders and a great part of Eastern Flanders.

In the original article an outline is given of the general scheme of the Battle of Thourout-Thielt; the events thereof are related under the several dates, October 14th to October 19th; the narrative being brought to a close with a brief reference to the final operations which began on October 20th and ended on November 11th—the date on which the armistice was signed.

The Defeat of the German Army.

The original article on the above subject is contributed by Colonel Feyler, who directs attention to a curious discussion which has been taking place in military circles in Switzerland. The discussion seems to have started owing to the opinion having been expressed that "at the date of armistice, November 11th, 1918, the German army had been beaten *morally*, but not technically."

"This debate," writes Colonel Feyler, "contains matter of greater interest than does the quarrel of the Byzantine coachmen, although from the practical standpoint, there is as little real sense in it."

It is pointed out in the the original article that subtle distinctions in the degree and quality of a defeat possess no practical value. The aim of strategy is to compel an enemy to bow to his adversary's will; that is to say, to cause an enemy to accept unconditionally the measures dictated to him by his adversary and to conform to the same When beaten generals are reduced to accepting a situation imposed by the will of their adversary, it matters little what may be the extent and quality of the technical resources still in the possession or at the disposal of their army. They renounce, by the acceptance of their adversary's terms, the use of such resources, which they virtually admit have lost all military value.

Many instances are recorded in history of armies which, although

still capable of fighting, have laid down their arms at the bidding of their generals. But it does not follow that generals who take so extreme a step as to surrender are either traitors or incompetent or immoral. Colonel Feyler gives his views as to the probable meaning of the expressions "*not technically* beaten"; it applies, he thinks, to an army which is still in possession of the means which enable it to manœuvre with sufficient freedom to ward off immediate defeat or surrender. He explains that if his assumption as to the meaning of the expression "not technically beaten" is correct, *i.e.*, that which its authors intend it to convey, very few armies have suffered defeat either in the Great European War or in the long history of the Wars of past ages. He deals with the various operations of the Great War and points out that, if his interpretation of the expression in question is correct, only the armies of Samsonoff and Rennenkampf in East Prussia and the Ottoman hosts, in Palestine, have really suffered defeat. The subtleties in the distinctions which the authors of the phrase "not technically beaten" wish to introduce in the quality of defeat, if generally accepted, would render it necessary for the whole of the military history of the world to be re-written; the Germans would have to be deprived of the credit given them for victories at Forbach, Rezonville, St. Privat, &c.; Napoleon I. could no longer be hailed as the victorious general of Austerlitz and Jena, &c.

Colonel Feyler points out the absurdity of the distinction which it is attempted to make between the *moral* and the *technical* defeat of an army He examines the situation which led the Germans to ask for an armistice in November and shows conclusively in what a hopeless condition the German armies were. At the date of the armistice, the Central Powers had only 17 divisions in reserve, of which two only were resting. On the other hand, the Entente and Associated Powers had 30 divisions in Lorraine, under the orders of Generals Mangin and Gérard, which could have been utilized for an attack east of the Meuse on November 14. In addition the American Third Army was ready to take its place in the front line. Warned that a French attack was imminent in Lorraine, the Germans had already ordered the evacuation of Metz and Thionville to begin on November 11. During the four months, July 18 to November 11, the Entente Powers had given the Germans battle on an extended scale on more than twenty occasions, and not in one of them had the latter scored a success. In view of the fact that to all outward appearances the German armies had up to this moment seemingly possessed solidity and resisting power and remained, in a technical sense, well organized their want of success was significant and is alone attributable to the excessive fatigue of the German soldier brought about by the undue strain put upon him.

The Germans had been obliged to surrender all the ground won by them in the first half of 1918 and were back again in the positions on which they had met the powerful attacks of their enemy for many long months in the earlier years of the war. It may be that the German High Command now made the serious mistake of staking everything on the *technical* equipment of its army. The Great General Staff did not dare to adopt the strategy which had proved so successful in the

hands of Marshal Joffre, in 1914, when he took the bold course of temporarily abandoning Northern France and even giving up his second line of defence on the front La Fere—Laon—Rheims. It may be that the German leaders were afraid of their people; they perhaps realized that if the German military measures conformed to the requirements of the strategical situation the German nation would at last be undeceived and they probably foresaw the consequences.

The Germans made a further mistake in placing so much reliance on the strength of the "Hindenburg Line." A *resumé* of the operations which resulted in the Germans being driven out of their positions on the line Verdun—Rheims—Soissons—Lille—the coast west of Ostend, is given in the original article; three sketch maps accompany the text.

Colonel Feyler, in conclusion, points out that, in military matters, it is the fundamentals that alone count, the rest must be ignored. In the case of the Western Front, the chief feature of the situation was that the German army had been greatly reduced in numbers, equipment and *morale* by four months of retreat and continual defeat, so that its leaders could no longer count on manœuvring it into such a position as would enable them to ward off eventual defeat. A retreat to the Rhine would have probably involved the loss of a great part of the German army; to avoid this catastrophe, the German High Command had no other course open to it but to ask for an armistice, the terms of which, when made known, it was not in a position to resist and to which it, therefore, had to agree unconditionally.

NOTES AND NEWS.

Switzerland.—The military budget for 1919, as revised by the Federal Council, has been accepted by the Federal Council. The Swiss military budget for 1914 was approximately 9¼ million francs; that for 1919 amounts to 38½ million francs.

The question of the Swiss army of the future is discussed. To point a moral, it is stated that the exclusively insular and colonial policy which has prevailed in the British Isles for many centuries past, nearly ended in a disaster for the British nation; her Expeditionary Force of 1914 was quite inadequate to meet the situation of August, 1914. Thanks to the existence of the conscript army of France, time was gained and the British people were thus enabled to build up its new army. Switzerland should take the lesson to heart. Further, it is suggested that if Switzerland entered the League of Nations as a neutral State, it would be necessary for her to maintain an army proportionate, in relation to her means, to those of the other members of the League.

The present Chief of the Swiss General Staff, Colonel-Commandant de Sprecher is retiring from his post shortly. It is urged that his successor should be an officer who has the entire confidence of all sections of the Swiss army. It is recommended that a clean cut should be made with the old *régime*. ¶ The *Société des Officiers* in Berne have addressed a request to the *Comité Central de la Société des Officiers* for a meeting to be called for the purpose of drawing up a programme of subjects for discussion during the current year. The Lausanne sub-section of

the *Société des Officiers* is supporting the request made from Berne. It would appear that the officers in Berne are interested more particularly in political questions such as disarmament, neutrality, compulsory service, etc., whilst those in Lausanne, on the other hand, desire precedence to be given to purely military questions, such as military training, education of officers, &c. These conflicting claims have to be adjusted.

Portugal.—A special correspondent states that the Portuguese troops which have been fighting on the Western Front are to form part of the "Army of Occupation" to be maintained by the Entente Powers in the Rhine provinces.

The Portuguese are much gratified by the visit of the British cruiser *Active* to the Tagus; they see in this visit a manifestation of the continuance of the ancient friendship of the two nations. During the war the Portuguese losses at sea, due to the U-boat warfare, amounted to two small ships of war, 33 steam-ships, 48 sailing-ships, and several fishing and coasting boats; representing in all a loss of 93,500 tons.

The first batch of Portuguese prisoners of war have been repatriated; they, like other prisoners, complain of the ill-treatment suffered by them at the hands of the Germans.

International News.—The contributor of the notes under this head points out that the diplomatic situation in Europe should clear up in March of this year, when it should become evident which nations are sincere in their desire for peace and which the nations are on whom peace must be forced. The armies of the Entente powers will, he says, have a quiet time during the winter, but the armies of the League of Nations should be ready for a campaign against the "recaltricants" in the coming spring-time.

The contributor of the notes classifies the "recaltricants" in three categories: (1) the Central Powers; however, their defeat was so serious that they are not likely to be a dangerous adversary next spring; (2) Russia and the several states which came into existence on her disruption; the attitude of the Russians towards the Entente, particularly in relations to the proposed meeting at Prinkipo, indicates that they prefer the present state of anarchy to continue rather than see peace restored in their country; and (3) malcontents in the camp of the Entente powers. There are people in the foregoing categories who, it is suggested, will only yield to force and the League of Nations must be prepared to act accordingly.

Arbitration, though a simple remedy in theory, is a most difficult one to put into practice. War as a mode of settling international quarrels is not likely, it is said, to be abolished as a result of the labours of the Paris Conference nor in the year of grace, 1919. There are, it is pointed out, approximately 40 millions of neutrals in Europe: Spaniards, Scandinavians, Dutch and Swiss; they have enjoyed the benefits of peace, but they have maintained and are maintaining armed forces, well equipped and well trained. It is suggested that the neutral powers should place their armies at the disposal of the League of Nations for the purpose of garrisoning the territorities, the possession of which is now being contested at the Peace Conference.

No. 3.—March, 1919.

THE NEED FOR MAINTAINING AN ARMY IN SWITZERLAND.

The article by Colonel Sarasin on the above subject begun in the February number of the *Revue* is concluded in the number under notice. The training and education of the man in the ranks is dealt with in this part of the article. Colonel Sarasin states that in order to decide what is the best kind of training which should be provided for the soldier, it is first necessary to ask one's self: what are the qualities looked for in the soldier? He sets out, under five heads, his answer to this question, as follows: (1) A soldier should be loyal, well-disciplined and brave; (2) he should possess habits of orderliness, cleanliness and smartness; (3) he should be strong and active; capable of making long marches, of getting over obstacles and of throwing hand grenades to a good distance and with accuracy; (4) he should be a good marksman; and (5) he should be a man of intelligence, capable of acting on his own initiative, whenever engaged on detached duties or under circumstances requiring personal decisions.

The time available for obtaining the multiple results stated above are, says Colonel Sarasin, all too short, and therefore the best use must be made of it. Of the five heads enumerated, which constitute the indispensable qualifications of a soldier, particularly that of the infantryman, the first two are essentially dependent upon the moral qualities of the man.

Colonel Sarasin deals with the rôle which officers, particularly the subalterns, ought to play in developing the soldiers' moral qualities. The subjects of drill, gymnastics, bayonet exercises, rifle practice and the part each should play in the training of the soldier are touched upon in the original article.

In conclusion, Colonel Sarasin expresses the opinion that (1) the Swiss National Army should be recruited on the basis of *compulsory* military service; it is the duty of the heads of the Republic to make the necessary provision for the proper training of such an army and of finding it in up-to-date arms and equipment; (2) an absolute necessity exists for increasing the personal authority of officers of all grades over the rank and file; in consequence, officers must be more closely associated with the training of their men than heretofore; (3) the selection of men for non-commissioned rank and their training subsequent to appointment should be left to a greater extent than at present in the hands of the officers commanding the various units; and (4) the methods of training recruits and the men in the ranks should be entirely remodelled; every element of a vexatious nature should be entirely eliminated from the scheme of training.

Colonel Sarasin urges that every officer and every military society or institution in Switzerland should interest himself or itself in the great patriotic work of bringing about reforms which are urgently wanted in the Swiss Army.

W. A. J. O'MEARA.

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